One World

Economics for the Citizen

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Introduction

The residents of Europe probably had no idea that an historic epoch was starting with the dawn of the industrial revolution. But science, and the mechanization of agriculture and manufacturing, gave rise to a snowballing increase in output and growth of the human population, especially in the last century. It took 1,600 years for the world's population to double from 300 million in the year one thousand to 600 million in 1700. By 1900 the population had doubled again to 1.3 billion and then it exploded. Today, in 2023, the human population of the earth is 8 billion and growing.

At the same time, and enabling this growth, there has been an enormous increase in the productivity of agriculture, goods production, and services. As COVID demonstrated vividly, the easy flow of investment capital and dramatically lower costs of shipping have knitted the world together economically, each country is a player in this larger interdependent economic system.

Finally, all this human productivity and population growth are causing a warming of the climate at a speed almost unprecedented in earth's history. Human dominance of the globe is now so complete that some geologists have named this the Anthropocene Epoch: the age of humans.

Globalization is certainly not an undiscussed phenomenon but the degree to which it has accelerated, and the profoundness of its impact is perhaps not fully appreciated. At the same time, what has been called the Fourth Industrial Revolution, is reshaping our human world: we can now automate processes that were not possible without the computer, robotics, and machine learning. And finally, we are running up against the limits of what the earth can support in terms of human population and activity.

To be honest, I drafted this book because I realized I did not have a big picture of the current state of the world economy and where it is headed. It has been a voyage of discovery. There are excellent sources online and in print that present data and analysis on specific topics, but it is still quite a chore to get from these detailed studies to a complete canvas. Along the way you may find yourself as surprised as I often was.

- Worldwide, import and export trade is about 50% the size of a country's total economic activity, also called GDP. Even in the US, imports and exports combined are about 25% the size of GDP.
- Agriculture in the US employs less than 1% of the population directly, and accounts for less than 1% of GDP despite producing twice as much food on less land as in 1960.
- About 80% of US workers are employed in the "service sector", as manufacturing is increasingly automated. Manufacturing employment percentage is declining in all "advanced economies" and even in China which is a manufacturing powerhouse.
- Getting to "net zero" in greenhouse gas emissions is a political problem, not an economic problem. It would take a surprisingly small investment as a percentage of GDP and could be financed over time with a substantial payoff.

- The United States hosts the largest number of migrants in the world, about 46.6 million in 2015, or about 14.5% of the population, but other wealthy countries, such as Canada, Australia, and Germany host more migrants as a percentage of their populations.
- China had almost balanced trade in 2019, with a net trade surplus of only 0.7% of GDP.
- Foreigners own about 40% of US stocks compared to the 30% of US stocks which are held in domestic retirement accounts.
- Accounts in the Cayman Islands, population 68 thousand, own more US Securities than does China, population 1.4 billion. The Caymans is only one “tax shelter” country.
- Which states do you think had the largest initial job losses from increased trade with China? California followed by Texas. Hardly basket cases.
- In 2019, US personal income was $56,616 per person (men, women, children, and the elderly) in the US, or $177,774 for a statistical family of 3.14 persons.
- Many of the largest US companies are privately held. That includes Mars, the candy company, Publix supermarkets, Enterprise rental, and Cargill an agriculture and food company with $165 billion in revenue.
- Most of the billionaires in the US and overseas come from middleclass or poor families.
- Wind and solar are now the cheapest ways to generate electricity.
- Studies indicate that automation has caused far more manufacturing job losses than trade. In fact, the US manufactures more now than ever, but with far fewer people.

These interesting facts emerge from the chapters on productivity, trade, and migration which form the big three of globalization, as well as the chapters on income and wealth distribution both within countries and between them. Human dominance of the planet also requires us to look at the ability of the earth to support our continued increasing consumption and waste, so there is a chapter focused on the economics of sustainability issues.

One cannot discuss any of this without a basic economic framework. Fortunately, economic principles can be explained in common sense terms, no complicated mathematics required. Part I of this book covers the basics of modern economics, which, depending on your level of comfort with the subject, you may choose to skip or quickly review.

Part II looks at data to try to paint the big picture of the economic world and how it is changing.

Finally, in Part III we summarize and consider what the future holds and how we could address issues such as income inequality and sustainability through economics.

Part I - An Economic Primer

The basic concepts of economics are not hard to understand because they (mostly) agree with common sense, but together they create a powerful framework for comprehension. Almost all economists across the political spectrum subscribe to the same basic economic concepts even though they may argue about priorities, policy, data and data interpretation, and many detailed economic mechanisms. This primer covers the basics of “free market” economics with emphasis on how productivity changes, trade, and immigration impact workers. No higher math is required!

Free Markets, Demand and Supply

Markets

Markets have been around since the earliest days of human civilization, having existed in ancient Babylonia, Assyria, Phoenicia, Israel, Greece, Egypt and elsewhere. Some towns had market days while cities often had permanent marketplaces. Many cities still have markets like the ancient bazaars: dense alleys crowded with merchants often grouped by what they sell: fish sellers here, clothing sellers there. The ancient world also had extensive networks of trade: the Silk Road from China to the Middle East, Phoenician traders sailing the Mediterranean, caravans across the Sahara.

Over time markets in many places became more regulated with charters and standardization of weights and measures and coinage allowing for easier comparison shopping and confidence.

We all have a pretty good idea of what constitutes a marketplace: a physical, or more recently virtual, trading venue where sellers offer goods and services and buyers shop for these goods and services.

What makes a market a “free market”? The market has to be open to all sellers and buyers, these sellers and buyers have to be free to decide what they want to make, and finally the sellers and buyers have to be free to decide at what price they will buy and sell any particular item.

It is important to note that the definition of a free market doesn’t just require that there be a free marketplace: it is not just trade that has to be free, but also the decision of what to produce and buy in the first place.

Governments can help facilitate free trade and markets through regulations such as the ones already noted which include a standard, well-regulated currency, standardized weights and measures, and many others such as requiring accurate labeling of products.

How Pricing Works in a Free Market: Supply and Demand

In a free-market buyers looking for a product, be it a bushel of corn or an industrial robot, shop around for the best combination of price, features, and quality. If there are many suppliers of the same product, the supplier must sell at the same price as the others. This is the “market price”, which is the price buyers are willing to pay for the item. But what if the buyers don’t want to pay the price the suppliers want? The actual price at which buyers and sellers get together is determined by what economists call the “law of supply and demand”. The best way to illustrate it is through diagrams. Let’s start with the buyer side of things.

The Relationship of Demand to Price

Let’s suppose you’ve gone to the store and are considering buying broccoli. Your decision is going to be influenced by how much you want the broccoli[1] and how much it costs. If it costs a lot, you might buy less of it or not buy it at all. Someone else who really likes broccoli might be willing to pay more for it than you would. Adding up how much broccoli everyone will buy at any specific price gives the “demand curve” for broccoli which might look something like this:

[1] In economics “how much you want something” is called its “utility” to you. Since you have a given income, you will balance how much you buy of anything so that you are not giving up even more “utility” by not using that money to buy something else. By your balancing act you are assumed to “maximize your utility” given your preferences and income. Your demand for any item at a given price reveals how important it is to you (its utility to you).

Figure 1 hypothetical demand curve for broccoli.

In this chart we see that if the price of broccoli is $1.25 per pound, people would buy about 5 million tons of the stuff.

The demand curves for different products have different shapes. For some products, such as broccoli, there are many other vegetables one can buy, so demand for broccoli is sensitive to price. Other products, such as gasoline, don't have alternatives in the short run. If you want to drive your car, you need to buy gasoline. So, the short-term demand curve for gasoline slopes down only slightly. Again, some people with limited budgets will have a more downward sloping demand curve: as prices go up, they will have to cut back on driving. Rich folk will probably not cut back much or at all.

The demand curve relates the price of an item to how much of it gets sold. The actual price at which a product is sold, broccoli in this case, and the quantity of it produced depends on another curve, the supply curve.

The Relationship of Supply to Price

The amount of a good or service produced also depends on price. Clearly if the market price is less than the cost of production, suppliers will stop producing the item and the quantity available will drop. Eventually the quantity will become low enough that a shortage is created, and buyers will have to pay more. If, on the other hand, the price of the item is higher than the cost of

production plus a reasonable profit, suppliers will increase output (or new suppliers will jump in) causing the price to drop.

It should be noted that short run supply curves are fairly flat: it takes time to ramp up production. Historically this was an issue in farming. Good prices this year caused farmers to grow more the next year causing a glut and lower, sometimes disastrously lower, prices the next year.[2]

Let us take a look at a hypothetical long term supply curve for broccoli:

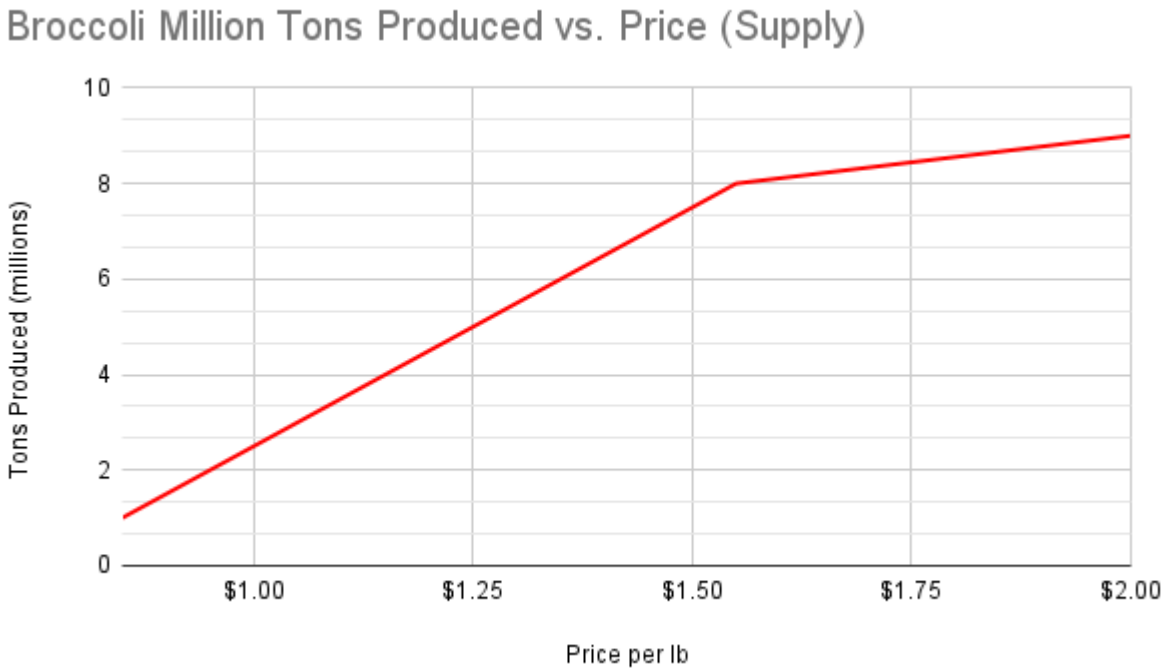

Figure 2 Hypothetical supply curve for broccoli.

Here we see that farmers will grow more broccoli as the market price increases. Some farmers will have fields and climates that are particularly suited to growing broccoli and their cost to produce it will be low. As the price goes up, other farmers with less productive fields will be able to cover their costs of production profitably and will turn to growing broccoli. Most supply curves tilt upward like this.[3]

How do we know what the supply and demand curves for a particular commodity are? We find that out from actual experience. If Broccoli costs so much, so much of it is sold (this is demand at that price) and so much of it is produced (supply at that price). Let's plot both demand and supply curves on the same chart:

[2] Various farm programs were developed to address the problem of agricultural overproduction including incentives for farmers to take land out of production in some cases.
[3] There are exceptions of course. For example, some sections of a demand curve may tilt down due to economies of scale: making things in large quantities can lower the cost of production.

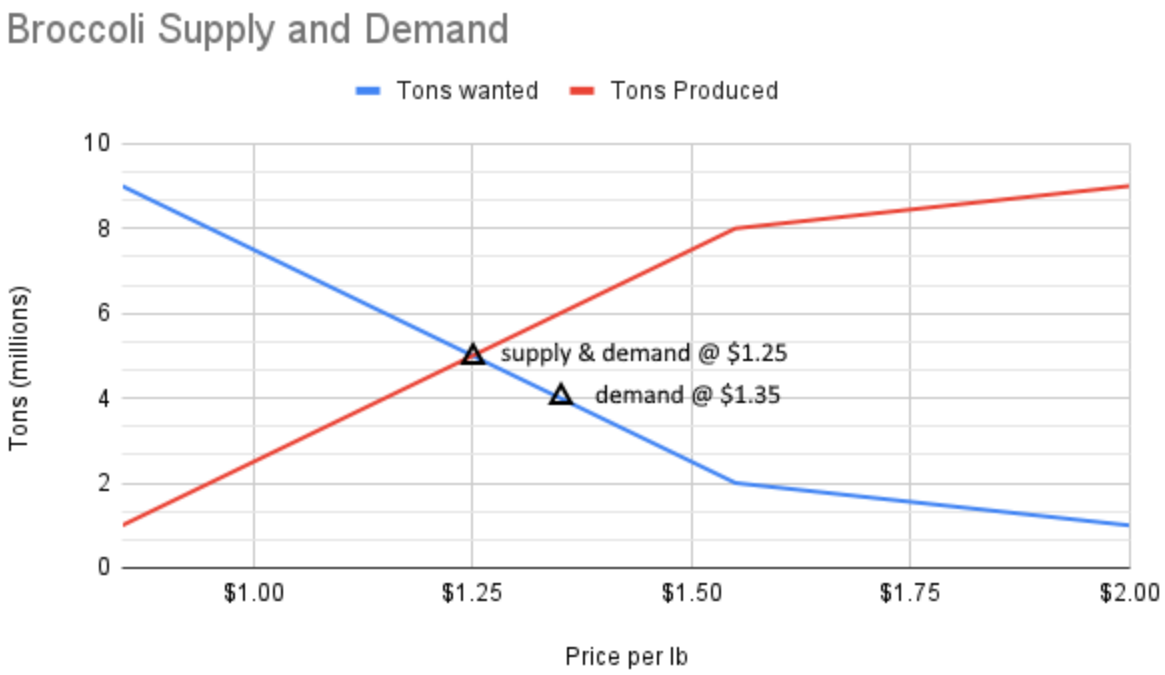

Figure 3 Broccoli Supply and Demand

When we plot both curves together, we see that the amount of broccoli people want to buy exactly matches the amount (in the long term) that suppliers will produce when the price is $1.25 per pound. At that price producers will grow, and consumers will buy, 5 million tons of broccoli. If farmers grow less than that amount, then the supply will be less than 5 million tons. Due to the lower supply, there will be an excess of demand over supply, and prices will rise. Farmers will be able to raise prices until demand is reduced and supply and demand meet again. For example, if supply drops to 4 million tons (say due to a drought), prices will go up to around $1.35 as shown because enough people will be willing to pay the higher price. At $1.35 demand will equal supply. This new higher price of $1.35 will encourage farmers to grow more broccoli the next year which will cause prices to drop. Eventually, over time, the equilibrium price and quantity of $1.25 is approached[4].

Note that this balancing of supply to meet demand, given production costs, is automatic in an ideal free market economy and is achieved through market pricing. A recent example is the shortage of face masks at the beginning of the COVID epidemic. The price of masks went sky high as demand greatly exceeded supply. This caused a large increase in mask manufacturing over time, and a consequent lowering of prices. As this example shows, it takes a while for

[4] With many producers and imperfect information, the match between supply and demand is actually not so precise. In agriculture, there can be fluctuations due to droughts for example. Also, if the price one year is high, farmers may grow too much of it the next, overshooting the equilibrium point. Governments sometimes have bought excess crops or paid farmers not to produce to try to smooth such curves in agriculture in particular.

supply to catch up with changes in demand. In this case the demand curve went up at all prices, and supply increased over time as manufacturers ramped up production.

There are many products and services and for each there is a demand curve. These demand curves reflect the aggregate preferences of consumers: so much for broccoli, so much for premium TV channels. For each item an ideal market adjusts supply and prices in such a way that they reflect the relative amounts of each item that people in the aggregate want given their budgets and the actual cost of producing the item. Adam Smith famously referred to this as the "invisible hand of the market". Economists now also have another way of putting it: they say it "maximizes utility". We'll discuss that more later, but it is worth noting that aggregate demand curves don't necessarily reflect yours or mine. We might not have much use for super yachts, but there is a demand curve for them.[5]

A Note on the Shape and Shifts of Demand and Supply Curves

Demand and supply curves are mostly common-sense conceptual aids for understanding how an ideal free market works. The downward sloping nature of the demand curve is intuitive: as prices go up, demand goes down, and many observations support this general conclusion[6]. As mentioned above some items are more "price sensitive" than others, so the downward slope is steeper for some products than others. As the population grows, overall demand for any product or service will grow with it, but the shape of the demand curve isn't necessarily changed: if you are a factory owner you might predict a 10% growth in demand from a 10% growth in population. Overall demand and the shape of the demand curve can shift over time due to changes in tastes, technological changes (e.g. demand for horses as cars were adopted), and changes in income distribution, among other factors. Demand can change rapidly due to a shock such as the COVID pandemic, but usually changes fairly slowly, so short term prices tend to be pretty stable.

Similarly, supply is usually pretty much fixed in the short term. In our broccoli example it takes time to grow a new crop, say a year. The short-term supply curve is essentially flat: the quantity is fixed regardless of price and only demand can change. Longer term supply will change in response to demand as more farmers plant broccoli or more cars are produced at existing factories or more car factories are built. Costs of an item can also change in response to changes in the costs of the materials or labor used to make it.

Finally, technological changes have a major impact on the cost of goods and services. Famously, before Henry Ford introduced the assembly line to build model T Ford cars, cars were hand built and very expensive. Ford saw that there was an enormous demand for cars and that he could build them less expensively in quantity. The industrial revolutions (there were

[5] Similarly, "utility maximization" takes incomes as a given and looks at how the market maximizes it under that constraint. More on that in part 3.

[6] There are a handful of documented cases in which decreasing prices for a commodity caused a decrease in demand. These are referred to as "Giffen goods".

several) greatly reduced the cost of producing many goods, and computerized automation, sometimes called the 4th industrial revolution, and machine learning, continue the trend today.

Benefits of an Ideal Free Market

The benefit of an ideal free market is that it is extremely efficient at allocating resources. We have briefly mentioned how your preferences and overall budget determine how much of any item you will want to buy at a given price (its “utility” to you), and how that scales up to form the demand curve for everyone.

For a specific product, ideal free market conditions mean that exactly the “right” amount of resources will be devoted to producing it. Competition ensures that suppliers will be optimally efficient in producing the product in the quantity where the demand and supply curves meet.

Scaling up from one product to the entire market, producers of all products compete for resources, so under ideal free market conditions, there will be an optimal allocation of resources throughout the economy. This “ideal allocation” ensures that resources are used in a perfectly efficient way to maximize the satisfaction (utility) of consumers subject to their budget constraints.

Given the conditions that define an economist’s ideal free market and utility, the above can be shown mathematically.

One can appreciate the power of the free market by considering the alternative of a planned economy where what is produced and in what quantity is centrally decided. Since there is essentially a monopoly on production, the competitive incentive to reduce the costs of production is missing. The state does not have to produce goods in quantities that satisfy consumers desires, thus reducing overall “utility”. There is little incentive to introduce new goods or services. Even in market economies, there may be times when a government wants to put a thumb on the scales of what is produced (and what is not produced), but the history of fully planned economies shows pretty clearly that they don’t work as well as market economies. The Chinese economic miracle is largely due to their decision to abandon planning in favor of free markets.

Which brings us briefly to note that economic systems don’t necessarily align tidily with political systems. One can have a capitalist free market economy in an absolute dictatorship as easily as in a democracy. It is also possible to have a vibrant free market economy with substantial state ownership. Singapore, which has been ranked as having the most open economy in the world, and the most “pro-business” one, has large state-owned enterprises[7]. It also has one of the highest per capita incomes in the world, higher than the US.

[7] https://www.weforum.org/agenda/2019/10/competitiveness-economy-best-top-first-singapore-secret-consistency/

Free Market Caveats

So, if the free market is so great at allocating resources and meeting the needs of consumers, why doesn't the government simply stand back and let it rip? Well, to begin with there are some things, such as “defense” or a highway that you and I, the consumer, are not going to buy directly. If we want those things we have to get together and buy them. That requires taxes and government spending. But the main reason we can’t stand back and let an ideal free market rip is because the conditions we’ve imposed on describing it simply don’t, and can’t, exist in the real world.

Some requirements for an ideal free market for both a single product and the market in general include:

- Many producers and consumers
- No anti-competitive behavior
- Perfect information
- Homogeneous products
- Perfect factor mobility (factors are explained later, but think labor)
- Moral behavior by all parties
- No tariffs[8]
- No increasing returns to scale
- No transaction costs.
- Rational buyers and profit maximizing sellers.
- A number of other conditions

In addition to these conditions for an ideal free market, there are also things that simply fall outside the market unless the government is involved. We’ve already mentioned defense and roads which are examples of “public goods”, but there are other “externalities” to the market. For example, a factory that releases toxic waste into a river may cause costly health and environmental damage downstream, but these costs are “external” to the market since the factory doesn’t pay them.

When the conditions of an ideal free market aren’t met, and when there are externalities and a need for public goods, there will be less than optimal resource allocation without government involvement.

We might ask then, if an ideal free market doesn’t exist anywhere, why should we bother to study it? First because the broad outlines of how an ideal free market operates apply to imperfect markets. Secondly, by considering an ideal market we can find ways to make imperfect markets operate more like the ideal perfect one.

[8] High tariffs separate a domestic market from the global one. So, the “no tariffs” condition for a free market only applies when considering a global market.

Market Imperfections - A Brief Discussion

Among the many possible “market failures” that can occur in a real market, we’ll mention just a few. First is the need for information: in order to pick products and services we need information about them. For resource allocation to be ideal, consumers not only have to know about a product but also be able to figure out which is the best one for the price. The Internet, with its reviews and easy returns, has greatly increased our ability to find products and services and compare them. However, there are some services for which information is still lacking. In the United States health care pricing is usually hidden and certainly not subject to individual price shopping. Price for a blood test range from $22 to $37 in Baltimore, Maryland, but in El Paso, Texas, the range is $144 to $952[9]. This indicates not only a lack of information but other market failures such as a limited number of suppliers in any geographic area, and the fact that insurance makes consumers insensitive to the costs of specific services. These market failures lead to an inefficient use of resources.

As the healthcare example shows, the requirement that there be many suppliers for a product or service is also not always met. The most extreme cases are “natural monopolies” such as the utilities that supply electricity, gas, and water to homes. It makes no sense to have multiple competing electrical grids or water pipes to the home since there are “economies of scale” such that costs go down as the number of subscribers goes up. Because of these economies of scale, a single winning company can emerge naturally or be given exclusive rights by a government. In order to prevent price gouging the natural monopolies mentioned are regulated by, or provided by, government at one level or another[10].

[9] Nunn, Ryan, Jana Parsons, and Jay Shambaugh. n.d. “A Dozen Facts about the Economics of the US Health-Care System.” Accessed July 18, 2021. https://www.brookings.edu/research/a-dozen-facts-about-the-economics-of-the-u-s-health-care-system/.

[10] Over time technology can change. So, for example AT&T was given a monopoly on telephone service until cable and other technologies allowed for competition. Facebook and eBay are de facto unregulated monopolies not because they have high capital barriers to entry but because they were able to get a lot of users early on and the user base itself provides much of the utility of the service. That is called a “network effect”.

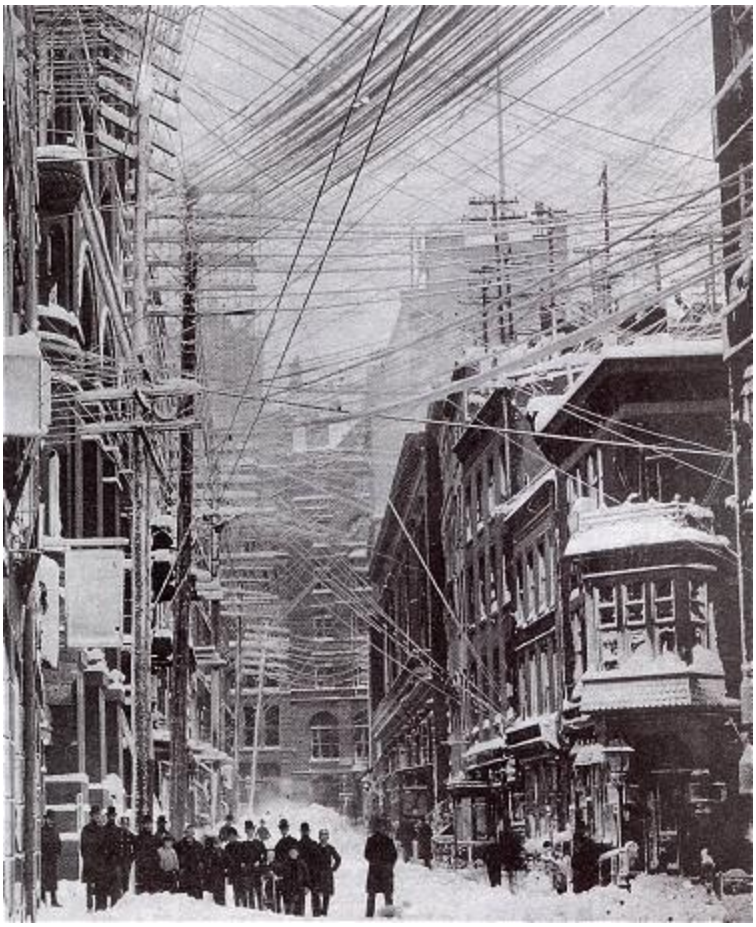

Figure 4 Chaos of Telephone, Telegram, and Power lines NYC 1880 before monopolies were granted. Credit: Wikipedia[11]

There are less extreme forms of limiting the number of suppliers. When we discuss labor, we'll see that licensing requirements such as for plumbers, electricians and doctors can limit supply thus increase prices. In manufacturing, high barriers to entry such as the need to build an expensive factory can limit the number of suppliers, although with economies of scale and several suppliers that doesn't necessarily mean supplies will be limited or prices suboptimal. Supply can also be limited by collusion. An example is OPEC, the oil cartel, which was set up to coordinate oil production and so control pricing. Many countries have laws barring collusion "in restraint of trade" to prevent companies from getting together to limit supply or take other anti-competitive actions. Supply is also limited through the use of patents which give companies a time limited monopoly on specific "inventions" such as pharmaceuticals.

Finally, the ideal free market requirement of moral behavior is unrealistic. Here are some of the conditions in the Chicago meat packing plants that Upton Sinclair recorded prior to the passage of the Food and Drug Act of 1906: "diseased, rotten and contaminated meat products were processed and labeled for sale, workers with tuberculosis spit up blood, coughed on meat, meat for canning was piled on floors covered in human urine, spit, rat dung and dead rats." Markets

[11] https://en.m.wikipedia.org/wiki/War_of_the_currents#

favor the cheapest product and in the absence of regulations such as standardizing sanitary conditions and requiring accurate labeling, the unscrupulous will flourish. Company size is certainly no guarantee of moral behavior, Armour and Company was the biggest meat packing company in Chicago at the time Sinclair visited, and there have been plenty of recent cheating behavior by some of the world's largest firms. A final example of immoral behavior are all the fake reviews on the internet. It is estimated that about a third of all reviews are fake, making it more difficult to get accurate information about products and services.

Externalities and the Free Market

Figure 5: Factory Smoke. Credit: Photo by Chris LeBoutillier on Unsplash

The ideal free market only works with goods and services which are sold, but there are things of value "external" to the market. Take, for example, a factory that belches forth polluting smoke which adversely affects the health of residents for miles around and contributes to acid rain which reduces timber harvests in other states. There are real quantifiable costs to this smoke, but they are "external" to the market and the factory's products do not reflect these real costs to society. Since the costs of production don't include these "external" costs, resource allocation through supply and demand pricing is no longer optimal. Governments may attempt to address these externalities in various ways. For example, by creating regulations that require that the smoke be cleaned up, or by taxing the pollutants at a level that reflects the cost of the damage done. While water, air and sound pollution are common negative externalities, there are many others. There are even some positive ones, such as the benefit of education not just to the individual but to society. Keep reading :)

Making Markets More "Ideal"

You've probably heard the term "laissez-faire economics". The basic idea is that leaving the market alone is the best way to achieve ideal resource utilization and growth. Hopefully our discussion of market imperfections and externalities gives you some skepticism about this

assertion. The free market is indeed excellent at meeting the desires of consumers and allocating resources efficiently. It is also excellent at encouraging innovation and the introduction of new products and services. But the market of “laissez-faire” economics is not an ideal free market due to the market failures we’ve just discussed, and certainly doesn’t address the issue of externalities.

Many laws and regulations have been created to bring the market more in line with the ideal, and hence to make it more efficient, to address externalities, and to address the fallibility of human nature[12]. Does this mean that all such laws and regulations are perfect or even needed? Of course not. But the market left alone would be about as perfect as a football game with no rules or referees to enforce them.

At the most basic level, governments provide the “infrastructure” on which markets depend such as standardized weights and measures and currency. These come down to us from ancient times. Governments also create rules relating to property and stable laws and courts to deal with contracts and trade disputes.

In more recent times, as we’ve seen above, governments have sought to address other problems to bring the functioning of the market more in line with the ideal and hence more efficient in the allocation of resources to meet consumer desires. Far from being government interference in a perfectly functioning market, experience has led to government intervention to keep the market functioning well and in accordance with moral principles. We’ve seen that governments have had to create and enforce requirements related to truth in labeling, mandating that foods and drugs be safe and effective, that professionals be licensed, that consumer products not contain hidden dangers, that interest rates be published and accurate, that buildings meet engineering standards to ensure safety, and so on. Governments have also had to ensure that competition remains robust by enacting legislation to outlaw anti-competitive collusion, break up monopolies where possible and regulate them when not. Finally, governments have had to address externalities by requiring that air and water not be polluted among other things.

The efficiency of the free market would suggest that where possible regulations should mandate ends and not specific engineering means to those ends. For example, a carbon tax raises the cost of emitting carbon dioxide to address the enormous potential costs of global warming. That leaves the decision on how to lower costs by reducing emissions to individual businesses, and how to rebalance the mix of products and services to the market through the mechanism of supply and demand equilibrium[13].

[12] Regulations have the force of law. Laws are created by legislative bodies, but in some cases the legislative bodies will leave the details of implementation to agencies. The agencies issue regulations which have the force of law. Imagine the legislature trying to create a law for every road speed limit.
[13] Many “conservative” economists, and even some daring Republican Congressmen (in the past) have proposed a carbon tax because it is a market solution. Cap and trade also makes use of market forces but requires a bureaucracy and is easier to game.

While there are laws and regulations that could be better designed or are no longer needed, an equal or worse danger is posed by what is called “regulatory capture” where an agency (or legislators) responsible for regulation are themselves from the industry or beholden to it. Wealthy interests can also get legislation passed which favors them economically. An example is the depletion allowance which has provided the oil industry with an enormous tax break relative to other businesses. Differential taxation of industries distorts the market, in this case to favor the oil industry.

One final government intervention in the market we should mention is actions taken to counter market crashes. When left alone, markets show an unfortunate tendency to go through boom-and-bust cycles. In a downturn, demand falls which causes some to lose their jobs and others to spend less because they’re afraid of losing their jobs, and this in turn causes demand to fall even further precipitating a crash. During and since the great depression, governments have countered this cycle by pumping up demand through deficit spending during downturns, and slowing demand in various ways when the market overheats. This “Keynesian”[14] intervention has proven highly effective in ameliorating market swings.

Making Markets Less “Ideal”

As in the case of the Oil Depletion Allowance, there are times when government actions make markets *less* “ideal”. A couple of examples include tariffs and patents.

Tariffs on foreign goods will be discussed in the section on trade, but it is clear that, by adding a tax on imported goods, tariffs interfere with the market by increasing the cost of those goods on which the tariff is applied. This is usually done with the intent of protecting domestic producers from competition.

Patents also influence supply and demand by intent. A patent is a form of property right that gives the holder exclusive rights to use an invention for a period of time, say 20 years. Patent laws are quite ancient, the first codified ones dating back to 15th century Venice. The purpose of patents is to provide inventors an incentive to spend the time and money necessary to come up with new and useful products and machines which benefit society, and they do that by allowing the holder of the patent to either exclusively commercialize the invention themselves or charge others to use it. In this way a patent is like other property, and we’ll be looking into that in the section on factors of production. It is probably not fair to say that patents and copyrights make markets less ideal, rather they allow an intangible right to be traded in the market for positive purposes such as increased long run productivity. But clearly in some cases, such as some essential medications, they have been subject to misuse. It is interesting to note that property rights in general, like patents, are created by governments, they are no more “divine” than the rights of kings. What gets patented is determined by the patent office.

[14] After economist John Maynard Keynes (1883-1946)

Other government interference that makes markets less “ideal”, like the oil depletion allowance, are often the result of lobbying by industry, or in some cases badly constructed mandates or incentive programs.

Finally, we should note that government taxation and spending influence the demand for goods and services by raising costs through a sales or value added tax. The taxes collected are spent for various purposes and this spending is not directly dictated by consumer preferences. Instead, those preferences are expressed through voting in democratic countries, but that is outside the market mechanism (which gives a clue why there are so many lobbyists and so much spending on elections). A sales tax will raise the prices of all taxed goods and services, reducing demand for the taxed items. An income tax doesn’t affect prices directly but reduces overall consumer demand while increasing demand from the government.

Factors of Production

When you make (almost) anything you need materials such as wheat flour, wood, steel, or plastic, which in turn come from **natural resources** such as land, forests, iron ore or oil. **Labor** is required to process these natural resources. The farmer grows the wheat on the land, the wood is harvested from the forest, the iron ore is mined and processed to make steel, and the plastic is processed in a plant which employs engineers and others. As these examples show, in addition to raw materials and labor, machines and tools are required to harvest, smelt, and process just about any manufactured product and almost all services. The machines, tools, buildings and so on used to produce goods and services are called **capital** in classic economics.

These three inputs to everything humans make or do are called “factors of production”.

Labor

The concept of labor is intuitive but needs a bit of qualification when it comes to economics. In economics “labor” is human effort expended to produce goods or services for the market. This definition omits domestic labor such as in-home cooking, cleaning, childcare, and any volunteer activities. Farmers, managers, sports stars, doctors, construction workers, cooks, accountants, all perform labor. As this list indicates there is a vast range of skills used in performing labor which are usually a combination of native ability and learned know-how.

There are supply and demand curves for labor, but it is here that we see the need to break labor down into specific types. It makes no sense to combine the supply and demand curves for doctors with that of computer programmers or restaurant workers. However, the general

principles of supply and demand apply to all labor regardless of type. Supply and demand for a specific type of labor determine the equilibrium price and quantity of that labor.

The supply of a specific type of labor can be limited because a profession can require innate abilities which only a subset of people have. Many might aspire to be artists or musicians but not all of us have the native ability. Compensation can be high for people with particular aptitudes, such as talented actors and sports figures.

The supply of labor can also be limited by educational requirements such as the need to have a medical degree to practice medicine, or to obtain a plumber's license to be a plumber. Sometimes these educational requirements can be onerous enough, or admission to educational programs may be restricted enough, to limit supply even though there is a surplus of individuals willing and able to pursue those careers. Supply can also be limited by physical proximity: you can't hire a plumber from three states over even if they charge half as much.

The supply of what help-wanted ads used to call "general labor" is more flexible. People can move easily between jobs that do not require extensive education or special talents. This mobility means there is effectively a large supply of labor for such jobs unless unemployment is extremely low (i.e. demand for "general" labor is high compared to supply). Workers in these jobs have very little bargaining power, you pretty much have to take what the employer offers. Unions are formed to increase the bargaining power of labor, including some highly trained workers such as airline pilots.

So much for supply, what about the demand for labor? Consumers sometimes directly buy labor, for example to paint your house or watch your children. Even in such cases the worker is often employed by a business. So, the demand for labor is in most cases determined by business hiring which of course does at some point stem from consumer demand. How much labor will a business hire and at what cost?

In economics, in an ideal market, businesses will hire workers as long as the additional cost of the labor is less than the additional revenue that labor produces. In other words, if I can hire 3 workers at $150 per day, and the added sales I will make adds up to more than $450 (assuming no other additional costs), I will hire those workers. The amount of additional revenue that hiring an additional worker produces is called the "marginal product" of labor. That explains why a major sports figure, or a movie star, can command extremely high compensation: their employers have calculated that they can make even more money than their compensation by hiring them.

If I can keep hiring workers and keep making money by adding them, why don't businesses keep hiring workers without limit? There are several reasons. First of all, in economics, it is usually assumed that there are "diminishing marginal returns" for adding any factor of production. It's easy to see that if you have a factory of a certain size, you only need so many workers and that adding more beyond that point will just waste money. If you build a new factory you can hire more workers, but eventually if all the businesses in your product line add more

factories two things will happen: (1) there will be so much product being produced that prices will fall (the old supply and demand relationship), and (2) you may do so much hiring that the cost of labor goes up. With returns falling and possibly the cost of labor rising, you will eventually stop adding capacity.

How much will labor get paid? This is an important question for most of us. The answer is "the absolute minimum that business can get away with". This is not because businesses are bad or greedy, although they can be both of course, but simply because the market requires producers to minimize costs under competition, workers to compete for jobs, and businesses to compete for workers.

There is no inherent "bottom" to how little workers can get paid under competition. If there is a surplus of labor, wages can sink to the point where it requires multiple jobs, inordinate hours, or a side hustle of crime or begging to make ends meet. Charles Dickens described the misery of British workers under competition during the early industrial revolution. In our time, minimum wages, a standard work week, and various income support programs have been established to help keep wages and income from sinking to that level[15]. Minimum wages force supply curves "higher" for goods and services that use minimum wage labor. Whether this results in "loss of jobs" in any particular business depends on the steepness of the demand curve (how much demand goes down with an increase in price) and the amount of the increase. Hence one hears discussion of whether McDonalds will sell fewer hamburgers if the cost of the hamburger is a few cents more because of a higher minimum wage. We will look more closely at how an increase in the minimum wage affects the economy, and utility, under ideal free market conditions later.

The connection between marginal productivity and compensation is clear for some occupations, such as for a nurse or doctor under fee for service. Let's suppose a hospital wants to hire a doctor. The hospital has contracts with insurance companies that specify how much certain procedures or office visits cost. Knowing the mix of such services the doctor will provide, the hospital can figure out how much the doctor will "bring in". They can then offer the doctor a salary that covers that amount and the doctor can decide, based on other offers and what he or she could earn in private practice, whether they will accept the offer. The salary the hospital will have to pay will be determined by the overall demand and supply of doctors, and the costs of medicine will rise or fall along with those salaries. At least that is a simplified description of the process.

For production workers, the "production function" which relates the inputs to outputs helps sort out the marginal productivity of the worker. Say that a large auto factory produces 50 cars an hour. Back in the days when cars were painted by hand, this meant that the factory would need enough painters to paint those 50 cars. Not having enough painters means that the number of cars produced per hour slows down, and since that means that the other workers and machines on the assembly line are not being used efficiently, there is a quantifiable revenue gain from

[15] Since the cost of living varies widely across the US, the level at which a wage is "livable" also varies. That said, the minimum wage in many states falls short of any reasonable modern standard of living.

hiring another painter. The revenue gained from hiring a painter while holding other inputs to the same level is that painter's marginal productivity. Clearly as we get closer to the number of painters needed to paint 50 cars per hour, the additional revenue resulting from each painter declines. In this example it seems pretty clear we will want to hire enough painters to paint all 50 cars (and a spare or two to allow for sick days, vacations, and holidays) when demand for cars is sufficiently high that the factory can sell all its output. Unless the cost of a painter is inordinately high of course. As usual the actual wage paid to the painter will be determined by the supply and demand for painters.

Sometimes it is harder to directly see the relationship between the wages paid to a “worker” and their “marginal productivity”. For example, how much additional revenue (or savings) does a programmer at corporate headquarters bring in? For that matter, what additional revenue (or savings) does the CEO bring in? If we hire a cheaper CEO will the company’s performance suffer?[16]

Natural Resources

Natural resources (aka raw materials) are all the materials and capacities which are provided by nature such as land, minerals and ores, coal, water, waterpower, air, and old growth timber. In short, anything used by humans which is naturally occurring.

Agriculture requires land, water and minerals, and manufacturing requires materials derived from ores and other natural resources. Pretty much every good and service requires the expenditure of energy which is also derived from natural resources.

Many people get pleasure from the natural world, and indeed many cities and towns have departments of “Parks and Natural Resources”. There is a value to clean air and water. As is the case with domestic labor, these largely nonmarket values were often ignored in the past.

Natural resources are limited in quantity, although some like air are in ample supply and freely available. In classical economics, natural resources were referred to as “land” and indeed most natural resources are in some way tied to the land. A farmer grows crops on the land, and landowners can sell mineral or logging rights on their land to the highest bidder. Housing, malls, and factories are built on the land. As is the case for everything sold on the market, supply and demand determine the price of natural resources, and overall demand is ultimately determined by consumer’s demand curves for the various products using any given natural resource.

In classical economics the term “rent” was applied to the “unearned” income a landlord could make by simply allowing a farmer to use his land. Back in Adam Smith’s day, most land was inherited, and the well-healed lived lives of luxury financed by the rents on their estates. Today

[16] Many studies have failed to find that higher CEO compensation translates to better company performance. We will address CEO compensation in part 3 when we look at income and wealth inequality.

land is actively bought and sold, and its price reflects an expected return. In short, the price of land and other natural resources is determined by the market. As usual there are imperfections in the market for natural resources. We've mentioned the oil depletion allowance and externalities such as the enormous cost of global warming which are not reflected in the market price of fossil fuels.

Capital

In common parlance when we speak of "capital" we often mean "wealth". In economics, capital is classically defined as the machines, tools, buildings, and other long lasting physical equipment that we use to turn raw materials into the goods and services we consume.

Modern economic theories have defined other forms of capital as factors of production. For example, the workforce of a business will have special knowledge and skills which are also required to produce goods and services and which, like physical capital, would take considerable time and money to assemble. This is called "human capital'. There are other "intangible" assets which are counted as capital in accounting, such as intellectual property which includes patents and trademarks, and "goodwill" which includes your relationship with your clients built over time[17]. Then there are financial assets which don't directly enter into the productive process, but which also count as capital on a balance sheet.

There are three very broad classifications of businesses used by the US Bureau of Labor Statistics in collecting economic statistics such as employment. Goods producing industries such as manufacturing and construction employ about 7% of US workers, agriculture less than 2%, and "services" 85%[18]. So services, which may not use a lot of physical capital such as machines, are a very large part of our economy now. Since our main interest in capital is in looking at the relationship between productivity changes and income, we will clearly need to look at both physical capital and human capital. A law firm (a service) clearly doesn't need a lot of physical capital beyond fancy conference tables, as most of their capital is human capital and goodwill.

Like other factors of production, the "price of capital" is determined by supply and demand. If a company wants to buy a new and improved piece of machinery, it could borrow the required money from a bank. The bank would charge the prevailing interest rate adjusted for risk. The business will buy the equipment as long as the return on the equipment exceeds the costs including interest payments.

We will look at capital accumulation in the wealth sense later when we look at real world data on income and wealth inequality.

[17] Goodwill isn't shown on a balance sheet unless purchased by acquiring another company.
[18] "Employment by Major Industry Sector." 2020. September 1, 2020. https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm.

Other Factors of Production

Recently some economists have posited “entrepreneurship” as a separate factor of production. The entrepreneur is thought of as orchestrating the other factors of production to create a successful enterprise. However, here we will view entrepreneurship as labor, and the skills of the entrepreneur as akin to those of other managers with perhaps additional components of imagination, leadership, and luck, thrown in. As we will see when we discuss actually quantifying factors of production, it is much easier to come by statistics on work hours than it is to measure “entrepreneurship”. The job description of an entrepreneur is “entrepreneurship”, and like other human capital, is quite difficult to measure and quantify.

If one looks at the actual production of goods and services, it is clear that one can slice and dice resources in many ways and, as we’ve seen in the case of labor, the traditional factors of production are hardly homogeneous. A robotics engineer may work in a manufacturing plant but the type of labor he or she supplies is not the same as a manager or machine operator. When considering productivity data in part two we will have to deal with such issues.

Raising the Minimum Wage, Jobs & Utility

Let's look at how a rise in the minimum wage affects the economy under ideal market conditions. To review, in an ideal competitive market, consumers decide how much of anything they want to buy *given their budgets* and personal preferences. It is assumed that consumers will "maximize their utility" so that another dollar spent on any given good or service will give as much satisfaction as a dollar spent on any other (otherwise they could increase their satisfaction by buying less of the one good or service and more of the other.) Suppliers will produce goods and services as inexpensively as possible because of the pressures of a competitive market. Suppliers will hire labor, like any other factor of production, until the cost of an extra unit of labor, say a work hour, is just equal to the extra revenue, including profit, produced by that labor. Labor too is subject to competition and the laws of supply and demand. Under ideal market conditions with no government intervention and assuming workforce mobility, labor is paid "just the right amount" to maximize overall utility as reflected through the demand curves for all goods and services[19]. An increase in the minimum wage means that goods and services employing minimum wage labor will cost more relative to other goods and services than they did before. If labor were like other factors of production, this would reduce overall utility: the higher cost of the goods and services means that less of them are sold, so people who would have bought the item at the lower price have lost "utility" and people who buy at the higher price are losing the "utility" of buying something else with that extra money.[20] But labor is *not* like other factors of production. Labor is people and these people working at minimum wage also have "utility" curves.

Economists usually assume that as you have more of something, the less "utility" you get from additional amounts. For example, if you've had broccoli twice in a week, it is likely your utility from an extra helping of broccoli will be less than the first helping. The same is certainly true of money. A thousand extra dollars to Bezos or Gates certainly has less "utility" to them than it does to someone making a low income. So, when considering what happens to "utility" when the minimum wage is raised, we have to balance the utility reductions mentioned above against the utility gains to minimum wage workers.

It is not really possible to measure utility directly, but it is extremely likely that the utility of minimum wage workers who keep their jobs and don't lose offsetting government benefits increases more than the decrease in utility from other consumers as a result of the price rises because of the just mentioned utility of increased income. Effectively, better off people pay for an increase in wages to poorer people, and the loss of utility from the better off is less than the increase in utility to the worse off.

The entire argument about the efficiency of ideal markets rests on the assertion that it maximizes utility given the existing income distribution, when one relaxes the condition of "existing income distribution" one finds that overall utility is increased through more egalitarian distribution of income. By the way, it is entirely possible that some of us, or even most of us,

would get a net increase in utility by giving up some income to increase the income of the poor. I think that's the idea behind charitable giving.

Substitution of Factors

In economics it is assumed that one can, to an extent, substitute one factor for another. So, when one buys a machine that takes the place of some workers, one is substituting capital for labor. Similarly, one can often use less energy in a production process by buying more efficient machines or processes, in effect substituting capital for energy. This happened at the time of the late 1970's "oil shocks". As the price of oil went up, industry learned how to become more efficient with energy, often actually lowering costs in the process. The result was a cut in the demand for oil and consequently a fall in its price despite the efforts of the OPEC cartel.

The substitution of factors depends on the costs of each. When wages for a specific task are low it doesn't pay to buy an expensive machine to replace the labor. If wages go up, it may make sense to buy the machine. This will tend to keep wages down for that specific task.

Productivity

The world we live in is incredibly complex. Sometimes it helps to create an imaginary world where we can think about economics in simplified terms. Below we create an island in the Pacific Ocean where we can explore the effects of productivity, trade, and migration, the big three of Globalization.

[19] "Just the right amount" if we treat labor like a raw input and the price of labor is strictly based on abilities and training (i.e. economic value) without considering that "labor" is people who have "utility". So again, utility maximizing given income.

[20] To make this even more complicated, if the price of a raw material goes up, rents to the owners of the natural resources go up which increases their utility while end consumers of the raw material lose utility. In some sense labor is like a raw material.

The Island - a thought experiment in Productivity

In the first thought experiment we can apply the principles of competitive equilibrium we discussed above to see what happens when there is a sudden increase in wheat production (i.e. productivity) and no international trade and essentially no government intervention.

The Island is a small place with a total population of 4 million people. Three million people live in small cities along the heavily populated north coast and pursue nonagricultural professions from fishing to banking. The remaining million people are spread through the southern three quarters of the Island and grow the staple wheat which feeds the island.

During a normal year, the Island's small farmers grow enough wheat to feed the entire population, and sell their wheat to buy fish, tractors, shoes, and the other goods and services produced in the city. But the year we're looking at is far from normal. The agricultural research station at Island University introduced a new variety of wheat seed in time for the annual planting, and now the farmers are suddenly growing twice as much wheat as usual per hectare. Labor productivity is defined as the amount of a particular good or service you can produce with say an hour of labor. Since the same amount of machines and labor can harvest the new wheat, wheat farming has suddenly become twice as productive.

As a result of the huge harvest of wheat, the price of wheat falls. There's only so much you can do with wheat and farmers, desperate to dispose of their harvest, have to underbid each other to sell. The demand curve for wheat falls off sharply. Farmers go broke and many of them have to sell their land to corporate farming entities with deep pockets. The price of agricultural land falls precipitously. The displaced farmers have to look for jobs in the city which causes a major labor glut and a fall in the wages of unskilled workers.

On the other hand, all the non-farmers have had a major boost to their effective incomes since the price of wheat and everything made from wheat has gone way down.

Is this sudden increase in productivity beneficial overall? The answer in the short term is far from clear. Farmers have been badly hurt, and wages for unskilled workers have declined.

In the long run, things look a bit different. The cost of wheat is permanently lower, so everyone has more income to spend, manufacturing and services have expanded in response to increased demand, and the displaced farmers have found employment in these new jobs. In short, there are more goods and services in the economy than before, gross domestic product (GDP) has increased, and in principle this growth in GDP could make everyone better off. Of course, whether everybody is better off depends on income distribution, which we will discuss further later.

This extreme example is like a speeded-up version of the industrial revolutions[21]. Charles Dickens' depictions of Britain during the initial industrial revolution give a bleak picture of what can happen when productivity increases without any protective measures. Eventually of course, the industrial revolutions lead to enormous increases in productivity from which we all benefit, and many protections have been put into place to ameliorate the pain of the process.

The above thought experiment omitted government action and international trade. Let's now look at how the undesirable blows of this productivity increase could have been softened.

First of all, what are some of the things the farmers might do themselves?

The farmers could band together, and all contribute half their wheat to a big bonfire. But they're not organized and it's likely there would be a lot of cheating. They could get their trade association to push alternate uses for wheat, like brewing beer and making glue. To help the beer sales they could start an advertising campaign to get teens to drink more sweetened alcoholic wheat drinks. It's unlikely that any of this would be more than marginally effective.

What government interventions might help?

The farmers have a disproportionate representation in the government because they are spread over three quarters of the land. They have used that legislative clout to get a bunch of non-free-market support for agriculture. In particular there are agricultural price supports and when the glut of wheat hits, the government is obliged to keep buying wheat to prop up the price. The result is that the entire "extra" wheat is bought by the government and stored in massive silos where it will eventually rot. In the meantime, the farmers all benefit from an enormous transfer of income from the city folk who have to pony up the money to buy the "extra" wheat. And since the farmers are now producing twice as much wheat and selling all of it, they have a great incentive to keep on producing too much wheat. The entire benefit of the productivity increase in wheat is thus lost[22]. Clearly this is *not* the way to handle a productivity increase.

Other government programs could soften the blow of the productivity increase without essentially negating its benefits of increased income and GDP. These programs involve income transfers to distribute some of the extra national income produced from the winners (most of the population) to the losers (the displaced farmers and unskilled workers). Such programs include unemployment benefits, minimum wage requirements, and other transfers. It is also possible for the government to take measures to increase employment, either directly

[21] There have been several "industrial revolutions" as major productivity changes occurred. The initial one was water powered, the second used electric power to expand production, etc. There has also been an ongoing agricultural revolution which has greatly reduced the number of workers needed to grow an abundance of food.

[22] This example may seem laughable, but similar programs have in fact been instituted in the USA and other countries. See for example Malone, Kenny. 2021. "Big Government Cheese (CLASSIC)." NPR, May 21, 2021. https://www.npr.org/2021/05/21/999144678/big-government-cheese-classic.

through spending money on public works or services, or indirectly through stimulating demand through tax or interest rate cuts. These measures would help ease the painful adjustment process resulting from the increased productivity in wheat.

The Island - Part 2 Trade

Up to now, we have not allowed The Island to trade. Maybe the Island's population is extremely protectionist and there is little trade with the rest of the world. But now let us change this and suppose that The Island in fact has healthy trade relations. What happens now when the wheat harvest suddenly doubles due to the productivity increase?

With free trade, The Island's farmers are free to sell their extra wheat in the world market. The Island is a small place and its entire wheat harvest, even doubled, is a very small part of the world harvest, and so selling half internationally will have almost no effect on the price of wheat. The world price of wheat is high enough that the farmers can ship their wheat and still make a tidy profit since their cost per bushel has gone down by half. Suddenly the farmers are rolling in dough, the cash kind. They go on a spending spree, employment picks up, and with it wages. Imports also go up to balance the additional exports[23]. The net result is that everyone on The Island gets richer and employment increases. We will, for the moment, ignore the ominous possibility of the new wheat seed being adopted worldwide through "technology transfer".

The above thought experiment shows that productivity increases, especially sudden ones, can cause short term economic pain but in the long run increase overall output. Trade can help smooth such dislocations, and government actions can help with the shock of transition.

Productivity in Economics

Productivity in economics refers to the amount of labor and other inputs that are required to produce a good or service. In its simplest form, labor productivity, it measures the amount of labor required to produce something. For example, it might have taken 80 hours of labor to produce a car in 1965, and 20 hours to produce a car in 2018 implying a fourfold increase in labor productivity. Unlike the example of a sudden increase in productivity we used in The Island thought experiment, labor productivity increases typically happen incrementally over time, even if in the end they can create some of the same problems we saw in that example.

[23] For a small country like The Island, exports and imports will tend to balance out over time through, you guessed it, the supply and demand for their currency. If the country imports more than it sell, it's currency will have to go down relative to other currencies so that the relative costs of its goods go down and it sells more abroad.

What can cause labor productivity to increase? The obvious answer is that technology improves over time. Clearly it takes more time to hand wash clothes than it does to dump them in the washing machine and press a button. It is also clear that productivity can improve through adding more capital. The more washing machines there are, the less total labor will be spent in washing clothes. Finally, the use of energy can change labor productivity. If you don't have electricity in your house, the washing machine isn't much help.

In general, in economics, it is assumed that there are declining returns to increasing a factor of production. If you have an automobile plant with a certain number of machines which require a certain number of workers, adding workers (or work hours) until the required number is reached will greatly increase output. But once the plant is fully staffed, additional workers won't produce much more output. The same applies to adding more machines of the same type without adding more workers. Of course, if you add workers, machines, and energy in the proper ratio you can grow output at the same productivity level. You can, for example, simply replicate the plant to produce twice as much output. But simply increasing capital and labor in a fixed proportion using the same technology and abilities doesn't increase productivity.

To increase productivity, you can do a number of things. Let's suppose that at the car factory the cars are painted by hand. If you install painting robots you will reduce the amount of labor per car and increase labor productivity. This is a new type of machine and will increase the amount of capital in the plant. You might already have welding machines in the plant but as they wear out you could replace them with automated machines that cost the same but don't require as much labor. That is a technology change that increases productivity without requiring more capital[24].

What happens to worker pay when labor productivity increases? It seems intuitive that if it takes half as many labor hours to produce a car, the factory could pay each worker more. And indeed, it could *if* cars sold for the same amount and other costs remained the same. But the cost of cars is, under ideal free market conditions, going to be determined by supply and demand, and, under competition, the price of cars will go down until it just covers the cost of production (including reasonable return to capital, aka profit). Of course, sales of cars at the new lower price will go up. If the number of cars sold doesn't go up as much as the labor productivity increase, the number of workers can be reduced meaning that workers may very well have to compete for jobs. And it is the supply and demand for workers of a specific type that determines their wages, so wages for these workers may go down. By the way, with changes in technology come changes in the type of workers needed. When painting robots are installed, there will be less demand for skilled painters and more demand for robot technicians.

[24] There are many other ways productivity can be improved. For example, a large factory may be more able to use expensive machines than a smaller one. That is called "economy of scale". Increasing worker retention can improve productivity since experienced workers can be more efficient. There can be synergies between businesses that are concentrated in a region (think Silicon Valley). Businesses are always striving to improve productivity.

When productivity goes up in the auto industry, workers affected by the change may not see an increase in wages, in fact some of them may lose their jobs, but the general public will effectively get a pay raise when the price of cars comes down.

If we look across the entire economy, if there is a general increase in productivity, the same amount of goods and services can be produced in a smaller number of work hours. Since people have to spend less of their incomes on these goods, there will be increased demand and more goods and services produced including perhaps new ones not available before. The extra demand and new production can absorb the workers displaced by automation. In short, when productivity increases, and employment stays the same, national income goes up: the quantity of goods and services per person increases. That doesn't mean that everybody benefits equally, or even at all, that depends on the vagaries of the supply and demand for different kinds of labor.

Productivity increases as mentioned can be brought about by increasing the number of machines being used by workers, which is referred to as "capital deepening", or by increasing the efficiency of technology. To try to quantify the role of technology versus increasing capital per worker, economists developed a measure called "total factor productivity" (also called multifactor productivity) which relates inputs of labor and capital to output. The increases in output that cannot be attributed to changes in labor and capital are inferred to be due to technological change[25]. Robert Solow who introduced total factor productivity in 1957 estimated that 80% of productivity increases over the period 1909 to 1949 were due to improvements in technology, not increases in capital per worker[26]. In a developing economy there is usually a need for more capital to increase productivity. In a fully developed economy increases in productivity are mostly due to technological advances.

In Part II we will look at the data on productivity increases and who the winners and losers are, but it's no spoiler to say that the increases have been enormous. Despite producing more output than ever before, agriculture in the US went from employing 80% of the population in the early 1800's to less than 2% now, and manufacturing went from employing over a third of workers in the US in 1960 to 7% now. In the US costs and prices, adjusted for inflation, have fallen in agriculture and manufacturing as total factor productivity has improved[27]. In rapidly developing

[25] total factor productivity, is based on a model called a production function which is a highly simplified mathematical relationship between labor, capital, and output. Using multiple actual data observations on labor, capital, and output, it is possible to estimate how much of the growth in output is due to growth in labor and capital and an upward trend in overall output not attributable to either. That upward trend is the increase in productivity attributable to technology change. Economists have often refined MFP calculation to include intermediate products, human capital and energy.

[26] "Robert Solow's Nobel Acceptance Speech 1987." n.d. Accessed August 10, 2021. https://www.nobelprize.org/prizes/economic-sciences/1987/solow/lecture/.

[27] In recent years, perhaps surprisingly, capital deepening is responsible for more of the labor productivity improvement in the US. See Figure WW115.

countries, on the other hand, most of the improvement in labor productivity is due to increased use of capital[28].

It is interesting to note that increases in wages relative to the cost of capital can drive increases in labor productivity: as wages go up, investing in more machinery to reduce labor costs makes sense. The same can happen in reverse: if labor is abundant, wages may go down relative to the cost of capital and labor productivity increases may slow. However, if machines simply become more efficient as they are replaced this connection is less important, but still should be kept in mind when explaining productivity changes over time.

Measuring Productivity

Businesses are always striving to minimize the cost of producing a given level of output. When designing a factory, for example, the inputs would include predicted labor and capital costs, energy costs, costs of intermediate products such as sheet steel and components purchased from vendors, and other costs such as local taxes and transportation. The drive to minimize costs ensures continuing pressure to increase productivity by applying new technology, negotiating lower prices with suppliers, and looking for ways to increase labor productivity. But labor is not homogenous, so companies measure outputs of different types of labor separately using appropriate goals for each. In a car factory one could use the number of cars a painter finishes in a day as an appropriate metric for judging the productivity of painters. Amazon is famous for their employee metrics and the incentives, positive and negative, they use to encourage productivity.

While firms measure productivity to minimize costs, countries collect aggregate productivity data as one measure of how the economy is performing. Rather than directly dividing output (cars say) by labor hours, output is usually measured in dollars. In the United States, the Bureau of Labor Statistics publishes data on labor productivity at the sector and major industry level. To compare productivity numbers over time, output must be adjusted for inflation. If the price of cars has doubled in 20 years, $2 billion dollars' worth of cars today are the same as $1 billion dollars' worth of cars 20 years ago, and so the productivity numbers for the automotive industry in terms of dollar output of cars divided by hours of labor must be adjusted accordingly (in this case, halved). The best-known inflation rate index used to adjust current (aka nominal) dollars is the Consumer Price Index, or CPI, which is based on the cost of a "basket" of goods and services that a consumer might buy. If the same basket of goods and services costs 5% more this year than last, then inflation is said to be running at 5% and any dollar figures must be reduced by 5% to compare with the prior year. Using the CPI, and other inflation indexes such as the Producer Price Index, one can compare productivity over the years in output dollars

[28]In developing economies where a lot of new capital is needed and wages are low, governments may intervene to capitalize some industries, for example steel production, even though doing so doesn't reduce costs. The alternative free market process involves investors investing in labor intensive industries in low wage countries, eventually driving up wages and thus making capital investments in other industries more profitable. China has used both strategies.

adjusted for inflation divided by labor hours. The actual calculation of an inflation index is quite tricky since what was in the “basket” 20 years ago may not correspond well with what is available today. We’ll consider some of these details in Part II when we look at the data.

The aggregate measure of productivity we’ve just discussed lumps all labor together and measures output per hour of labor. When we looked at how a company measures productivity, it was quite different, output is determined by the combined efforts of different types of labor employing different types of machinery (or more generally capital) and raw or intermediate materials such as energy.

Countries often also produce a measure of productivity that includes other factors of production, not just labor. We mentioned this measure briefly before, it’s called total factor productivity, also referred to as multifactor productivity.

Total factor productivity (TFP) is computed by looking at the percent change in output of an industry or sector over the course of a year and comparing that to the percent changes in inputs including labor and capital and intermediate goods. Each input is weighed by how much of it is used (in dollars). So, for example, if an industry uses 60 million dollars’ worth of labor, 30 million dollars’ worth of capital, and 10 million dollars of materials (total = 100 million dollars), then the weights for each factor would be 0.6, 0.3, and 0.1 which adds to one. If the output of the industry increases by 10% but labor only goes up 5%, capital by 7% and materials by 10%, even without applying the weights to each input we can see that output went up more than the inputs. The extra output cannot be “explained” by the increases in labor, capital, and materials, and is thus said to be due to an increase in total factor productivity. This increase in productivity can be quantified: it is simply the percent change in output divided by the combined weighted change in inputs. If the output grows as fast as the inputs, then they both grow at the same rate and the ratio of output increase to input increase is one. If output grows faster than the inputs, productivity increases and TFP is greater than one.

Why would one want to compute total factor productivity? Simply, it is a better measure of “real” productivity growth. To take an example, let's suppose that output in an industry grows ten percent but the amount of labor doesn’t change at all. Then calculated *labor productivity* also rises by ten percent (ten percent more output from the same amount of labor). If the amount of capital used also stayed the same in dollar terms, then *total factor productivity* also rises ten percent because we are now producing ten percent more output with the same inputs (neither labor nor capital used has gone up, but we’re getting ten percent more output). In this case we can safely say that productivity in the industry has gone up, probably because of improved technology. But suppose that the amount of capital used has gone up twenty percent while labor stayed the same. Then calculated total factor productivity does not go up ten percent, and the increase in labor productivity is likely due to the addition of more capital, not just technology improvements. Total factor productivity statistics make it possible to see what is happening more clearly.

The total aggregate output of a country is referred to as it's "gross domestic product" or GDP[29]. GDP per capita indicates how much output the country produces in dollars per person, while GDP per worker is a measure of average labor productivity. Both can be used to compare the relative productivity and income of different countries and can also give us an idea of how actual incomes of groups of workers fare against the average.

Gross domestic product includes spending for consumption or investment by consumers, government, and businesses but doesn't include intermediate goods because their cost is built into final sales. GDP also includes sales overseas but purchases from overseas have to be subtracted from total sales since they weren't produced here. Since all these sales are income to someone in the country, GDP balances neatly to national income which is why "gross national product", and "national income" can be used interchangeably and are in fact calculated separately as a cross check.

In the USA the GDP per worker in 2019 was $131,047. For comparison, GDP per worker in China was $31,416, in Germany $103,013, and in India $19,270. These numbers correspond to average productivity, or output, per worker[30].

We will make extensive use of GDP per capita and per worker numbers when comparing the economies of countries in the sections on world productivity and income distribution.

Productivity Summary

To recap, labor productivity refers to the value of output (say dollars' worth of cars) produced when compared to the amount of labor used to create that output. "Higher" labor productivity means that more output is produced per hour of work. To compare labor productivity over time, output values have to be adjusted for inflation. Productivity can also be compared over time by comparing output growth to the growth of all inputs, including labor and capital and possibly other inputs, such as fertilizer used in growing a crop. This is termed total factor productivity. Increases in output not "explained by" increases in input show up as higher total factor productivity and are often attributed to improvement in technology. Productivity increases show up in the marketplace as lower costs for goods and services relative to wages, at least in the aggregate, but workers are often displaced in the process. In the end society as a whole is made better off by productivity increases since there is more output per work hour, but this increase in income is not usually distributed evenly, at least in the short run, as those displaced by productivity increases may not find work that pays as well as their old jobs. As we saw in The Island thought experiment, trade can help ameliorate the employment effects of increased

[29] GDP doesn't include the cost of replacing machines and other capital as it wears out. GDP net of depreciation is called Net Domestic Product (NDP) and is a better measure of output and income that could be consumed. GDP in the USA was $21.4 billion in 2019 while NDP was $18 billion.

[30] "World Bank GDP (current US$)." n.d. Accessed December 15, 2021. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

productivity. In the absence of trade barriers, exports and employment will go up when productivity results in lower prices[31]. For a country as a whole, productivity is measured as "gross domestic product", or GDP, per worker. A similar measure, GDP per person, indicates how rich a country is, on average, but of course says nothing about income distribution. One can get an idea of how countries compare economically by looking at their GDP per capita and per worker.

International Trade

While most people understand the benefits of trade on a free market within a country, free international trade is not as universally seen as beneficial. Yet exactly the same factors that make trade within a country beneficial apply to international trade. If trade is restricted, say through tariffs or import quotas, that creates, by definition, a market imperfection. It is no wonder that free market economists generally believe the advantages of free trade outweigh any disadvantages.

Trade happens constantly, in supermarkets, between businesses, on the Internet. It is how the demand and supply curves and their intersection determine "market price". People and businesses will look for the best price for goods or services and buy the one that has the lowest price when all factors such as quality and durability are figured in. To continue in business, the supplier has to ger a price that includes all the costs of producing the good or service, transportation costs, etc. and any taxes, such as state cigarette tax that have to be paid when crossing state lines[32].

It is intuitive that trade within a country is a good thing. If every state had to have its own car factory, cars would cost a lot more because there are enormous economies of scale in the automobile industry. Maine would find it very expensive to grow oranges in greenhouses, while Florida is not really great for potatoes.

As these examples suggest, trade within a country increases not only competition but also the variety of goods and services that can be purchased. It also suggests that a state within a country, or rather the producers in each state, should and will produce what they produce most efficiently compared to other states. Indeed, trade is largely about differences in productivity between locations. To get a feel for this, let's look at how wages in a traded good are related to productivity differences.

Comparative Advantage

[31] Prices always have to be adjusted for inflation in order to be comparable over time. We'll look at how that is done in Part II.
[32] Cigarette smuggling far outpaces illegal drug smuggling in the USA in dollar volume terms.

Consider two countries, we'll call them Rich and Poor. Rich is fully industrialized and has, on average, twice the productivity in producing stuff as Poor. That means that it takes on average twice as much labor to produce something in Poor as in Rich. If we assume that Rich and Poor trade with each other, then (ignoring capital costs for simplicity) workers in Poor can only be paid half of what workers make in Rich if the prices of goods made in the two countries are going to be equal. For example, if it takes 1 hour of labor to produce a shirt in Rich and the labor rate is $10 per hour, then the shirt would cost $10 plus materials and shipping etc. In Poor it would take 2 hours to produce the shirt, so the maximum labor rate would be $5 per hour for the shirt to cost the same and be competitive in trade. Simply put, because of a lack of capital, workers in Poor can only make half as much stuff in the same time as workers in Rich, and so can only have half the effective pay rate per hour.

Now suppose that in Poor, there is a product that doesn't take twice as much labor to produce as in Rich. Say bicycles can be put together in 5 hours in Rich but it takes 7 hours to make one in Poor, so not twice as long. At $10/hour the labor component of the bike in Rich is $50, but in Poor, where the labor rate is $5/hour, the labor to make the bike is only $35. So, bikes made in Poor can undercut bikes made in Rich and the owners of bike factories in Poor can make a tidy profit.

This tendency of trade to favor higher *relative* labor productivity is called "comparative advantage" and was first described by the brilliant early economist David Ricardo in his book "On the Principles of Political Economy and Taxation" in 1817. In our example, Rich has an *absolute* labor advantage in producing both shirts and bicycles, but Poor has a *relative* (aka comparative) advantage in producing bikes compared to shirts.

Let's look a bit more at what happens to the manufacture of bikes in Rich and Poor. Since Poor can undercut Rich in bicycles, bicycle manufacture in Poor will expand but will decline in Rich. As prices for bikes decline in Rich, demand will increase, and eventually the supply and demand curves will meet in the usual way, and the number of bicycles manufactured in Poor for export to Rich will reach a more or less constant level of say 20,000 bicycles a month. This will increase employment in bicycle manufacturing in Poor and it may help to raise wages there depending on how "tight" the supply of labor is and how big the bike segment is relative to the entire economy.

What happened to the workers displaced from bike manufacturing in Rich? We have been implicitly assuming that labor is a mobile factor of production for bikes, so the bike workers in Rich should be able to find other work at $10 per hour. In fact, there will be many other industries in Rich that have a comparative advantage over Poor and where Rich will in fact export to Poor. The United States, a rich country in terms of capital, exports a lot of vehicle parts and integrated circuits because it has a comparative advantage in those products relative to some other countries[33].

[33] Comparative advantage is often defined as an economy's ability to produce a particular good or service at a lower opportunity cost than its trading partners. If as a businessman I can earn a better return investing money in making tablecloths for export versus making tables for export, then I will do so. The

There are some other lessons we can learn from this example of comparative advantage. Note that the price of bicycles has gone down in Rich. This not only puts extra dollars in the pockets of bicycle buyers but also allows some people who couldn't afford bicycles before to buy one. If bike workers in Rich had to match the labor rate in Poor, $5 per hour, then every such dollar would have to come out of their pay but if the general labor rate in Rich is not affected and the bike workers find other employment, possibly in an industry in which Rich has a comparative advantage, then clearly Rich benefits from the trade. And so does Poor since they can trade goods in which they have a comparative advantage for goods in which they have a relative disadvantage. In other words, it is a win-win for both countries and that applies even if the bike workers in Rich can't quite get the $10 per hour they were getting before because of the lower price of bicycles in Rich.

Don't worry if you have a bit of difficulty "getting" comparative advantage through the example above[34]. The more intuitive way to put it is that you should do what you do best. Sure, you'd like to be the absolute best, and hence make the most money, but doing what you do relatively well is the next best thing. If you think about it, that's what we usually do, or try to do, in our work lives. Comparative advantage says that two countries with differences in relative productivity will always be able to trade to mutual advantage. Prices will come down (which is equivalent to wages going up), more goods will be produced (because a decline in prices or increase in wages means an increase in sales), and there will be more diversity of goods and services.

A quick note on the equivalence of falling prices and increasing wages. If the cost of a car, say, goes down by 20% or your pay goes up by 20%, you still pay less for the car relative to your income. "Real" income changes are measured in terms of how much income goes up relative to a basket of goods. This is the "inflation" adjustment we're all aware of and mentioned above. Since we're measuring real wages in terms of a basket of goods, it doesn't matter whether the basket of goods has gotten cheaper, or wages have gone up. Of course, both can go up due to inflation, which is a general price increase, but the ratio of wages to the basket of goods will change, and that change will be positive for both increased productivity and trade in the comparative advantage model. However, workers in trade competitive industries can in fact lose out at least in the short run because the benefits are not evenly distributed. If I work in a profession that is unaffected by trade, then a cheaper bike is great. But not so much for the bike worker who may take a pay cut in shifting to a different job. Since trade is not restricted to bicycles, large segments of the population may find themselves seeming to earn less. Sure, they will pay less for bicycles and other traded goods, but for non-traded goods such as health care and education their lowered incomes will now not go as far. This does not mean that trade

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reason for the difference in opportunity costs is related to differences in relative labor productivity among other things. Opportunity cost is a fancy way of saying getting the best return for money. Your opportunity cost for investing in one thing is the return you could have made investing in the best possible alternative. Opportunity cost = Return on option A – Return on option B.

[34] The famous economist Paul Samuelson once said, "Thousands of important and intelligent men have never been able to grasp the principle of comparative advantage or believe it even after it was explained to them." I've always intuitively wondered why people don't fall off the bottom of the earth, even though I know the answer. We'll look at the evidence on comparative advantage in Part II.

overall has not benefited the country in dollar terms, but it does mean that the benefits are unevenly distributed and overall "utility"[35] may go down unless redistributive mechanisms are in place.

One last wrinkle. Let's say Poor, like China 30 years ago, has abundant labor. Bicycle manufacturers won't have to raise wages to attract all the labor they need. Instead, competitively, they will keep prices low, which will expand their sales to Rich. In local terms, wages haven't gone up, nor have prices gone down (unlike in Rich). How is this a win? Well, exports will increase, which will either increase GDP or allow for more imports or, more realistically, both. And there is only "spare labor" because the wages on offer are still better than, say, working as a subsistence farmer. So, in fact Poor will benefit.

Comparative advantage, like the perfect free market, describes a simplified ideal which helps us understand and model trade. Like the perfect free market there are many assumptions that underlie the model and numerous real-world imperfections and additional considerations. We can learn a lot about trade in the real world by considering how it differs from the ideal of comparative advantage.

First of all, our two country two product example which only considers labor is way too simple and makes many unrealistic assumptions[36]. Economists have worked hard to show that comparative advantage holds when considering many countries and many products even when some of the assumptions are made more realistic. And the fundamental insight of comparative advantage still applies when other factors of production, in particular capital, are added to the mix to create more comprehensive trade models. There is also statistical research to support comparative advantage[37].

In the real world most goods have to be shipped and many services can only be performed locally. The cost of a good includes not just the cost of production but also shipping costs and any tariffs. For many heavy, lower priced items the shipping costs can outweigh any productivity advantages. This explains why countries tend to trade most with their closest neighbors. The US's top trading partners in 2019 were Canada and Mexico, and only then China.

[35] The workers who are hurt economically may feel more pain than the larger group that benefits from lower prices feels the benefit. "Utility" to individuals cannot be summed in straight dollar terms.
[36] A good list of assumptions underlying the 2 country, 2 product example can be found at: Borad, Sanjay Bulaki. n.d. "Comparative Advantage." Accessed August 27, 2021. https://efinancemanagement.com/international-financial-management/comparative-advantage.
[37] See "Economists Find Evidence for Famous Hypothesis of 'comparative Advantage.'" n.d. Accessed August 25, 2021. https://news.mit.edu/2012/confirming-ricardo-0620 or Krugman, Paul R., Maurice Obstfeld, and Marc Melitz. 2011. International Economics: Theory and Policy, 9th Edition. Addison-Wesley pp 45-47.

Can Trade Hurt Wages?

The assessment of trade just given indicates that international trade is always a good thing, that it just extends the benefits of the ideal market beyond a country's borders. But in fact, trade, even within a country, can be a disaster for some people despite producing overall benefits for the country. In the United States, for example, when auto manufacturing plants moved from the high labor cost (unionized) states of the Northeast and Midwest to the low labor cost (non-unionized) southern states, it hurt an entire region. On the other hand, the lower labor costs helped keep down the price of cars for all consumers. Trade theory suggests that the winners could have compensated the losers with something to spare but of course that rarely happens and workers in the trade competitive industry usually find themselves worse off, at least temporarily[38].

It is important to note that even displaced workers benefit from lower prices. Garment workers displaced in the US by imports were able to buy imported clothes for less than they could have produced them themselves[39]. To recap: the lowering of prices relative to wages from “cheap imports” amounts to a general wage increase, as we’ve noted. As we’ve also seen, wages are directly related to productivity, so in an industry affected by trade, real wages in the importing country could only fall to the point where productivity times wages between the two countries (importer and exporter) are roughly equal in that industry. In short, the real determinant of a wage differential between countries at full employment is productivity. Trade allows *both* countries to focus on producing goods and services where relative productivity is highest, and neither country can be made worse off, in the aggregate, through trade. So, countries can only be made better off, in the aggregate, by trade[40].

That said, displaced workers in an importing country can be made *relatively* worse off, and not just in the short run. To understand how, we only have to remember that not all goods and services can be traded, and that labor cannot always freely flow from one occupation to another. People holding jobs that are not subject to trade will benefit from the lower prices resulting from trade while the workers in trade competitive industries will find their skills in less (or no) demand. The result is an increase in income inequality. Further, the increase in supply of labor resulting from workers being displaced by trade (internal or external) will bring down wages generally in jobs for which these workers could compete.

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[38] Historically when jobs migrated, so did workers, and in the US we have seen a migration of workers from the former “rust belt” states to the South. With the advent of income support programs worker mobility has declined in “developed” countries. This leads to problems associated with regional underemployment and income decline. In the US an excess rural population is made possible by various support programs as well.

[39] Poor working conditions in other countries are the equivalent of lower wages and do not affect the conclusions about comparative advantage. There are moral reasons to seek that these be addressed.

[40] This applies to trade between two countries. An exporting country can be harmed if its exports are hurt by competition from a new competitor, but that is not an argument against trade as a whole, rather an argument for trying to limit foreign competition through trade secrets and patents and other means. Also, a country can be hurt by competition for resources, but presumably the resources were either not available or more expensive domestically. The economist Paul Samuelson pointed out the multi-party trade issue.

Overall economists attribute most of the job losses in manufacturing in the US to automation and other productivity increases rather than to trade competition. In the US, manufacturing's share of real GDP has remained at around 12% from the 1940's through today, while the share of employment in manufacturing has declined from around 28% to below 10%[41]. In other words, we manufacture as much stuff now as we ever did (more in real dollar terms since GDP has grown) but do it with far fewer workers and at lower cost. Workers displaced from jobs because of automation or trade find other work as the economy grows, often in services. We will look at the implications of this shift, as well as the relative contributions of automation, trade, and immigration in Part II.

Balance of Trade

We have made the blanket assertion that free trade, in currency if not utility (think overall happiness, we'll get to this later) terms, is as mutually beneficial between countries as it is internal to a country, and for the same reasons. How is this assertion affected by the "balance of trade"?

The balance of trade refers to the difference between how much a country exports and how much it imports. In 2019, the United States had the following trade volume and balance of trade deficits with its top trading partners[42]:

Canada	$727 billion traded with less than a billion deficit. Exports and imports of goods and services were both $363 billion.
Mexico	$682 billion traded with a $104 billion deficit. We bought $393 billion worth of goods and services from Mexico and sold $289 billion worth.
China	$638 billion traded with a $304 billion deficit.
Japan	$306 billion traded with a $56 billion deficit.
Germany	$260 billion traded with a $67 billion deficit.

If we buy more goods and services from another country than we earn from selling them goods and services, the difference has to be financed somehow. It's just like a family buying more than it earns in a year. How does this happen?

There are two major ways to finance a deficit in the balance of trade:

- Selling assets such as companies, real estate, and stock
- Borrowing money through sales of government and corporate bonds

[41] "Is U.S. Manufacturing Really Declining?" Federal Reserve Bank of St. Louis. November 4, 2017. https://www.stlouisfed.org/on-the-economy/2017/april/us-manufacturing-really-declining. However, "real" output is "adjusted" for "quality" which can lead to an overstatement. For a less rosy assessment of US manufacturing see Baily, Martin Neil, and Barry P. Bosworth. 2014. "US Manufacturing: Understanding Its Past and Its Potential Future." The Journal of Economic Perspectives: A Journal of the American Economic Association 28 (1): 3–26.

[42] "International Trade in Goods and Services." n.d. Accessed December 29, 2021. https://www.bea.gov/data/intl-trade-investment/international-trade-goods-and-services.

A few hypothetical examples of how this happens will help to clarify. Let's say Toyota sells cars made in Japan in the United States and is paid for those cars in US dollars. What can Toyota do with these dollars?

- Toyota can park the dollars in a Citibank account in New York. The bank account is a US financial asset that is now owned by a Japanese company which it can cash out at a later date. We sold an asset.
- Toyota could use the dollars to build a factory in the US. This is also an asset and represents an increase in wealth for a Japanese company. Since the factory could be sold, it also is a form of savings.
- Toyota could buy a US car parts company with dollars. Again, this is a US asset which is sold to a foreign company.
- Toyota could also sell dollars for yen on the foreign exchange markets. If there isn't an equal quantity of dollars bought for yen by US companies (i.e. balanced trade), there will be a glut of dollars and a shortage of yen. The Japanese Government may buy US treasury bonds with Japanese tax revenue to stabilize the exchange rate. This is savings by Japan through the purchase of a US asset. From a US perspective it is a loan from Japan.

In the end, the combination of asset purchases and loans must balance the trade deficit. If it doesn't there will be a surplus of dollars on the currency exchanges, and as we know a surplus of anything will make its value fall on the market. If the trade deficit with Japan were not balanced by the sale of assets to Japan and loans from Japan, the dollar would fall in value against the yen which would make Japanese goods and services more expensive in the US and US goods and services less expensive in Japan. That would tend to decrease the US trade deficit with Japan. But for a large, rich, creditworthy country like the United States, selling assets and borrowing money can go on for a very long time. The same is not true for smaller emerging economies.

We will go into more detail on the numbers in Part II, but the net difference between US assets abroad and foreign holdings of US assets has grown to keep pace with the trade deficit and was around $16 trillion dollars in 2019, or about $4 trillion dollars less than the 2019 GDP of $20 trillion[43]. This is like having a mortgage of $100,000 on your house, and an annual income of $125,000. With low interest rates (2019) this was not an unmanageable burden for the US, but as interest rates rise and the debt increases, the burden will increase.

Oddly, there isn't a strong consensus among economists about whether trade deficits are always good or bad. When Toyota opens a factory in Tennessee it creates jobs in the US. The fact that the profits "belong" to Japan is really not terribly germane in an era when capital flows easily around the world. General Motors is as likely to build a factory abroad as Toyota and both do so to maximize profits.

[43] "U.S. International Investment Position, Third Quarter 2021." n.d. Accessed February 8, 2022. https://www.bea.gov/news/2021/us-international-investment-position-third-quarter-2021. This article also contains more details on the composition of US and foreign holdings.

Building or buying factories is called “foreign direct investment” (or FDI) and this type of investment is actually sought after by many less-wealthy countries as a way to increase capitalization. The other component of US debt to the rest of the world is “portfolio investment” such as government and corporate bonds. This borrowing can finance current consumption but also finances investments which hopefully yield a return which exceeds the borrowing cost.

For a smaller country, high net foreign debt poses a clear danger as investor loss of confidence can precipitate a crisis. For the United States, large trade deficits financed by borrowing and asset sales help drive the world economy during hard times and foreign direct investment in producing products and services create jobs and help drive productivity increases here. On the other hand, payments on foreign loans (e.g. foreign purchases of US Treasury bonds), dividend payments on US equities and other “portfolio” debt act as a drag on the economy. It is clear that borrowing to finance current consumption benefits current consumers at the expense of future ones (our kids) who are saddled with the resulting debt.

Immigration

In the prior section we looked at how productivity and trade affect employment. Both cause changes in employment between sectors of the economy. Productivity increases lead to lower costs for goods such as manufactured items and agricultural products, but the increased productivity means that fewer people must be employed to produce the same level of output[44]. While it is hard to argue that increased productivity is “bad”, it can, and does, force workers to change jobs, and does cause changes to relative incomes and wealth. The same can be said for trade. Overall, trade has net benefits, often substantial, but again it creates economic winners and losers. We will look at who the winners and losers are in Part II, but it is not too much of a spoiler to note that they are often the same for both automation and trade.

How does immigration affect the economy? Does it have net benefits or costs? Does it also create winners and losers?

The economics of immigration bear some similarities to the economics of trade, but instead of importing goods from another country, labor is “imported” directly. Labor is clearly being imported in the case of temporary workers hired to pick crops or skilled workers brought in to fill “shortages” in high tech industries. But one can also think of immigrants, legal or otherwise, as being like imported labor in the short run and from an economic perspective.

If we remember that average productivity per worker determines the overall level of income in a country at full employment, we have a yardstick by which to measure the effects of immigration. Again, let us remember that, under full employment, trade can’t lower the overall level of

[44] By the “law” of supply and demand, lower prices increase demand for those goods, but often not enough to keep employment from falling.

productivity and hence cannot lower the aggregate level of income. Is that also true of immigration?

A couple of thought experiments will help. First let us suppose that a modest number of legal immigrants come to a country, and they have exactly the same skill distribution as the native population. Like native born children entering the workforce, these immigrants will both take jobs and become consumers themselves. They will require houses and cars and food and furniture and pay taxes exactly like the native population. This increased demand will cause industry to increase output by investing in more capital such as factories which will generate an increase in the same mix of jobs as before the immigrants came. In short nothing will change except for a growth in GDP which is proportional to the number of immigrants.

In a second thought experiment, let us suppose that a larger number of "low skilled" immigrants come to the country[45]. In the long run it is reasonable to assume that these immigrants, or their children, will acquire the same skills as the native population, which came over in prior waves of immigration, at least in the US. In the long run then it is reasonable to assume that these new immigrants will be assimilated economically, and the long run result will be a growth in GDP proportional to the growth in population and with no change in productivity relative to what would have occurred in the absence of the wave of immigration.

However, as in the case of productivity changes and trade, there most certainly will be short-term effects. Even though economists sometimes speak of a long-term equilibrium, real world economics is constantly in a state of flux. The new immigrants, coming from low wage countries, will be willing to work for low wages and will compete with native workers for laboring jobs that don't require strong native language skills. The increased supply of labor will result in lower wages for such jobs, for both immigrant and native workers. Lower labor costs in turn will drive down prices for some goods and services, and as in the case of both productivity and trade, lower prices will benefit those whose wages are not affected.

Again, we see that there are winners and losers from immigration. Winners get the benefits, losers have to deal with increased competition, lower wages, and unemployment. The benefits to the country from "less skilled" immigration include:

- Lower prices for some goods and services. For example, low cost boneless and skinless chicken breasts are largely available because the meat packing industry was able to shift from domestic unionized workers to immigrant labor[46].

[45] I hate the term "low skilled" but there are few alternatives. Immigrants fall primarily into two groups: highly skilled - think programmers and scientists, or "low skilled" meaning with less than a high school education. However, my personal experience tells me that a lot of "low skilled" migrants actually often have manual skills such as masonry, plastering, and welding which take time and talent to acquire.
[46] National Center for Farmworker Health. 2014. "POULTRY WORKERS." http://www.ncfh.org/uploads/3/8/6/8/38685499/fs-poultryworkers.pdf. See details later in this book, Part II: migration.

- Immigrants may provide some goods and services that might not be performed at all otherwise.
- Lower labor costs and a predictable source of labor induce businesses to expand and invest, increasing output. This in turn can increase the need for native labor with good language and managerial skills.
- As is the case for any population growth, immigrants create demand for goods and services. For example, rents may go up, and home building may increase as a result of demand from immigrants. Again, these increases in demand for goods and services benefit some natives but can hurt others.
- Paradoxically, importing cheap labor can reduce the demand for goods and services from low wage countries by making domestic manufacture of these items cost competitive.

There is one group that benefits enormously from immigration, and that is the immigrants themselves. Immigrants often come from poor countries and their material standard of living dramatically increases when they migrate to a rich country. Since the migrants go from a country with relatively lower productivity to one with higher productivity, world productivity and per capita income increase. Countries however have to regulate immigration to accommodate home country business (usually pro-immigration because it keeps the labor supply growing and wages down) and home country labor (including those negatively affected by immigration who tend to want to limit in-migration). That worldwide productivity increases when people move from poor countries to rich ones is not a factor in determining a country's immigration policy.

Two other factors that countries do consider in migration policy include the demographics of the workforce and humanitarian considerations. In much of the "developed world" the workforce is aging, and the next generation will have to pay for the care of their elderly baby-boomer parents. Fertility rates in Europe and Japan are well below the replacement rate of 2.1 births per woman[47]. According to one estimate, approximately 533,000 immigrants would need to enter Germany every year to keep the population, and workforce, from falling[48]. Clearly politicians in Germany have an incentive to welcome immigrants, the vast majority of whom are young. The US also has an aging population and a birthrate of less than 1.8 children per woman. Our population would be falling if not for immigration.

There are also humanitarian considerations when it comes to immigration. In addition to economic migrants, there are now, as there have been throughout history, many people who are forced to flee for their lives due to wars, genocidal attacks, or imminent starvation. Many countries accept such immigrants on a priority basis. It is sometimes difficult to separate economic migrants from those who are really in danger of losing their lives "back home", but a mistake can be a death sentence. The United States had a total of about 360,000 resident

[47] The replacement rate of 2.1 births per woman over her lifetime applies to developed countries. In countries with higher mortality for women before the end of their reproductive lives, the replacement rate is slightly higher, up to about 2.3 births per woman.
[48] "Aging Workforces and the Politics of Immigration." 2017. Grayline Group. June 14, 2017. https://graylinegroup.com/aging-workforces-and-the-politics-of-immigration/.

refugees (also known as asylum seekers) in 2020, while Germany hosted over 1,000,000 and Turkey 3,650,000[49]. The US has a total of around 44 million foreign born residents presently and admits around 1,000,000 new legal immigrants a year. Refugees are a small fraction of those admitted each year in the US, the allotment has been well under 100,000 for years and as low as 15,000[50].

Finally, we noted that economic migrants tend to be high or low skill with relatively few in the middle. Low skilled migrants are unlikely to improve a country's overall productivity much at first, but the same is not true of high skilled migrants such as scientists and engineers. Some countries, such as Canada, prioritize highly skilled immigrants, as does the US.

We will try to sort out the data on the economic effects of immigration in part II, but most studies show that immigration doesn't have much effect on per capita GDP one way or the other in the United States. However, immigration, like productivity increases and trade, creates winners and losers and increases income inequality.

Capitalism, Socialism and All That Jazz

This overview of economics has implicitly assumed a market economy with private ownership and government regulation, a pretty common model. We have avoided labels, but of course countries differ in their economic and political systems. One often hears people talk of "capitalism versus socialism" or "capitalism versus communism". If we treat communism as a form of socialism, we can clarify this labelling dichotomy.

Capitalism and socialism are usually defined in terms of ownership of the "means of production".
In a capitalist country, industry and trade are controlled by private owners for profit.
In a purely socialist country, industry and natural resources are owned in common, and decisions on what to produce are planned.

The extremes of each system are laissez-faire free market capitalism on the one hand, and a totally planned socialist economy on the other. Neither extreme exists in the world today, and for good reason[51]. Central planning has given way to markets everywhere in the world, regardless of who owns the means of production. The "invisible hand of the market" is simply the best way to balance supply and demand and to drive innovation and productivity increases. As we will see in Part II, the remarkable rise of China, still an ostensibly "socialist" country, has been driven by its switch to market incentives and a mixed ownership economy. Even state-owned enterprises in China now are organized as profit seeking corporations with their own boards of

[49] "Refugee Population by Country or Territory of Asylum." n.d. Accessed February 16, 2022. https://data.worldbank.org/indicator/SM.POP.REFG.
[50] "The Current State of Immigration in the United States." n.d. Accessed February 16, 2022. https://www.immigrationhelp.org/learning-center/the-current-state-of-immigration-in-the-united-states.
[51] We've discussed the problems with laissez-faire capitalism at length.

directors and executives[52]. In addition, nearly half of China's GDP now derives from its vibrant, rapidly growing, "capitalist" private sector.

US Corporations probably come to mind as exemplars of "capitalism", but paradoxically they illustrate that the profit motive works even when ownership is widely distributed. US publicly traded companies are owned by their stockholders, and anyone with money in a retirement fund holds such stock. If everyone in the US held equal amounts of stock in say Facebook or Ford, these would be truly "socialist" entities on an ownership basis. Everyone wants to see the value of their shares go up, and the managers of these enterprises are highly incentivized, including financially, to grow their companies and increase profits.

In short, market economies are almost universal in the world today, and private ownership of much or almost all the productive capacity, capitalism, is equally widespread. When people talk about "socialism", especially in the US, they are usually talking about government measures designed to address the various issues we identified above with laissez-faire free market capitalism, such as externalities and monopolies and crashes. They are also often talking about any programs that redistribute income, such as Social Security and Medicare. Such redistributive programs don't directly affect the economic engine of market capitalism, but by influencing demand, they do influence what is produced. Medicare recipients, for example, will cause an increase in demand for doctor's services over the no Medicare alternative. Such programs are not "socialism" in an economic sense, and they often end up benefiting the economy. Public education, for example, has a positive effect on productivity, which makes us all richer in the end.

This is a book on economics, not politics, but it is important to clarify that capitalism and socialism are economic systems that are compatible with a variety of political systems. Singapore was mentioned earlier. It is a democracy rated as one of the least corrupt in the world and has an extensive state-owned sector producing one third of GDP and a per capita income higher than in the US. Nazi Germany, a mixed economy, had a corporate capitalist sector that benefited greatly from slave labor and government contracts. It was of course a dictatorship. Russia is also a mixed economy and dictatorship with much of the capital owned by a small group of oligarchs. Corruption is rampant. The US, Western Europe, and most other "advanced economies" are democracies and fully capitalist, but with varying levels of social programs and regulation. China has a complex one-party political structure and a hybrid economy with the party still "guiding" the economy through planning and industrial policy.

Labels such as "socialist" or "capitalist" are way too simple to characterize a country economically, and even less useful when characterizing a country's overall political and

[52] Guluzade, Amir. 2019. "Explained, the Role of China's State-Owned Companies." World Economic Forum. May 7, 2019. https://www.weforum.org/agenda/2019/05/why-chinas-state-owned-companies-still-have-a-key-role-to-play/.

economic structure. These terms imply a simple dichotomy when the reality is that countries must be characterized along many interrelated dimensions[53].

The Free Market and Utility / Happiness

In the economic primer, we looked at a textbook description of modern economic theory. Much of it is common sense, like the relationship between price and supply and demand. We discussed how an ideal free market maximizes "utility" given people's incomes. Utility describes how important a particular market product or service is to you. To review: you make your purchasing choices to maximize your "utility" or satisfaction given your finances and prices. That in turn causes businesses to compete for resources to produce the levels of products and services demanded by the market. Add that up across all consumers and you get resource utilization that maximizes "utility": there is no way to divide up resources that makes people more satisfied *given their finances*.

You may have noticed that the phrase "given their finances", is key to the above definition of utility maximization. As we discussed in the box on the minimum wage, an extra $1,000 to a poor person is almost certainly going to buy them more "utility" than is lost by a rich person who gives up $1,000. In fact, charity is sort of based on this concept: it provides "utility" to the giver as well as the receiver: both gain utility because of this voluntary exchange.

We won't go into a discussion of "utilitarianism" other than to note that a true free market almost certainly does not maximize overall "utility" when there is considerable inequality. In a true free market people are paid what their labor is worth under supply and demand just like any other input to the production process. But humans are not like inanimate factors of production. We could increase overall satisfaction (utility) by paying workers at the lower end of the income scale more. However, that might disincentivize such workers from seeking education to make their labor more valuable and productive, or from changing jobs, which could hurt overall productivity gains and thus future real incomes. But that in turn assumes that there is a reasonable level of mobility: as a low wage worker can you realistically pursue education if you're supporting a family for example?

Since there is no way to measure "utility" directly, the above soup of conflicting considerations must be addressed politically. We don't want to kill the golden goose of productivity gains brought to us by market competition, including labor competition. We should support mobility through education and other programs. But even with good support for mobility, not everyone will be able to find "good paying work". Someone trained in yesterday's technologies who was a solid cog in the productive wheel may not be able to learn a new occupation. There may be a glut of labor in some markets at some times. Advanced economies certainly produce enough to

[53] For a overview of the different types of capitalism, see https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/Capitalism

give everyone a decent standard of living, but do we strive to do so, and how? A variety of approaches have been used by rich countries as we discussed in the chapter on inequality.

While utility can't be measured directly, pollsters have found ways to rank "happiness" in terms of self-declared "life satisfaction" in consistent terms. Rather than detail that here, I will point you to the excellent discussion in Our World in Data[54] and summarize the findings. In brief, life satisfaction goes up with income. People are more satisfied with their lives in richer countries than in poorer ones as measured by GDP per capita. Within countries, people who make more are more satisfied with their lives than those who make less. In other studies, people are overall happier when income distribution is more equal. In sum, people are happier when they make more but the relationship between happiness and additional income is not dollar for dollar: a thousand dollars in ongoing income makes more of a difference to a poor person than to a rich person.

The Role of Government in the Economy

We have noted that since early times, governments have issued standard coinage and set standard weights and measures. Private property and a system of laws are also required in a market economy[55].

Most of the economies in the world today use a more-or-less managed capitalism model. Such a system has a robust market economy with private ownership, but government works to keep markets competitive, deal with market externalities, promote full employment, ensure that wages are sufficient to live on, provide some forms of social insurance, and smooth out business cycles. There has been an ongoing debate in both economics and politics about the extent to which government should intervene in the working of the market. "Neoliberalism" which is paradoxically a philosophy associated with conservatives, asserts that less government intervention in the market and lower taxes increases growth and makes us all richer, at least in the aggregate. Neoliberal policies (think "deregulation" and "supply side" and "trickle down" economics) were put in place in the United States under Ronald Reagan and in Britian by Margaret Thatcher. You can draw your own conclusions as to whether this was good, bad, or indifferent, when we look at the data on growth and inequality in Part II. Suffice it to say that too little government involvement in the market can be as bad as too much.

Managed capitalist economies, indeed, any market economy, is prone to booms and busts. These can be extremely painful, the Great Depression being a prime example. At the time, economic theory said that the free market would address these busts automatically: workers would simply have to take lower wages until full employment was again restored. Under supply and demand curves as usually drawn, this might seem to make sense. But what if there is no demand for labor? The economist, John Maynard Keynes, pointed this out and suggested that

[54] https://ourworldindata.org/happiness-and-life-satisfaction
[55] Strictly speaking you don't need private property in a market economy. A farmer doesn't need to own his land to take his crop to market, but he must have ownership of the product of his labor.

the problem was one of inadequate demand. If, for whatever reason, demand for goods and services falls in an economy, the demand for workers falls and some of them are let go. The unemployed are going to spend less, reducing demand further, and other workers become insecure and start spending less as well. Demand crashes, unemployment rises, and voila, you have a depression. Keynes suggested that governments should pump up demand by spending to make up for the lack of consumer spending. This is precisely what was done by FDR, and it worked.

When you think about it, the idea is common sense. The Biblical story of Jacob has him interpreting the dream of the Pharoah: save during the fat times and spend during the lean years. In Aesop's fable, during the summer the ant puts away food for the winter. In similar fashion, governments can cool overheated inflationary economies by cutting back on spending or increasing taxes and spur a sagging economy by spending more or cutting taxes. This is called "fiscal policy" since it relates to spending. A second tool, monetary policy, is used to manipulate interest rates: lowering interest rates makes money cheaper, which boosts spending and the economy, while raising interest rates makes big ticket items more expensive and can cool inflation. Governments around the world use fiscal and monetary policy now to smooth economic swings.

The recent COVID epidemic shows how powerful these tools are. Without governments "printing money" as some would say (actually, borrowing) the world economy would have crashed. The Great Depression would have been a picnic in comparison. After the end of COVID a mismatch between low levels of supply and high levels of demand resulted in inflation which prompted central banks to raise interest rates.

In short, government has a crucial role to play in market economies.

Part II The Economic World in Data

Economic theory provides a framework for economic data, but while theory is comparatively neat, real-world data is very messy despite the best efforts of statisticians. As we will see it is not easy to track productivity over time because the mix of products constantly changes. The same goes for estimating inflation: a “car” now may have many more features than one from 1960, how much of the price change in that time is due to these additional features?

The problem becomes worse when trying to compare or integrate data from different countries which may have different ways of collecting and categorizing data.

And then there are the econometric models which try to separate out the contributions of various factors in economic changes. How much of the change in employment in the auto industry in the US was due to automation versus trade for example. These models make simplifying assumptions and often vary quite widely in their conclusions.

Nonetheless, statisticians and economists have made heroic efforts to standardize data and draw conclusions from it. And what follows is a heroic effort to summarize some of that data and the conclusions drawn from it.

I live in the United States, so I have focused on the US as an example of a country at the productivity frontier, but much of what is true of the US is also true of other advanced economies. I have also given special attention to China as it is an equally large economy which has developed rapidly in the last few decades.

The Productivity Frontier

The Industrial Revolution(s)

Labor productivity tells us how much labor it takes to produce something. A horse lets a farmer plow a field much more quickly than he or she could without one and so raises their labor productivity, but at the cost of buying and maintaining a horse.

Throughout most of human history, productivity advancements were modest at best. The modern era of rapid industrial productivity growth began around 1760 when the British started inventing machines to spin and weave cotton and run them using waterpower. This greatly increased the amount of cloth that could be produced and lowered its cost, but also put the hand weavers of Lancashire out of business. The Industrial revolution continued with a suite of technologies advancing in step, including the use of coal and coke in iron making, the steam engine, railroads, the scale production of industrial chemicals and machine tools, and others. Equally as important were earlier and ongoing advances in agricultural productivity resulting from better crop practices, the introduction of the potato and corn and guano fertilizer from the New World, and improved agricultural machinery. These advances in agriculture allowed fewer farmers to grow enough food to fuel a population boom which in turn provided workers for the new factories[56].

In times of full employment, increased productivity raises average real wages and national income. However, working conditions and worker pay during the initial industrial revolution in Britain were abominable. Charles Dickens' father served time in debtors' prison and, to keep the family afloat, Charles at age 12 had to work in a factory, 10 hours a day, 6 days a week for the modern purchasing power equivalent of $41 a week, or around 70 cents an hour. Charles Dickens' novels are an indictment of working conditions in Britain in the mid-19th century. How is it that working conditions were so abominable after at least half a century of industrialization?

A truly impressive number of papers and books have been published on this subject. The consensus is that industrialization did raise real incomes significantly, but that living and working conditions were indeed awful. According to one analysis of available data, between 1781 and 1851 blue collar workers in Britain nearly doubled their real wages, agricultural workers saw an increase of around 60% from a lower base, and white-collar workers' earnings improved by 150%. Much of this occurred between 1813 and 1851, it took a while for the productivity increases to be reflected in income gains[57]. The increases in white collar wages are a clue to the growth of the middle class which attended industrialization.

That working conditions were lousy can't be doubted. The work week was generally 10 or more hours a day, 6 days a week. Children were widely employed at low pay, especially in the textile

[56] Culture also played a significant role in nursing the revolution.

[57] Lindert, P. H., & Williamson, J. G. (1983). English Workers' Living Standards during the Industrial Revolution: A New Look. The Economic History Review, reprinted in Mokyr, Joel. 2018. The Economics of the Industrial Revolution (Routledge Revivals). Routledge.

factories, with some as young as 8. Unions were at first outlawed and then widely suppressed. After 1850 the trade union movement started to take off in Britain, eventually giving rise to the Labour party and improvements in working conditions.

The United States remained a largely agrarian society until the end of the 1700's when the first textile factories were established using "stolen" British technology. In 1800, 80% of US employment was in agriculture, which declined to 50% in 1860 (and less than 2% today). As in Britain, output per capita doubled between 1800 and 1860[58]. After the civil war, US productivity continued to grow with the expansion of the railroads, steel making, the use of standardized parts, the electric motor, the assembly line and many other innovations. As in Britain, workers fought for better working conditions and pay. Political corruption was commonplace and favored monied interests. Huge influxes of immigrants prevented labor shortages and helped settle the West. Mark Twain and Charles Dudley Warner wrote a book, "The Gilded Age", a play on "golden age", that satirized this period of growth, corruption, and wild speculation, which later gave the period its name. Nonetheless the growth was very real: in 2019 dollars, GDP rose from $100 billion to $500 billion from 1870 to 1913 and real GDP per person went from $4,590 to $10,373 despite the massive influx of immigrants from Europe which more than doubled the population over that period[59]. However, wages were still low by today's standards. A laborer in the US earned about $12,000 a year in 2019 dollars.

After the Second World War, economic growth accelerated, particularly in the former British colonies of the United States, Canada, Australia, and New Zealand, and also in Western Europe. Some authors refer to 2nd, 3rd, and even a 4th industrial revolution as new technologies including the already mentioned electric motor, computers, and most recently automation gained widespread use, but these really form a continuing evolution with many other advances in technology, finance, and infrastructure contributing to increased productivity. The growth in productivity since 1950 is unprecedented in world history. The chart below makes this graphically clear[60].

[58] The labor and growth estimates for 1800 - 1860 are from Weiss, Thomas J. 1992. "U. S. Labor Force Estimates and Economic Growth, 1800-1860." American Economic Growth and Standards of Living before the Civil War. https://www.nber.org/system/files/chapters/c8007/c8007.pdf.

[59] Tables A1-c Maddison, Angus. n.d. "The World Economy: A Millennial Perspective" Oecd-Ilibrary.org. Accessed February 24, 2022. https://read.oecd-ilibrary.org/economics/the-world-economy_9789264189980-en. CPI adjusted from 1990 to 2019.

[60] The differences by country in income shown here are ameliorated by greater local purchasing power in poorer countries. Simply put, a dollar's worth of local currency often buys more in a poorer country than the same dollar would in a richer country. This is especially true of staple items. Economists call this "purchasing power parity" (or PPP) and when comparing per capita GDP between countries, PPP adjustment is often made. Of course, "per capita" GDP says nothing about income distribution in a country.

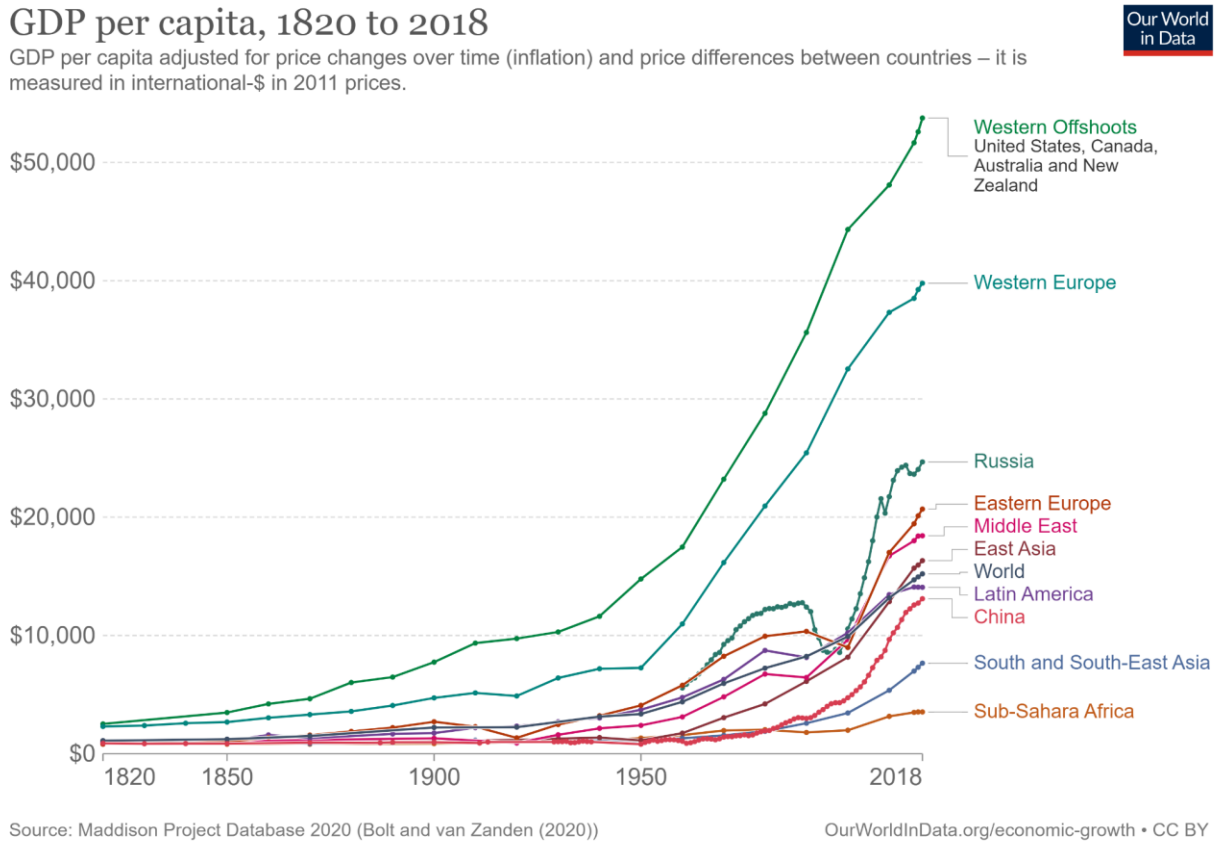


Figure 6 GDP per capita, 1820 to 2018. Graphic: Our World in Data. Data source: Madison Project

So great were the increases in productivity after the second world war that in 1968 a study by the Southern California Research Council, considering the need for recreational facilities, predicted that by 1985 Americans would have to work only six months a year for the same standard of living that they had then. The study envisioned Americans taking up to 6-month vacations, shifting to shorter work weeks, continuing full time for additional income, or retiring as early as age 38.

It actually took until 1998 for US inflation adjusted GDP *per capita* to double from 1965. It took longer (until 2010) for GDP *per worker* to double. This time lag was due to the fact that there were more people working, especially women, in 1998 than in 1965[61]. So instead of the rosy prediction of people working fewer hours as productivity and output increased, there were actually more people working in 1998, and indeed 2019, than in 1965! Why? Did everyone want

[61] As a percent of the population over 16. In 1965 39% of women were in the labor force, in 1998 that percentage had increased to 60%. Men's participation rate dipped from 81% to 75% over the same period. U.S. Bureau of Labor Statistics, Labor Force Participation Rate [CIVPART], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CIVPART, November 14, 2022.

twice as much “stuff” in 1998 and nearly three times as much “stuff” in 2019 as in 1965[62] and place a really low value on free time? Is there inherently something wrong with the way real GDP is measured? Was this due to changes in income distribution and benefits? We will try to answer these questions in the coming chapters. To get a feel for scale, GDP in 2019 in the US was around $142,540 per worker, or $285,000 for a two-worker family[63]. Of course, this is the average value of output.

Productivity Now

Labor productivity advances through technical progress, increased investment in capital goods, increased scale of production, and public factors such as investment in infrastructure and education, stable government, and well-structured legal and financial systems with low levels of corruption.

Economic literature often divides the world into “developed” and “developing” countries, with the former said to be “advanced economies” on the “productivity frontier”, meaning their industries largely use up-to-date technologies and are well capitalized[64]. In such countries labor productivity growth is largely determined by technical innovations. Developing countries on the other hand are not fully capitalized. They can grow much faster than advanced economies because capital investments can shift jobs from, say, low productivity farming, to much higher productivity factory work. The amazing growth of productivity and output in China shows how this process of catching up to the productivity frontier can snowball.

We will look at the advanced economies first to see what has happened recently on the productivity frontier, and we will then look at how productivity is increasing in the developing countries. While there are a variety of countries in both groups, especially in the developing world, I will tend to focus on the United States as an example of an advanced economy and China as an example of a developing one.

Advanced Economies - the Productivity Frontier

Productivity Increases and Deindustrialization

As we’ve just seen, the ongoing industrial revolution, and the concurrent agricultural revolution, have dramatically increased labor productivity in the “advanced economies”. Looking specifically at the United States, it took 80% of the population to grow food in the US in the late 1700’s it takes less than 2% of workers today. Manufacturing in the United States employed over 25% of

[62] U.S. Bureau of Economic Analysis, Real gross domestic product per capita [A939RX0Q048SBEA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/A939RX0Q048SBEA, November 13, 2022.
[63] BEA, BLS 2019 GDP is $21,381 billion, population 328.239 million, 150 million workers.
[64] Productivity increases tend to spread within an economy, not just within industries but between them, as real wages increase. As wages rise, investing in additional labor-saving capital becomes cost effective and necessary to compete.

workers in 1965 and now employs under 10% but still generates about 12% of real GDP[65]. Clearly fewer employees are needed to grow the food and manufacture the items we consume or trade. With less than 12% of the workforce, productivity gains in these two sectors of the economy have had profound effects on employment.

The chart below shows the changes in major sector employment in the US between 1960 and 2020. Goods producing employment, which includes manufacturing, has gone from around 30% of employment in 1960 to about 13% in 2020, and most of that decrease in employment has gone into “service providing” which includes health and education, business and professional services, trade, transportation and state and local government.

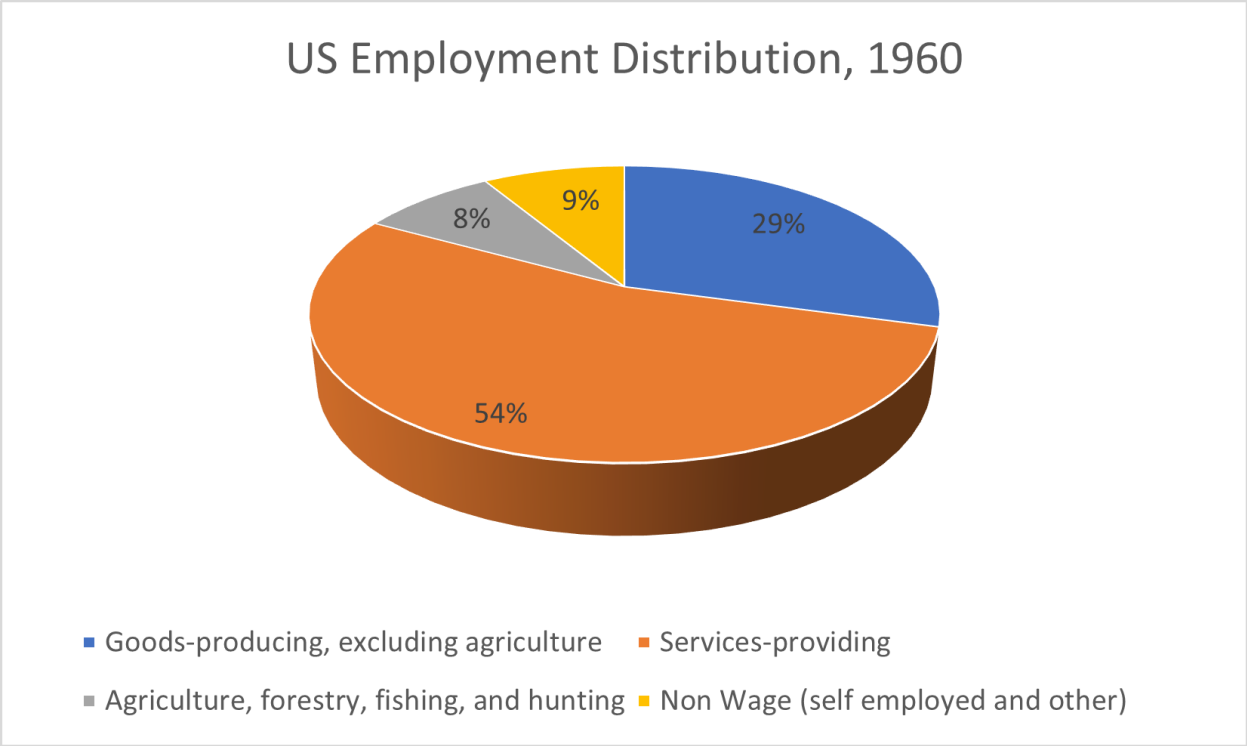


Figure 7 US Employment Distribution 2020 (before COVID). Source BEA NIPA Table 6.5

[65] There are methodological issues with the way the value of output is measured that suggest that the actual output of manufacturing is now a smaller part of GDP. See Baily2014-mf. Employment numbers are from BLS series data.

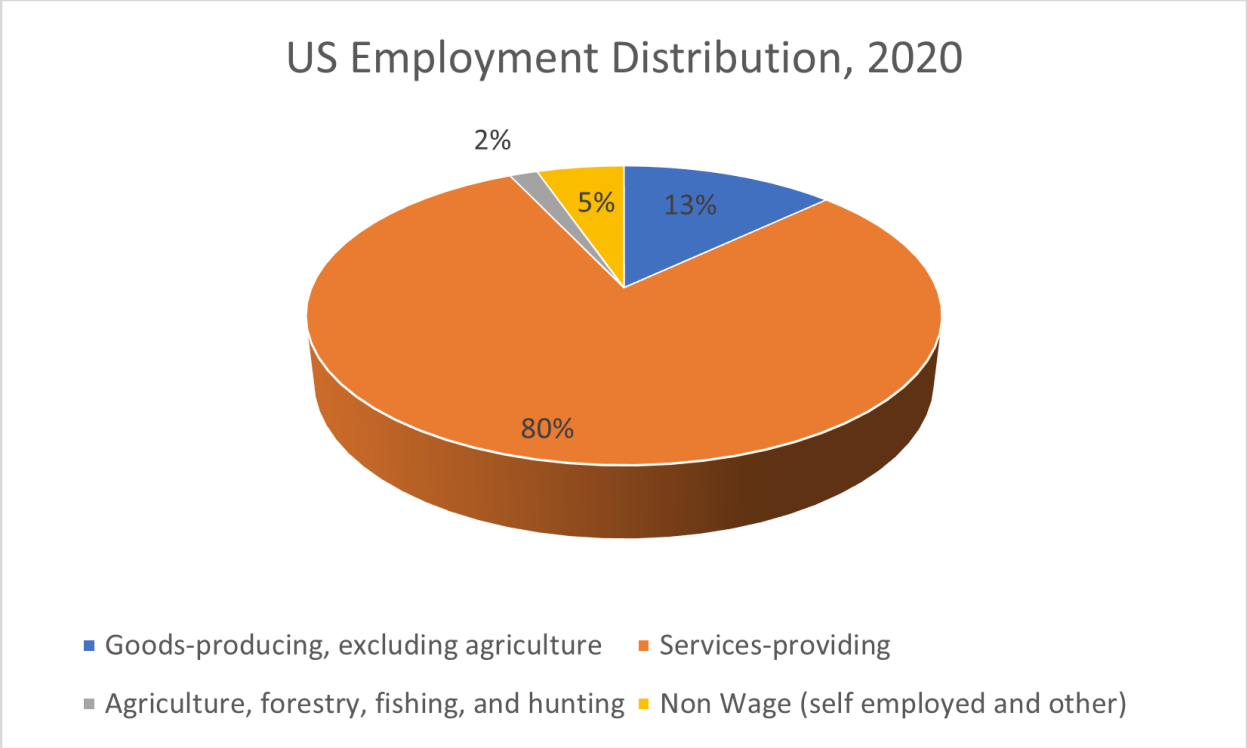


Figure 8 US Employment Distribution 2020 (before COVID). Source BEA NIPA Table 6.5

A more detailed look at the data shows the dramatic shift from goods producing to service providing, and which major economic sectors gained and lost jobs as a percent of the total. The last column shows how many more, or fewer, jobs each sector would have had in 2020 had the employment percentages stayed the same as they were in 1960. The biggest loser is manufacturing where the decline is 23 million jobs, the biggest gainers are health (13 million jobs) and education and professional services (10 million jobs). Agricultural employment is a tiny percent of the total but has lost 75% of its share of employment since 1960.

Table 1: Change in US Employment by Major Sector, 1960 to 2020

Industry Sector	% of Employees 1960	% of Employees 2010	% of Employees 2020	% Chg 1960 - 2020	Jobs lost/gained millions*
Agriculture, forestry, fishing, and hunting	**8%**	**2%**	**2%**	**-80%**	**-9.5**
Goods-producing, excluding agriculture	**29%**	**13%**	**13%**	**-56%**	**-23.2**
Mining	1%	1%	0%	-66%	-1.1
Construction	5%	4%	5%	3%	0.2
Manufacturing	24%	8%	8%	-67%	-22.3
Services-providing, excluding special industries	**54%**	**80%**	**80%**	**49%**	**37.4**
Wholesale trade	4%	4%	4%	-9%	-0.5
Retail trade	9%	10%	10%	14%	1.6
Transportation and warehousing	4%	3%	4%	3%	0.1
Information	3%	2%	2%	-32%	-1.2
Financial activities	4%	5%	6%	47%	2.6
Professional and business services	6%	12%	13%	133%	10.7
Educational and Health	5%	13%	14%	210%	13.4
Leisure and hospitality	5%	9%	9%	65%	4.9
Other services	2%	4%	4%	122%	3.0
Federal government	4%	2%	2%	-48%	-2.5
State and local government	9%	14%	12%	33%	4.4
Non-Wage (self-employed and other)	**9%**	**6%**	**5%**	**-39%**	**-4.8**

Table Notes
* Jobs lost/gained if employment distribution was unchanged from 1960. Total US Employment was around 150 million in 2020. This measure is only a baseline for comparison.
All data except agriculture are from the BLS series. Agriculture is from OECD data.
Transportation and warehousing 1960 is estimated from 1972 data. Agricultural employment is even lower using full time equivalent employment since a lot of it is seasonal.

This shift in employment agrees with the common perception that geographic areas with heavy concentrations of manufacturing have been hit badly by employment declines over the last 60

years. Similarly, the 9.5 million fewer jobs in agriculture helps explain why many rural areas face declining populations.

Note that since the total population has gone up, a decline in the *percentage* of workers in a sector does not necessarily mean there are now fewer workers in that sector. However, the *actual number* of workers in both the goods producing and agriculture sectors is now lower than in 1960. It is also interesting to note that the percentage distributions haven't changed much between 2010 and 2022. This suggests that for now whatever was causing these shifts between the major sectors has abated in the last decade.

What explains the decline in agricultural and manufacturing employment relative to services? There are three main drivers possible: differential productivity increases, international trade, and a change in demand from goods to services. One reasonable hypothesis would be that continued productivity improvements in agriculture and manufacturing have driven down the amount of labor required to produce the quantities of output that the market, including the export market, demands. Since less labor is required to grow food and produce goods, labor has flowed to service sectors such as education, health, and professional services. A second hypothesis would be that merchandise imports, trade, has reduced employment in manufacturing and that slack has been taken up by employment in services. Finally, we could imagine that as the price of goods declines relative to incomes, people find they'd rather spend money on services than more "stuff". In fact, if necessary, services such as healthcare and housing become more expensive relative to goods, people might *have* to spend more money on services.

What has happened in the US is a combination of all three. And the story in the other advanced economies is similar. Here for example is the change in percentage of employment in manufacturing for a sample of advanced economies:

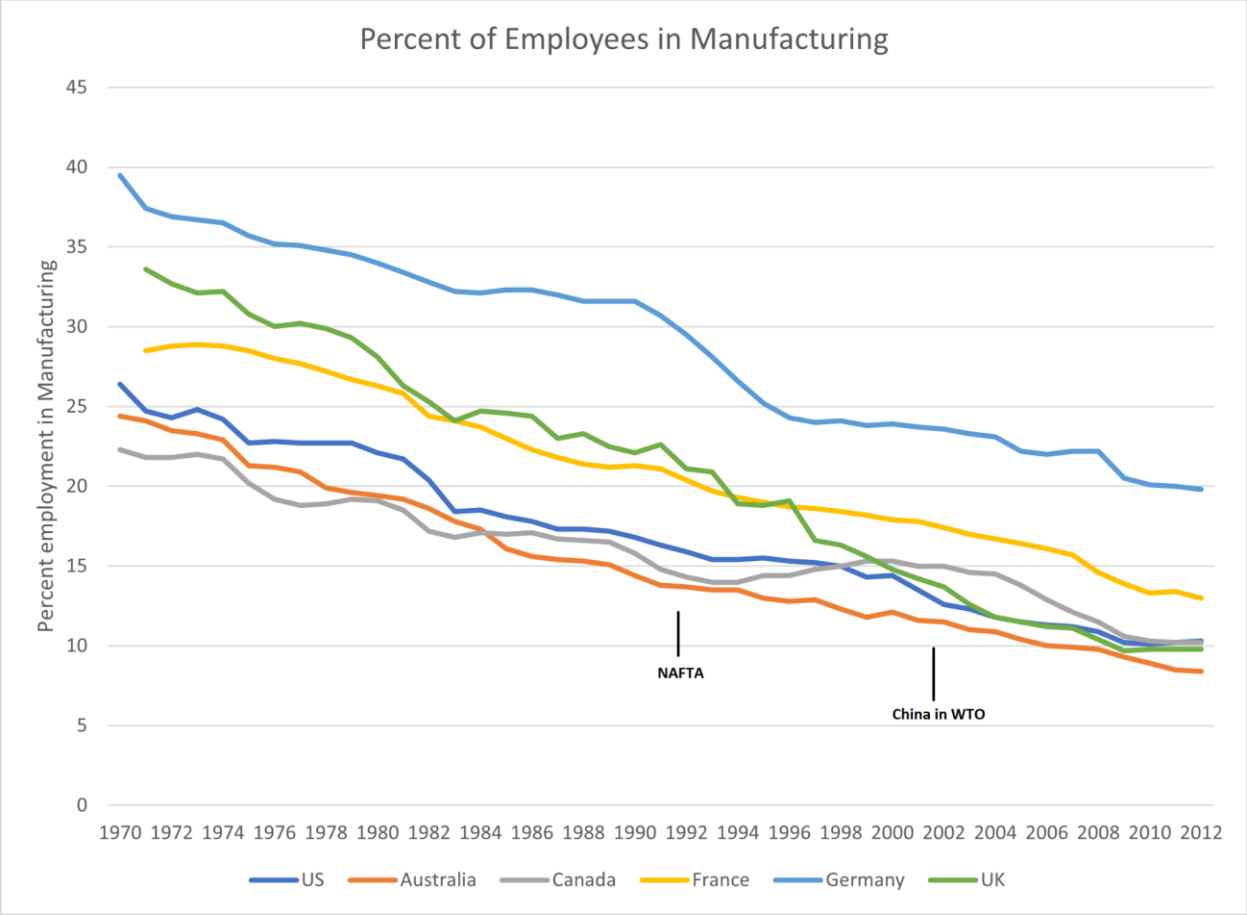
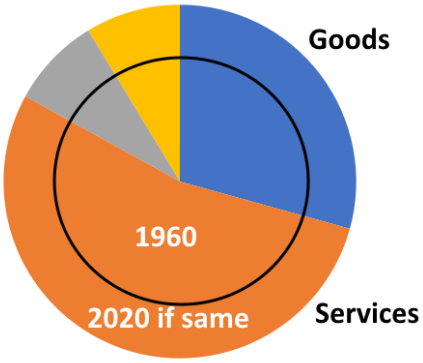


Figure 9: Percent of Employees in Manufacturing, Advanced Economies. Source: International Comparisons of Annual Labor Force Statistics, 1970-2012 Bureau of Labor Statistics WW119

Note that the percent of workers in manufacturing has declined in high income countries even when, like Germany, they run large trade surpluses. A lot of what's happened in the US is applicable to other high-income countries as well.

Before we dive into each of the major sectors of the economy let's look at what the effect would be on our pie chart of the three types of changes we just mentioned: differential productivity increases, trade, and lower demand for goods compared to services.



The graph on the left is our percentages of employment in 1960 again. If there had only been productivity increases, and these increases had been the same in all sectors, then in 2020, the pie would have gotten bigger, but the slices would have been the same relative size as shown.

On the other hand, if productivity increased faster in goods producing (the blue wedge) than in services (the pumpkin wedge), then the goods producing employment slice would get smaller relative to the services employment slice as we saw in the actual data shown in the employment pie charts above[66]. But the same thing could occur if there was an excess of goods imports relative to exports, then the domestic goods producing sector would also not have grown as much and its slice of the pie would get smaller. Finally, if demand had shifted to favor services over goods, then the goods slice would have become smaller as well. The dramatic shift from goods producing to services in the advanced economy countries has been termed “deindustrialization”, and all three factors mentioned above have played a part. However, , as we’ll see later, there is general agreement that increased labor productivity in manufacturing is responsible for most of the employment shift from goods production to services.

Agricultural Productivity and Employment in Advanced Economies

Looking at agriculture, we note that the US has nearly balanced imports and exports in agricultural products, and that output has more than doubled between 1960 and 2019 while the US population has grown by 75% [67]. What is more, the amount of land used by agriculture in the US has remained almost constant. We can infer that, as in the past, productivity increases have continued to reduce the amount of labor required in agriculture[68]. Some of this productivity increase is due to improved technology, crops, and fertilizers, but some is due to increased economies of scale which have resulted in the decline of smaller family farms. Twice the amount of food is being farmed using less than half the labor. The chart below shows output

[66] As mentioned before, increased productivity would result in lower relative prices which would increase demand. The demand increase would somewhat offset the job losses resulting from increased productivity. We are assuming that the increase in employment due to increased demand would be less than the loss of jobs due to the productivity increases.

[67] USDA Table 1. Indices of farm outputs, inputs, and total factor productivity for the United States, 1948-2019

[68] Trade, as we noted in the primer, creates economic incentives that encourage domestic industry to shift to the products produced with the most relative productivity.

and inputs in US agriculture.

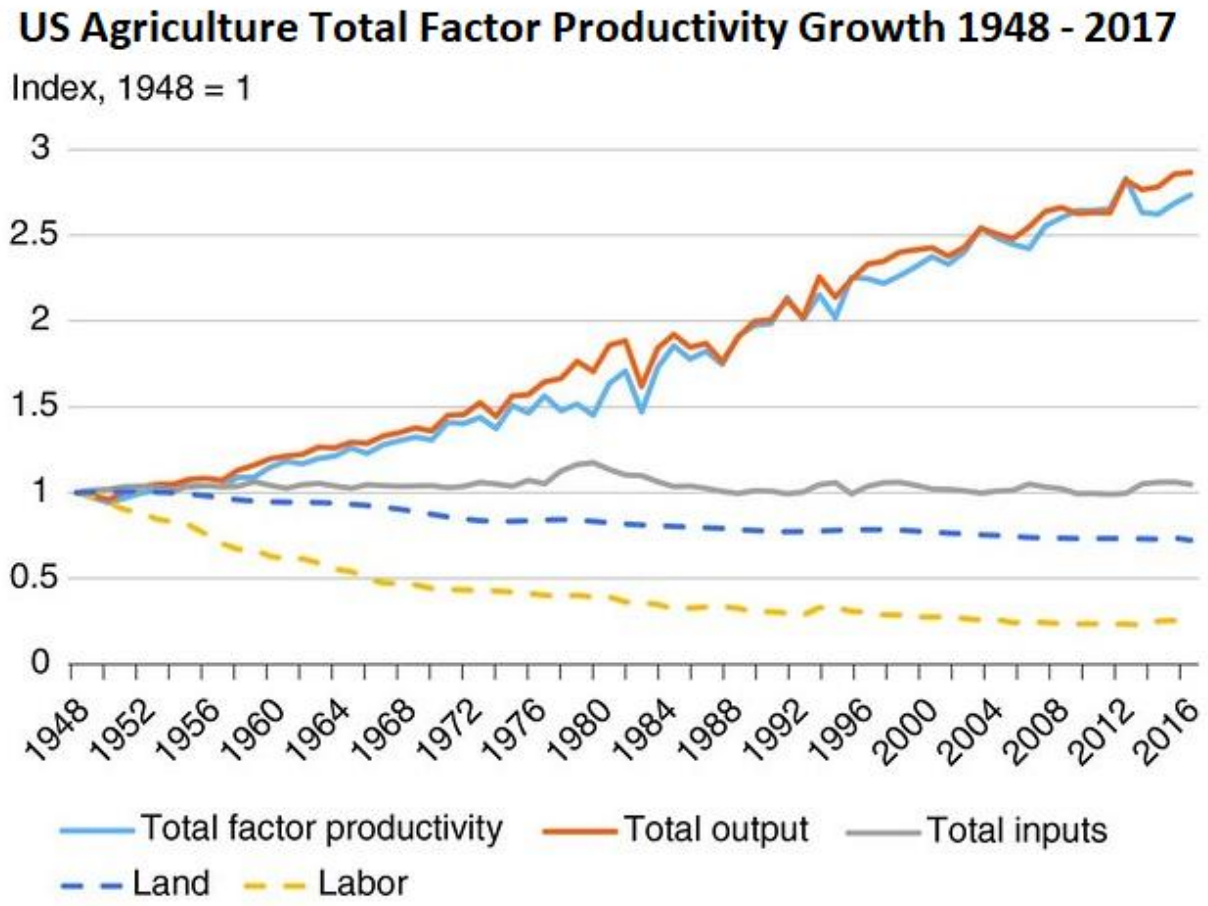


Figure 10: US Agricultural Productivity Growth, Source: US Department of Agriculture, Economic Research Service, using data compiled from the National Productivity data series, 1948-2017 WW117

The chart shows that we're producing about three times as much now as we did in 1948 while using less land and one quarter of the labor. Overall inputs, which include labor, land, fertilizer, fuel, and machines, have stayed about the same which is why total factor productivity (which measures the growth in productivity of all input factors combined) has grown along with output. Labor productivity has increased enormously, by a factor of almost 12 since 1/4 the labor produces almost 3 times the output. No wonder agricultural employment has fallen. In terms of dollar output, it is perhaps shocking to discover that even though agricultural output has tripled since 1960, farm output represents less than one percent of US GDP![69]

Worldwide the "Green Revolution" in high yielding crop varieties and the application of modern technologies and fertilizer has similarly raised world food production, allowing for the continued growth of earth's human population, and largely eliminated widespread famine.

[69] Down from 3.3% of GDP in 1960. A good quick overview of US agriculture economics and employment can be found at https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy.

All of this is great news, but has resulted in fewer agricultural jobs in industrialized countries such as the US. As is the case with any productivity increase, total GDP goes up since the same or greater output is being produced with less resources and displaced workers find work producing other goods and services which adds to total output. The migration of farm workers to the cities as agricultural productivity increased underpinned the early industrial revolutions. Since 1960 the "rural" population of the US has gone from 30% to 17% today and that population has aged[70].

While farm output, at $134.7 billion, represents just 0.6 percent of GDP, agricultural products are processed, cooked in restaurants, sold in stores, transported, and made into garments among other things. The USDA calculates that food related industries contribute about 5 percent of US GDP, or around $1 trillion current dollars[71]. These industries fall in either the manufacturing or services sectors though. For them agricultural products are simply intermediate inputs.

In summary, in the US and other advanced economies, agriculture, perhaps despite our preconceptions, is a tiny part of the employment and indeed economic output picture. Agricultural total factor and labor productivity have steadily increased, and it is likely that productivity will continue to increase, albeit more slowly, as technology and yields continue to improve. Looking at the last 10 years, it appears that farm labor requirements have stabilized at current levels in the developed countries. The winners from the increases in agricultural productivity have been all of us, as food prices have kept steady or in many cases fallen relative to the cost of living. In the US, chickens and corn roughly quadrupled in price between 1960 and 2019, but the consumer price index rose by over eight times[72]. Large farming operations have also been winners. The losers have included the displaced family farmers and rural communities that lost population. That said, society overall has benefited enormously from the lower prices of agricultural products.

Goods Producing Productivity

"Goods production" in US statistics includes mining, construction, and manufacturing. Some international statistics use "industry" instead. In any case construction has maintained a fairly steady share of employment, while the much larger manufacturing sector accounts for almost all of the decline in goods employment relative to services. When we refer to the "goods producing" or "industrial" sector, think "manufacturing".

Here again is the chart showing percentages of employment in the US "goods producing" sector for the years 1960, 2010, and 2020.

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[70]The definition of rural versus metro is not clearcut. This statistic is from U.S. Rural Population 1960-2022. www.macrotrends.net. Retrieved 2022-04-05.

[71] "Ag and Food Sectors and the Economy." n.d. Accessed April 6, 2022. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/.

[72] Producer price index series from the BLS for chickens and corn, CPI data from the BEA.

Table 2: Goods Producing Employment Source: Bureau of Labor Statistics

Industry Sector	% of Empl 1960	% of Empl 2010	% of Empl 2020	% Chg 1960 - 2020	Jobs lost/gained thousands*
Goods-producing, excluding agriculture	**29.3%**	**12.5%**	**13.0%**	**-56.0%**	**-23,188**
Mining	1.2%	0.5%	0.4%	-66.0%	-1,106
Construction	4.5%	3.9%	4.7%	3.0%	224
Manufacturing	23.6%	8.1%	7.9%	-67.0%	-22,305

* If 2020 percentages of employment had been the same as 1960

The huge decline in manufacturing as a percentage of total employment has already been pointed out and is well known. We have advanced three possible contributing factors: (1) higher relative labor productivity growth in manufacturing resulted in lower labor requirements, (2) imports and the trade deficit in manufactured goods suppressed employment in that sector, (3) a decline in demand for manufactured goods relative to services shifted employment from manufacturing to services.

There are hundreds of economic studies addressing these factors. Here we will look at the first, has manufacturing productivity grown relative to other sectors?

Unfortunately, it is not as easy to calculate productivity increases in many manufacturing sectors as it is in agriculture. While in agriculture output can be measured directly in, say bushels of wheat, in manufacturing output is almost always measured in dollar terms of “value added”. In assembling a Ford F150 truck for example, there are a mix of intermediate inputs over time, some of them from overseas, and it would hardly make any sense to look at “labor hours” to “assemble a car” without accounting for the intermediate inputs. Furthermore, the final output varies over time. A Ford F150 now contains a lot more electronics than the 1997 model so, when computing value-added, statisticians adjust the output value to recognize that the current model has more features. Of course, all dollar values also have to be adjusted for the product’s price changes in order to be comparable over time. If we want to compare the quantity of an item produced, and start with sales figures, we have to know its price. In addition, when coming up with an overall “manufacturing” productivity number, one has to group together many

industries, which may have quite different productivity changes over time, and include new products.

Despite these difficulties, economists generally agree that after the second world war until about 2010 manufacturing labor productivity increases in the US were higher than for the economy as a whole, and services in particular. In “Rising Tide, Is Growth in Emerging Economies Good for the United States?” the authors estimate that “value added per person employed grew by 3.3 percent per year from 1960 to 2007 in manufacturing, compared to only 1.6 percent per year for the economy as a whole.”[73] Other authors come up with lower numbers, and official US numbers from 1987 through 2019 show that manufacturing labor productivity grew more than overall business productivity, 220% vs 192% over the period as shown in the Bureau of Labor Statistics data below[74].

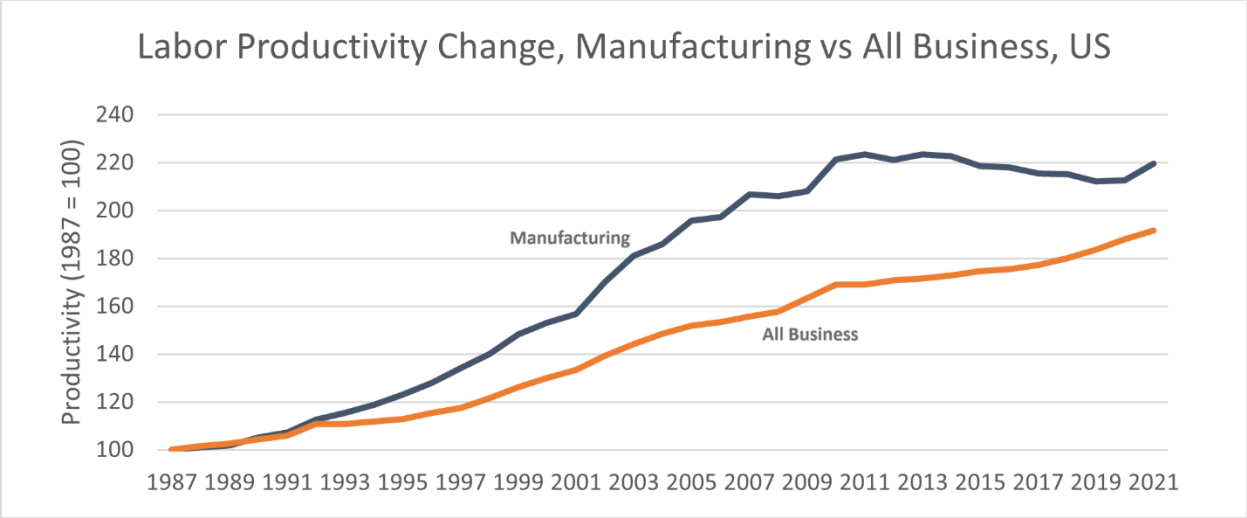

Figure 11 – Labor Productivity, Manufacturing vs All Business. BLS Series PRS30006093 and PRS84006093

[73] Edwards, Lawrence, and Robert Z. Lawrence. 2013. Rising Tide, Is Growth in Emerging Economies Good for the United States? Peterson Institute for International Economics. P90

[74] The BLS changed the way it gathers data in 1987 and it is difficult to combine this data with earlier statistics. A number of economists feel that the output value-added the BLS used for computers in this time period was overly inflated by quality adjustment. In short, as computer power increased, the BLS adjusted the output value-added. Without this adjustment growth in manufacturing is much lower. See Baily, Martin Neil, and Barry P. Bosworth. 2014. “US Manufacturing: Understanding Its Past and Its Potential Future.” The Journal of Economic Perspectives: A Journal of the American Economic Association 28 (1): 3–26.

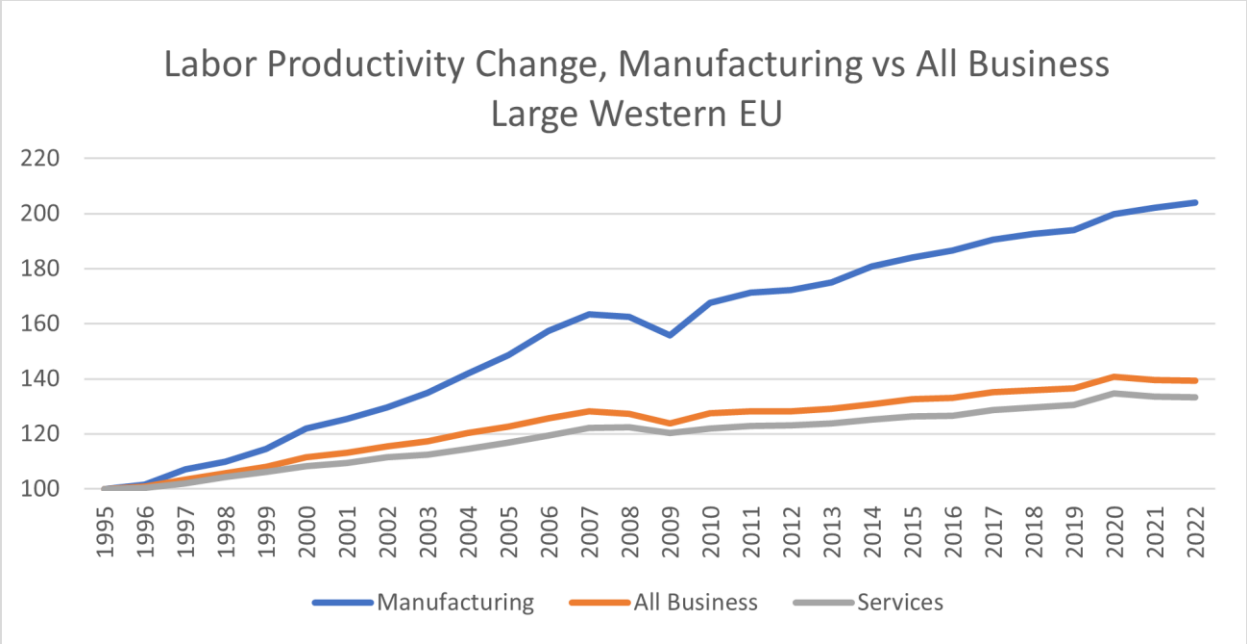

Figure 12 Chart: Labor Productivity Change, Manufacturing vs All Nonfarm Business Sources: US BLS series PRS30006093 and OECD Dataset: Productivity and ULC by main economic activity (ISIC Rev.4)

The peculiar hump in the US manufacturing productivity statistics shown above has given rise to some anxiety over a possible slowdown in growth[75], but others see it as a fluke related to the way computers were valued in earlier statistics, and possibly also the general economic weakness and stagnant wages after the 2008 recession[76]. The growth in manufacturing productivity in large European Union countries such as Germany and France is quite similar to the US in the last few decades.

We can see that higher productivity growth in manufacturing is an important factor in reducing employment in that sector relative to the services sector.

What is driving the increases in productivity in manufacturing? The chart below shows the overall size of productivity growth over time in the US and the contributing factors. This is not just for the manufacturing sector, but other sources corroborate that these apply to that sector[77].

[75] See for example "US Manufacturing Productivity Is Falling, and It's Cause for Alarm." 2021. IndustryWeek. July 12, 2021.
[76] When wage pressure is weak, there is less financial incentive to reduce labor costs through automation.
[77] Through 2002, see Aaron E. Cobet and Gregory A. Wilson. 2002. "Comparing 50 Years of Labor Productivity in U.S. and Foreign Manufacturing." Monthly Labor Review (BLS), June. https://www.bls.gov/opub/mlr/2002/06/art4full.pdf.

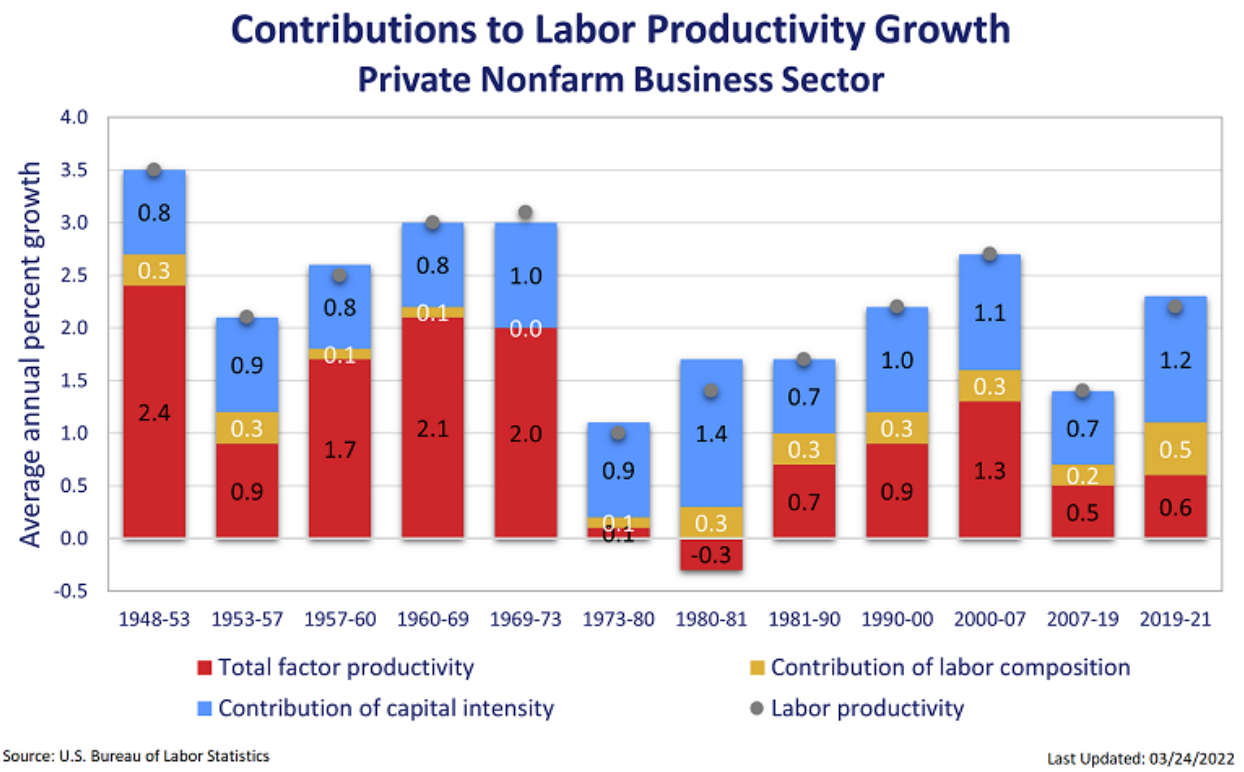

Figure 13 - Figure: Contributions to US Labor Productivity Growth. Source: BLS OPM Program, an updated version of this chart can be found at https://www.bls.gov/productivity/graphics/2022/graphic-3.htm WW115

Until about 1973, the major contributor to US labor productivity increase was “total factor productivity” which is a measure of output increases that cannot be attributed to increases in capital, labor, or other inputs. If you can produce more output without increasing inputs, you have increased total factor productivity. Prime contributors to total factor productivity include improved technology, economies of scale, better management, and a suitably skilled workforce. In turn improved technology is a product of investing in research and education, the scale of production is often dependent on infrastructure, and of course a suitably skilled workforce requires education. The next biggest contributor to labor productivity increases shown is capital intensity, which measures capital resources per worker. If workers are replaced by machines, the labor productivity of the remaining workers goes up since less labor is required to produce the same output. The final contributor shown on the chart is labor composition. Labor composition refers to the skill level of workers and goes hand in hand with technological improvements, and more capital equipment but can be an independent factor as well.

Since 1973 US labor productivity has been driven less by total factor productivity increases, including technology change, than by increased capital intensity, i.e. substituting capital for labor. Overall, year on year, labor productivity increases have been lower since 1973 than in prior decades.

The box below describes a couple of real-world manufacturing processes which shed light on why this might be the case for manufacturing. .

A Couple of Real-World Goods Producing Stories

The TV show “Food Factory” offers a fascinating glimpse into how foods are produced. In Season 4 episode 9 one segment is about Hershey’s kisses and another about the production of multicolored gummy rainforest tree frogs.

Both foods are produced, wrapped, and packaged almost entirely by machine with a few workers required to monitor the machines, add raw ingredients and the like. At the final stage of placing the boxes on a pallet and wrapping the entire pallet in plastic, the Hershey’s plant has a machine that performs that function while the gummy frog plant does that manually. Simply put, the cost of the machines required for this last step make sense for the high-volume kisses plant but not for the lower volume gummy frogs one.

This segment illustrates several things about manufacturing productivity now:

- Many factories are already automated to a high degree, so that the cost of labor is not a major factor.
- While further automation is possible it may not make economic sense
- Newer technologies such as robotics will not significantly improve the labor productivity of already fully automated processes which often use technology that was available by the 1970’s or before.

In contrast to the food factories, the automotive industry is the largest customer for industrial robots. Automated welding machines were introduced in the 1960’s and currently robots do almost all the body assembly, welding, and painting of car bodies. However much of the rest of the assembly is done by humans on an assembly line which would seem familiar to Henry Ford. Tesla tried to increase automation at its Freemont, CA plant but had to tear out some robots and go back to manual assembly. Elon Musk agreed that, even though robots are helpful, "excessive automation at Tesla was a mistake." "Humans are underrated." he added.

The main difference between the food factory automation and auto assembly automation has to do with adaptability. The food factory machines are single purpose and for the most part could not be adapted to produce a different food product, while the automotive industrial robots, such as welders, can be reprogrammed as needed to produce different models. The artificial intelligence and dexterity at the level required to replace humans in many production processes is still evolving. It now takes about 20 hours of labor to assemble a car from the intermediate components. At current pay scales, that is less than $1000 including benefits and overhead, so cost savings from further automation are limited.

That said, we’re likely to see a considerable increase in labor productivity associated with producing “a car” as we move from gas powered vehicles to electric ones. Electric cars use about half as many parts as gas ones, 15,000 as opposed to 30,000, and have only about 20 moving parts. That means fewer workers will be needed to build parts for, and assemble, these cars. There have already been layoffs announced in Germany and Japan ascribed to the coming technology switch.

Before we leave the subject of productivity growth in goods production in advanced economy countries, let's take a look at France which has gathered statistics on manufacturing productivity since way before most other countries.

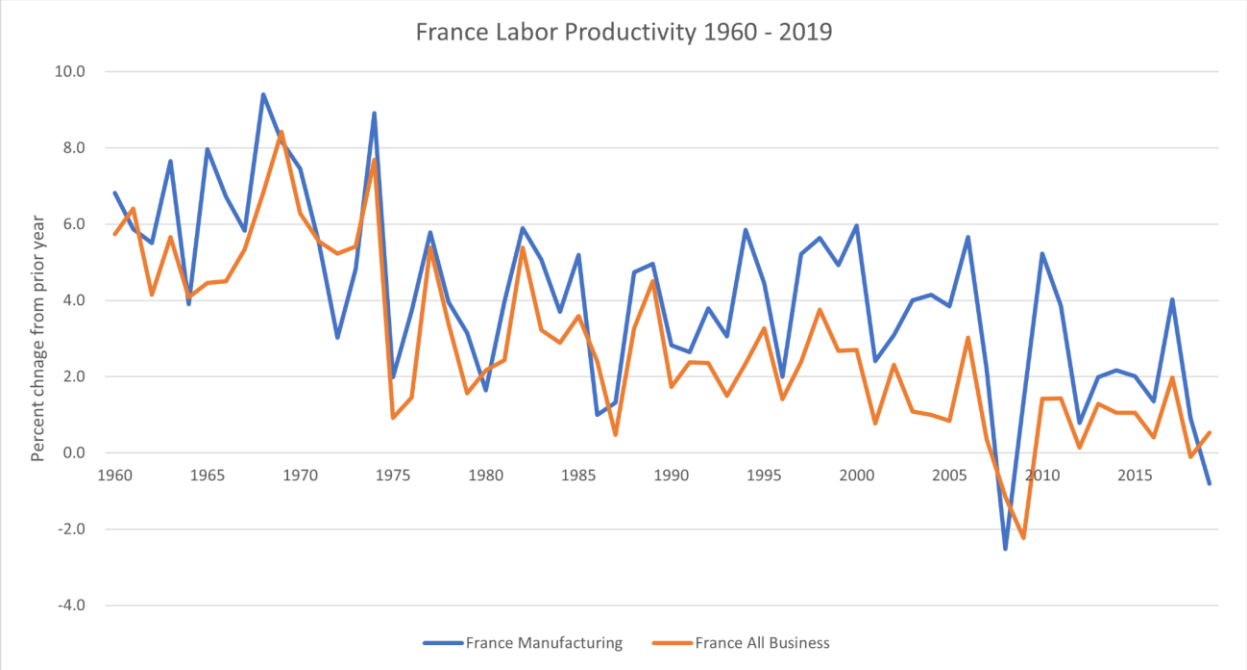

Figure 14 - OECD Dataset: Productivity and ULC by main economic activity (ISIC Rev.4)

Here are the averages:

Table 3 - France average productivity increase year on year

	Average increase 1960-2019	Average increase 1960-1999	Average increase 2000-2019
Manufacturing	4.1	4.9	2.6
All Business	2.8	3.8	0.9

We can see that in France productivity increases in manufacturing have consistently outpaced "all business" productivity which includes both goods production and services. In fact, the differential in productivity increases in France of 1.3% (manufacturing's 4.1% minus all business' 2.8%) over 60 years will produce the relative change in output and employment we've seen (roughly a 50% reduction in employment share in manufacturing). In the chart we can also see that productivity increases declined until the early 2000s but since then have been relatively flat.

The picture for goods production in advanced economy countries thus is one of amazing increases in productivity in the 20th century but with smaller increases in the last couple of decades. The employment picture for the last 60 years reflects this increase in productivity in manufacturing, with sharp drops in the percentage of total employment, but stabilizing over the last couple of decades at about 10%.

As to our question about the relative decline in manufacturing jobs, can we say that it is entirely due to greater productivity in manufacturing? Not without looking at the other two possible factors: trade and changes in the mix of demand for manufactured goods versus services. We'll sum up the evidence after the section on trade. For now, it is highly suggestive that manufacturing employment has fallen sharply in industrialized countries even when they run large trade surpluses, and that even in "developing" countries the ratio of services employment to manufacturing employment is growing. We have simply become very good at making "stuff" and that is really a very good thing.

Services Productivity

Here again is our table of employment changes from 1960 to 2010 and 2020 in the United States.

Industry Sector	% of Empl 1960	% of Empl 2010	% of Empl 2020	% Chg 1960 - 2020	Jobs lost/gained thousands*
Services-providing, excluding special industries	**53.7%**	**79.8%**	**80.0%**	**49.0%**	**37,401**
Wholesale trade	4.1%	3.8%	3.7%	-9.0%	-541
Retail trade	8.5%	10.2%	9.7%	14.0%	1,648
Transportation and warehousing	3.5%	2.9%	3.6%	3.0%	142
Information	2.6%	1.9%	1.8%	-32.0%	-1,195
Financial activities	3.9%	5.4%	5.7%	47.0%	2,604

Professional and business services	5.7%	11.8%	13.2%	133.0%	10,709
Educational and Health	4.5%	12.9%	13.9%	210.0%	13,416
Leisure and hospitality	5.3%	9.2%	8.7%	65.0%	4,854
Other services	1.8%	4.2%	3.9%	122.0%	3,043
Federal government	3.6%	2.1%	1.9%	-48.0%	-2,471
State and local government	9.3%	13.7%	12.4%	33.0%	4,416
Notes					
* Jobs lost/gained if employment distribution was unchanged from 1960. Total US Employment was around 150 million in 2020. This measure is only a baseline for comparison. All data except agriculture are from the BLS series. Agriculture is from OECD data. Transportation and warehousing 1960 is estimated from 1972 data.					

In the US, the services sector employment as a whole has grown from 53.7% of the workforce in 1960 to 79.8% of the workforce in 2019. The biggest growth has been in Education and Health, which went from 4.5% to 13.9% of the workforce, and in Professional and Business Services, which grew from 5.7% to 13.2% of the workforce. The BLS didn't separate out Education until 1987, but currently, Education is one-sixth the employment of Health. Professional and Business Services includes a grab bag of occupations: accountants, architects, lawyers, scientists, managers, janitors, security guards, office clerks, programmers, landscaping workers, etc. All of these service sectors gained employment share except for Wholesale Trade, Information, and the Federal Government. Some of these exceptions seem surprising so let's take a closer look.

"Information" includes publishing, motion pictures and recording, telecommunications, and data processing (which includes Facebook and Google, for example). That this sector would have lost employment share since 1960 seems strange but publishing has lost jobs and computer programming isn't included here, it's under Professional and Business Services. Amazon's roughly one million employees fall in multiple categories to reflect its various businesses.

Perhaps most surprising is that Federal government employment share has declined 48% while State and local government share has increased 33%. Civilian employment in the Federal

Government went from 3,370,000 in 1945 to 2,161,000 in 1960 and stood at 2,191,000 in 2019. Military personnel headcount went from 2,476,000 in 1960 to 1,388,000 in 2019[78].

The rest of the "services" super sector of the US economy saw increasing employment shares over the period, often large ones. The US pattern of services employment growth at the expense of the agriculture and manufacturing sectors is typical of other high-income countries including Western Europe, Japan, Australia, Canada, and others (see Figure 9). In these countries services now account for over seventy percent of employment. In middle-income countries, which include most of the rest of the world, both manufacturing and services are growing while agricultural employment shrinks. In China services have also been growing faster than manufacturing and now account for the largest share of employment at 47%[79].

It is pretty clear that agriculture and manufacturing currently require fewer workers than in earlier times, and that "service" sector employment will continue to grow in developing countries. We have seen that, in the advanced economies, productivity and employment share in agriculture and manufacturing have not changed much in the last decade.

The wealth of a country is often given in terms of GDP per capita and its productivity in terms of GDP per worker. Historically agriculture and manufacturing productivity increases have fueled enormous growth in the developed world. Now that these sectors account for a relatively small proportion of employment, and conversely, labor constitutes a modest part of the cost of agricultural and manufacturing output, increased growth in wealth and productivity falls largely to services. What can we say about productivity growth in services?

Productivity in many service sector industries is hard to measure and, in some cases, simply unlikely to occur. An example often used in economics is haircuts. Do you really want your hairdresser to cut your hair a lot faster? Can your waiter deliver the plates faster without destroying the ambience?

Productivity is the ratio of output to labor input (labor productivity) or a set of inputs (total factor productivity). In the case of many services, it is difficult to quantify the value of output meaningfully over time for an industry. To quote a 1999 Bureau of Labor Statistics article which is still true today:

...for a surprisingly large number of service-producing industries there is a lack of agreement among economists on the best definition of output. Economic literature has produced no consensus definitions for banking, insurance, other financial services, medical care, a variety of business and personal services, or retail and wholesale trade[80].

[78] This is misleading because there has been a huge increase in the use of contract labor by the Federal Government. Brookings estimates the total at around 10 million when such labor is added. See https://www.brookings.edu/articles/the-true-size-of-government-is-nearing-a-record-high/.
[79] https://data.worldbank.org/indicator/SL.SRV.EMPL.ZS?locations=XD-XT-XM-CN-IN
[80] "The Accuracy of BLS Productivity Measures." 1999 https://www.bls.gov/opub/mlr/1999/02/art2full.pdf.

The same report illustrates this by looking at the problem of quantifying the output of the banking industry:

Five different treatments of bank deposits have been recommended: deposits are treated, variously, as inputs, outputs, both inputs and outputs, either inputs or outputs and neither inputs nor outputs. Viewed in the light of this lack of agreement on the measurement of banking output, it is easy to understand why both the BEA and the BLS have opted for straightforward and simplified means of producing data on banking output. The BEA procedure extrapolates part of the bank output data by the use of input data and the BLS banking industry productivity measure includes an output measure that rests on counts of specific banking industry transactions[81].

A straightforward example of the problem of measuring productivity in banking over time is the emergence of the ATM. The ATM made it possible for consumers to do their banking 24/7 and in many locations. The cost of installing and maintaining ATMs is an expense which if not matched by cost savings elsewhere, or some valuation of the "worth" of this service to the consumer, will lower the computed productivity of retail banking, even though consumers are undoubtedly benefitting. This problem of valuing a bundle of changing services over time has some economists convinced that computing meaningful productivity over time for many services is impossible. We encountered the same problem in trying to compare the output of manufactured goods over time. What is the value of all the electronics in a modern car and how do you compare that to a 1960's car? Is a laptop that is 100 times as fast as an older one really "worth" 100 times as much? In some service industries these problems can become overwhelming.

Instead of looking directly at productivity let's look at prices. The table below shows how the prices of goods and services bought by consumers in the United States have changed since 1960, along with per capita consumption in 2019. Green rows indicate where prices have come down, and pink rows show where prices have gone up since 1960.

Table 4: US Personal Consumption by Industry

Personal consumption category by industry	Per capita consumption 2019	1960 % of Spend-ing	2019 % of Spending	Price Change 1960 to 2019
Overall Personal consumption expenditures (PCE)	**$43,847**			

[81] Ibid. BLS stands for Bureau of Labor Statistics, BEA for Bureau of Economic Analysis. These two agencies are responsible for most of the US statistics on employment and productivity.

Goods	**$13,611**	53%	**31%**	**-47%**
Durable goods	**$4,599**	14%	**10%**	**-77%**
Motor vehicles and parts	$1,564	6%	4%	-50%
Furnishings and durable household equipment	$1,095	5%	2%	-74%
Recreational goods and vehicles[82]	$1,279	2%	3%	-96%
Other durable goods	$661	1%	2%	--57%
Nondurable goods	**$9,012**	40%	**21%**	**-18%**
Food and beverages (groceries)	$3,133	19%	7%	-5%
Clothing and footwear	$1,210	8%	3%	-72%
Pharmaceutical and other medical products	$1,627	1%	4%	11%
Gasoline and other energy goods	$1,026	5%	2%	60%
Other nondurable goods	$2,016	7%	5%	-4%
Services	**$30,236**	47%	**69%**	**49%**
Household expenditures for services (per capita)	**$28,900**	45%	**66%**	**57%**
Housing and utilities	$7,815	17%	18%	35%
Health care	$7,470	5%	17%	162%
Transportation services	$1,505	3%	3%	25%

[82] This category is a testament to the difficulty of consistently pricing groups of products over time. The category includes televisions and computers which have seen enormous raw and "quality adjusted" price decreases over the period, which makes the 1960 to 2019 price change almost meaningless.

Recreation services	$1,772	2%	4%	18%
Food services and accommodations	$3,064	6%	7%	61%
Financial services and insurance	$3,560	4%	8%	58%
Other services (includes Education)	$3,713	8%	8%	40%
Nonprofit expenditures for households (mostly Education and Health)[83]	**$1,337**	2%	**3%**	

Source: BEA Table 2.3.4U. Price Indexes for Personal Consumption Expenditures by Major Type of Product and by Major Function and Table 2.3.5U. Personal Consumption Expenditures by Major Type of Product and by Major Function. CPI-U is used as the deflator. The "relative price change" is explained below.

Goods in this table have all come down in price with the exception of fuels and medical products, and most services have gone up in price, most substantially in health care. Housing and health care services are the two biggest consumer spending categories in 2019 at over $7,000 per capita each ($61,140 combined for a family of 4) in the US. Surprisingly, housing shows only a modest price increase between 1960 and 2019 but see the discussion below. Education isn't shown separately on this chart because it is around 2% of consumer spending ($308 billion out of total consumer spending of over $14 trillion, but this doesn't include public school expenditures or $85 billion in non-profit spending). Health care spending includes payments by insurance and government. The 2019 total "average" per capita annual personal spending of $43,847 comes to $175,388 for a family of four. That is an interesting number we'll look at more later.

Notes on this Table

A few notes on the values in this table should be kept in mind. First, trade is clearly an important factor in lower goods prices in some sectors such as clothing, and Personal Consumption Expenditures include imports. However, the US still produces most of its own goods, is a large exporter of goods, and, with increases in productivity flowing through to lower prices, relative prices capture relative productivity changes for domestic production. Second, all price increases and decreases are shown relative to the overall Personal

[83] Operating expenses of private nonprofits such as hospitals and universities. See https://www.bea.gov/help/faq/1009#:~:text=Final%20consumption%20expenditures%20by%20NPISHs,less%20their%20sales%20to%20households.

Consumption Expenditures (PCE) Price Index[84]. The overall PCE Price Index is like the better-known Consumer Price Index (CPI) but is preferred by the Bureau of Economic Analysis which produces the numbers in the table. Like the CPI, the overall PCE index indicates how much overall consumer prices have gone up year to year. The overall PCE index in 2019 was 6.7 times higher than in 1960 due to inflation. In the table anything that went up less than 6.7 times thus got cheaper relative to the general cost of living. So, for example, Motor Vehicles and Parts went up only 3.3 times so the price of cars fell by 50 percent relative to the overall cost of consumer goods and services. The last column of the table shows whether each category went up as much as inflation (6.7 times) or less and by how much. Did cars really get cheaper? Yes, relative to inflation, but we also have to consider incomes. If you are old enough to have worked in 1960 and were still working in 2019, you'd need to make 6.7 times as much in 2019 as you did in 1960 to have kept up with inflation. In a more realistic sense, someone doing what you did at the same age in 1960 would have to make 6.7 times in 2019 what you made then in order to have not lost to inflation. The PCE or CPI tells us about the cost of living but not about wages which we'll look at later.

Another note of caution - pricing services has the same issues as trying to calculate services productivity, indeed calculating output prices is one step in calculating productivity. As the nature of the service changes, a meaningful valuation of output requires trying to put a value on service components such as the ATM mentioned earlier. As a check, the chart also shows the actual percentage of consumer spending on each category. While what is available to the consumer changes over time, as do budgets, preferences, income and age distribution, the changes between 1960 and 2019 tell us a similar story to prices. Spending on goods has fallen from 53% to 31% of the household budget while services consumption has gone up proportionately. Families, in total, spend less than half as much on food shopping and clothes now as they did in 1960, more on fuel, and over 300% more on healthcare.

Calculated productivity and prices, and actual consumer spending, confirm that we are now spending much more on services than 50 years ago and that productivity growth in some major services is considerably slower than the growth in manufacturing productivity in prior times. Unless productivity growth in services picks up, the result will be slower increases in GDP growth per capita and worker, and accordingly slower growth in average real (i.e. inflation adjusted) incomes. This applies to all advanced economy countries. Developing countries that are still expanding their industrial base and modernizing their agriculture can expect higher productivity and per capita income gains.

The chart below graphically shows the change in US prices since 1978 as calculated by the BLS[85]. Note that these prices are not adjusted for general inflation, rather they show price

[84] The overall PCE ratio from 1960 to 2019 is 6.7 compared to the CPI ratio of 8.6.

[85] You may notice that these BLS consumer price indexes are different from the ones shown in the table above which are prices calculated using different methodology by the BEA. In general, the BEA numbers are lower, among other things they recognize that consumers may substitute products or services when

inflation for groups of products or services. For example, a new vehicle in 2017 costs roughly the same dollar amount as one in 1998. The “All Items” line shows the general rate of inflation, goods or services above that line got relatively more expensive, and stuff below that less so. (If you read the footnote, you will start to appreciate that there are multiple ways to compute the price changes that we consumers face, and these can lead to substantially different inflation numbers. This will be important when we look at how income changes stack up against price changes. For now, both ways to compute price changes agree on our major conclusions that services have gotten more expensive while products have gotten less so.)

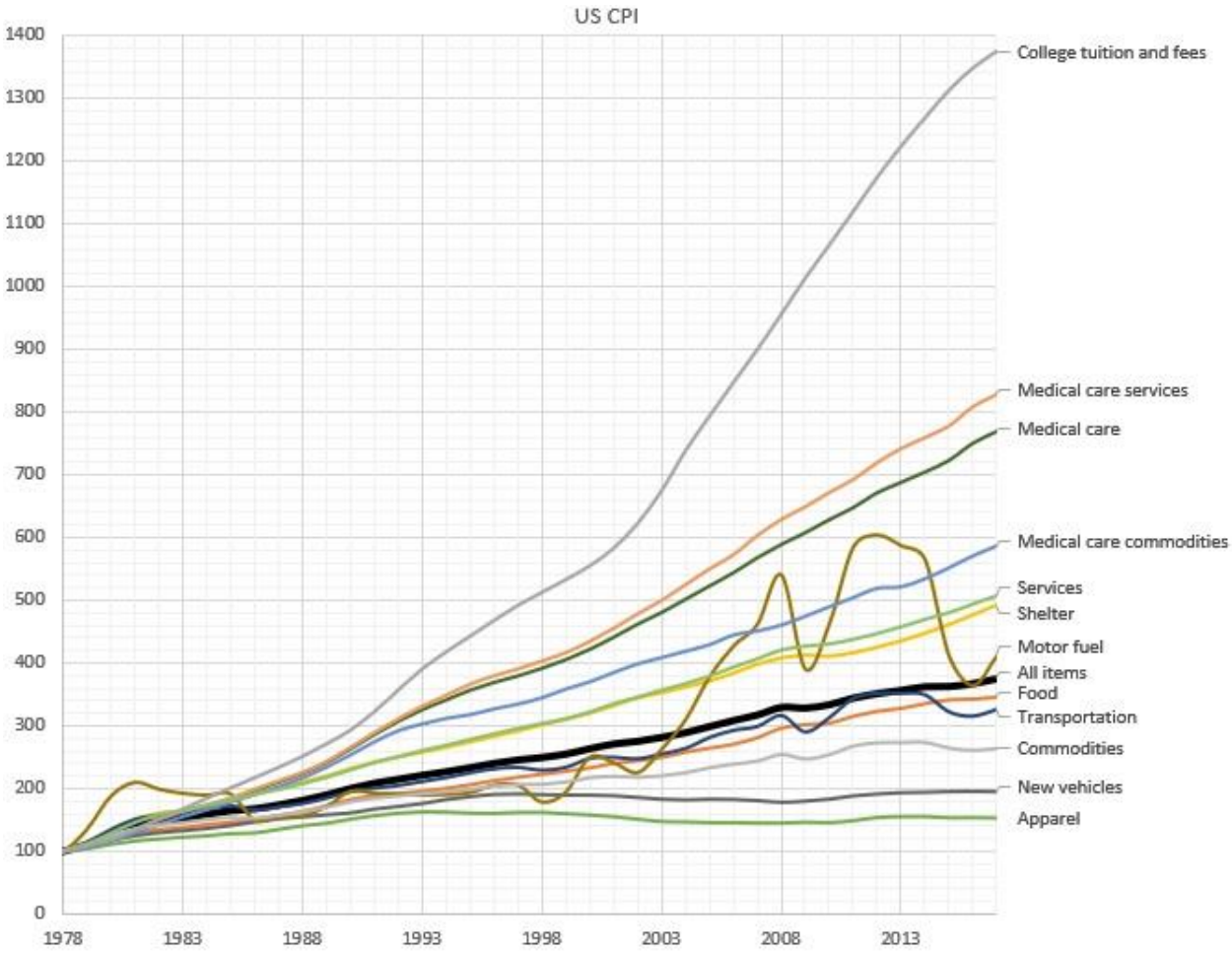

Figure 15: Price index (1978=100) not inflation adjusted. Source: By BoH - data from Bureau of Labor Statistics, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=75468943

prices change, while the BLS with its mandate to track in more or less real time doesn’t have information about consumer spending that would let it make such an adjustment. See “Differences between the Consumer Price Index and the Personal Consumption Expenditures Price Index.” U.S. Bureau of Labor Statistics May 2011 Volume 2, Number 3. https://www.bls.gov/opub/btn/archive/differences-between-the-consumer-price-index-and-the-personal-consumption-expenditures-price-index.pdf. The PCE is designed to reflect actual consumer spending.

In terms of spending the two largest cost items in services are health care and housing at over $7,000 *per person* in 2019. Indeed, the cost of an HMO plan for a family of four is over $28,000 according to industry sources[86]. Let's look a bit more deeply at these two hot topics, starting with health care.

Healthcare Costs

Table 4 breaks down personal consumption expenditures by goods versus services, and health care includes both. To get a more complete picture of health care costs in the US, we have to look at personal expenditures by function. The BEA also provides a table for this.

[86] https://us.milliman.com/en/insight/2021-Milliman-Medical-Index

Table 5: Table: US Personal (per capita) Expenditures on Health, and Price Changes.

Health Product or Service	Price Change 1960 to 2019 (inflation adj)	1960 per capita (in 2019 dollars)	2019 per capita (in 2019 dollars)	Spending increase per capita
Health (total)	126%	$996	$9,194	923%
Medical products, appliances, and equipment				
Pharmaceutical products	12%	$161	$1,608	998%
Other medical products	-47%	$5	$19	392%
Therapeutic appliances and equipment	-28%	$44	$214	488%
Health Services				
Physician services	94%	$283	$1,753	619%
Dental services	173%	$98	$418	428%
Paramedical services (home health, labs)	67%	$68	$1,211	1772%
Hospitals	251%	$308	$3,390	1102%
Nursing homes	140%	$29	$581	1983%

Source: BEA Table 2.5.5. Personal Consumption Expenditures by Function and Table 2.5.4. Price Indexes for Personal Consumption Expenditures by Function, inflation adjusted using overall PCE.

Overall healthcare prices have gone up 126% more than general inflation from 1960 to 2019. All the services have gone up significantly in price. But in addition to the *price changes* there has been an enormous increase in *consumption* of healthcare. Pharmaceutical prices, mostly generics, have only risen slightly since 1960 but we're spending 10 times more on them per capita![87] While hospitals charge an inflation adjusted 251% more now for similar services as in 1960, we're also using more than 10 times as much of this resource[88]. As a result, health care has grown from 6% of personal consumption spending to 21% in the US. The subject of healthcare economics requires a large volume, or several, on its own, so just a few additional notes. Healthcare costs have risen worldwide as shown in the World Bank data charted below.

[87] The prices of individual drugs, weighted for total consumption dollars, haven't gone up much but we're consuming a lot more drugs.

[88] Clearly CAT scans weren't available in 1960, so while prices have gone up, for example for a room, there are many new services being provided as well which results in higher expenditures. The aging population is also a factor.

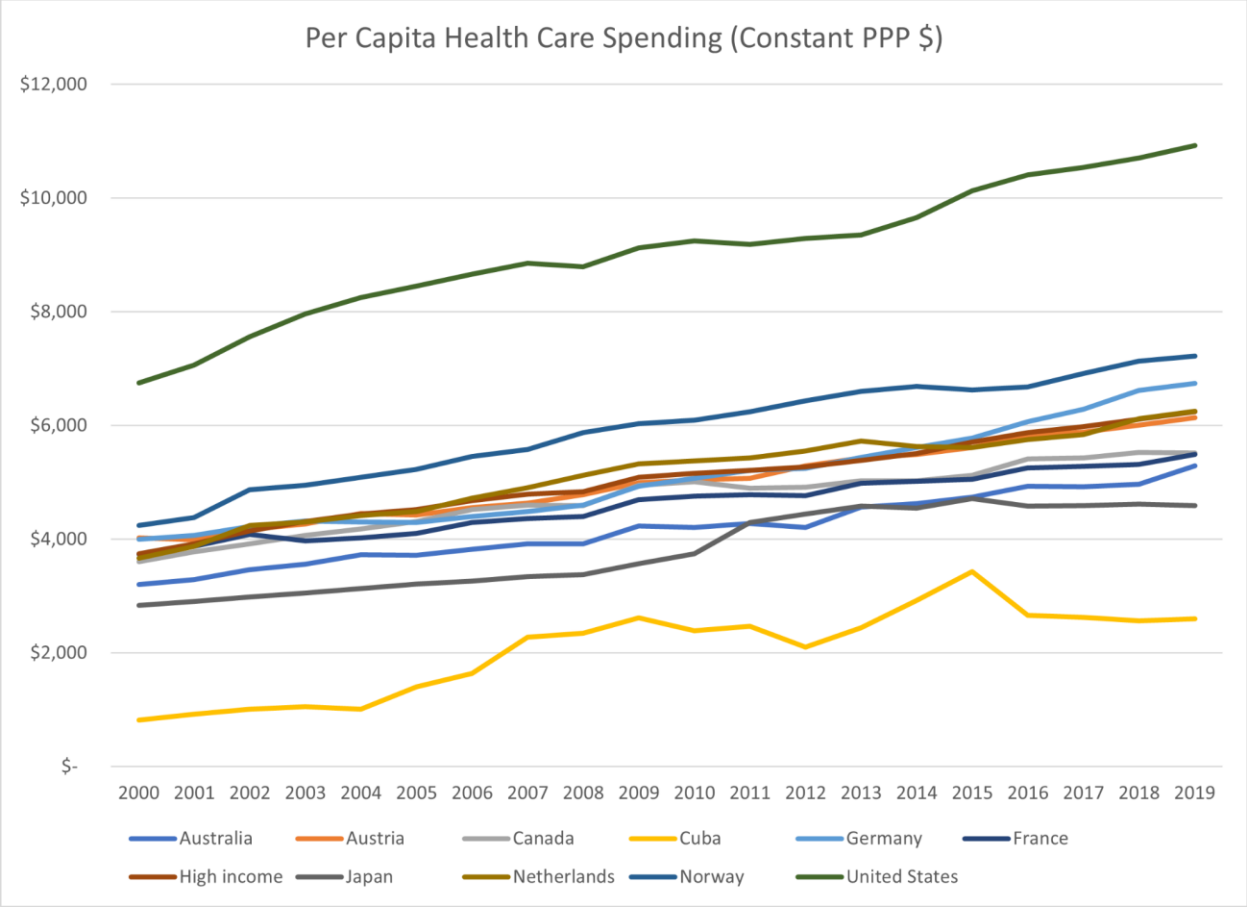

Figure 16: Healthcare costs over time. The US is the top line. Source: World Health Organization Global Health Expenditures Database accessed through World Bank data portal.

While per capita health care costs are rising in other countries, the US is clearly in a league by itself[89]. Despite the outlier spending, the Commonwealth Fund ranked 11 countries in healthcare outcomes using several metrics and concluded:

"Among the 11 nations studied in this report – Australia, Canada, the Netherlands, Germany, Switzerland, France, New Zealand, Norway, Sweden, the United Kingdom, and the United States—the U.S. ranks last, as it did in 2010, 2007, 2006, and 2014"[90]

[89] The per capita cost shown here is higher than personal consumption expenditures because total healthcare spending includes items such as research.

[90] Cronin, Joe. 2020. "Ranking the Top Healthcare Systems by Country." International Citizens Insurance. April 30, 2020. https://www.internationalinsurance.com/health/systems/.

We can also look at the percentage of GDP devoted to healthcare by country.

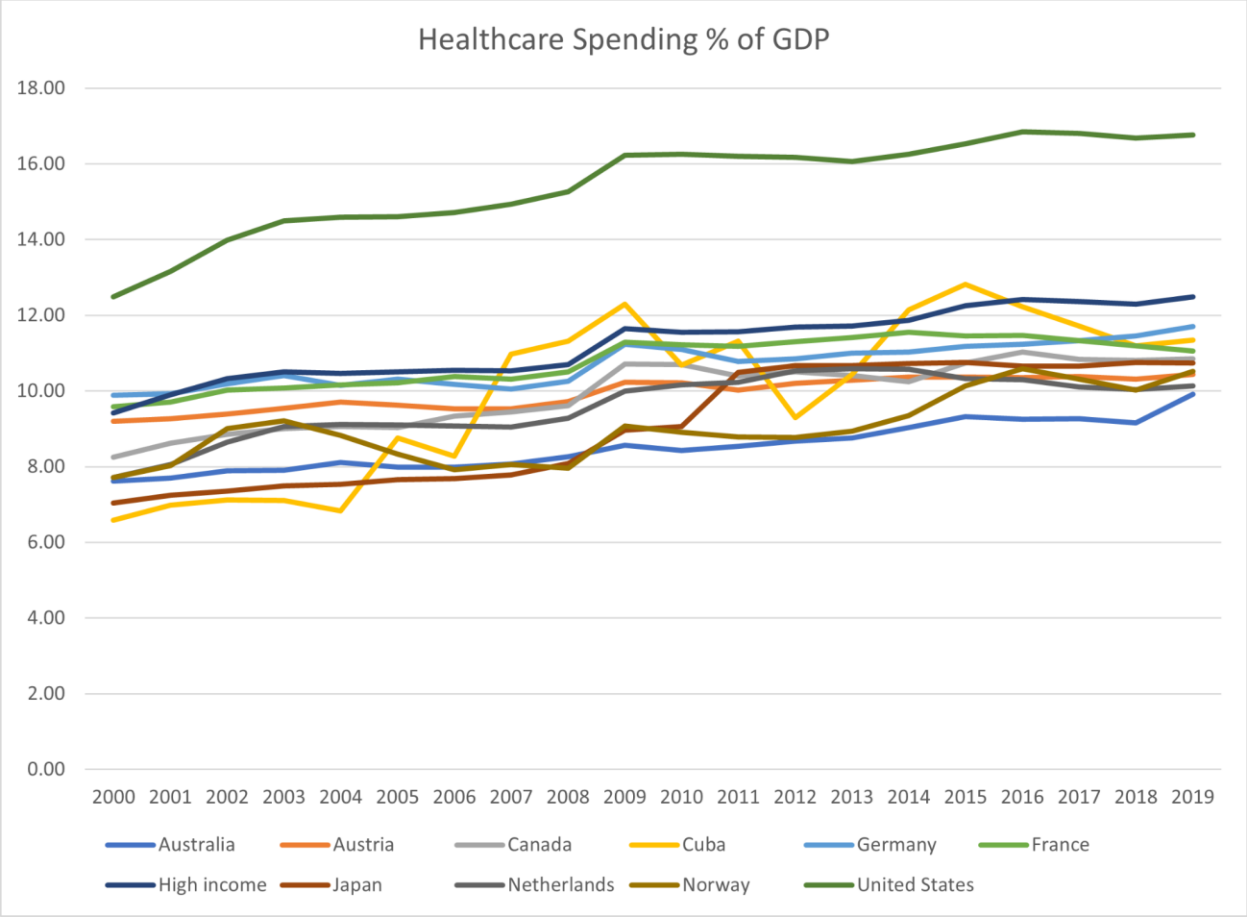

Figure 17: Source: World Health Organization Global Health Expenditures Database accessed through World Bank data portal.

Again, the US stands out.

Now we might suppose that greater healthcare utilization explains the greater per capita cost in the US, but it turns out that utilization is just as high in other countries. Furthermore, other countries insure virtually 100% of their citizens, while in the US about 91% of the population is insured, usually with copays. There are two main reasons for higher US healthcare spending:

1. Higher costs for pretty much everything medical in the US compared to other countries.
2. Inefficiency: about 30% of US Healthcare spending goes to administration largely because of an extremely convoluted billing structure[91]

[91] Himmelstein, David U., Terry Campbell, and Steffie Woolhandler. 2020. "Health Care Administrative Costs in the United States and Canada, 2017." *Annals of Internal Medicine* 172 (2): 134–42.

For a brief overview of why healthcare costs more in the US, see the excellent article “6 Reasons Healthcare Is So Expensive in the U.S.” in Investopedia[92].

Why Free Market Economics Fails to Control Healthcare Costs in the US

While this section looks at data, I would like to briefly review some of the economic theory related to healthcare, and why market competition fails to work to drive down healthcare costs. Healthcare tends to be price insensitive, or as economists put it, demand is inelastic with respect to price. In short, if you need a pill or an operation, especially for a life-threatening condition, you would probably not be looking closely at the price. When was the last time you “shopped around” for a medical procedure? If you are covered by insurance, you have little incentive to “shop” because your co-pay would be the same in any case. Furthermore, you probably don’t want to travel far from home for an operation, so the supply side is limited, there are often local monopolies. Market pressure only works to drive down costs if there are many buyers (there are) and many suppliers (there aren’t) and the buyers have an incentive to shop around (they don’t).

You might think that health insurance companies would be concerned about price. If they can insure a company's workforce for less than their competitors, they can boost sales. But insurance companies don’t have all that much bargaining power with large providers. The providers can set their rates for various services and simply “not accept” an insurance plan that doesn’t pay enough. That plan might be cheaper, but subscribers might want specific hospitals which have a “good reputation” or are local. The suppliers retain significant power to shape the market.

Finally, the proliferation of insurance companies in the private sector, and the complex financial arrangements, create very significant administrative costs. Fraud also adds to costs.

Pharmaceutical economics also points to market monopoly power. While the BEA/BLS calculate that overall pharmaceutical prices have pretty much gone up with inflation between 1960 and 2019, most of that can be attributed to generics: three quarters of prescriptions are filled with generics, but generics only account for one quarter of the drug market in dollars[93]. Patents are a state intervention in free markets which grant inventors a temporary monopoly in order to foster innovation. However, demand for many pharmaceuticals, unlike say a better mousetrap, is also inelastic, meaning that there is essentially no upper limit to what the company can charge, and some companies have clearly abused that situation. It is important to foster and fund innovation, but the drug companies have found many ways to game the

[92] “6 Reasons Healthcare Is So Expensive in the U.S.” 2015. Investopedia. August 6, 2015 updated January 2022 6 Reasons Healthcare Is So Expensive in the U.S..

[93] “The-Pharmaceutical-Industry-an-Overview-of-Cpi-Ppi-and-Ipp-Methodology.pdf.” n.d. https://www.bls.gov/ppi/methodology-reports/the-pharmaceutical-industry-an-overview-of-cpi-ppi-and-ipp-methodology.pdf.

patent system in ways that strictly increase profits even for drugs such as insulin that were invented more than 100 years ago[94].

In any case, pharmaceuticals offer a great example of the power of competition. An FDA study[95] finds that drug prices fall 39% when a single generic manufacturer starts competing with a branded drug. With two competitors the price falls 44%, with four competitors it falls 79%, and with six or more competitors the price falls an astonishing 95%.

In sum, healthcare and pharmaceutical pricing reflect monopoly power which helps explain why the market has failed to control costs and promote efficiency in the United States[96].

Housing Costs

Unlike healthcare, there is a robust market in housing with many buyers and sellers, abundant information, and greater elasticity of demand in response to prices. However, everyone has to live someplace, and an imbalance between supply and demand in a locality can cause prices to quickly escalate as we've seen of late.

The Bureau of Economic Analysis calculates that housing costs increased a modest 5% relative to inflation between 1960 and 2019, as shown in Table 4. That number is based on rents and, for homeowners, on rental equivalence, as well as other costs such as utilities. The calculation involves the detailed analysis of low-level Census data[97]. The Bureau of Labor Statistics also provides inflation indexes for various components of housing, the broadest of which is "Shelter" which, like the broad CPI, is based on "urban" consumers[98]. That cost measure increased by more than a factor of 12 between 1960 and 2019, or 40% more than CPI inflation[99]. The Census also publishes data on rents from the American Housing Survey. That survey is designed to track all US housing through a representative sample of housing units. The median "gross" rent in the American Housing Survey in 1960 was $71 while the median in 2019 was $1071 which is

[94] The same can be said of academic paper publishing, but fortunately there is a fascinating free article on the pricing of insulin in the US in 2020, prior to Biden's reducing the price https://academic.oup.com/jlb/article/7/1/lsaa061/5918811.
[95] Center for Drug Evaluation, and Research. n.d. "Generic Competition and Drug Prices." U.S. Food and Drug Administration. FDA. Accessed August 10, 2022. https://www.fda.gov/about-fda/center-drug-evaluation-and-research-cder/generic-competition-and-drug-prices.
[96] There are other reasons. For example, the healthcare industry lobby is the largest by far in the US. See https://www.statista.com/statistics/257364/top-lobbying-industries-in-the-us/.
[97] Rassier, Dylan G., Bettina H. Aten, Eric B. Figueroa, Solomon Kublashvili, Brian J. Smith, and Jack York. n.d. "Improved Measures of Housing Services for the U.S. Economic Accounts." BEA. Accessed May 1, 2022. https://apps.bea.gov/scb/2021/05-may/0521-housing-services.htm.
[98] 89% of the population lives in "urban" areas.
[99] "Shelter" is a major component of the CPI-U, so the relative increase in shelter costs would be even higher if this component were excluded.

a ratio of 15, or a **73%** increase over inflation as measured by the CPI[100]. So, you have a choice of numbers. We can conclude that if you've owned your own home for many years, it is likely that you will have seen a smaller increase in housing costs than a young couple looking for a new apartment in an urban area. That is especially true now in 2022 post-covid.

While there are housing booms and busts, the price level of housing should in the long run rise pretty much in line with the cost of building one, plus the cost of the land. When the price of houses or apartments is above the cost of building a new one, developers will build more until supply and demand balance. But there is a limited supply of land, especially in cities, so the price of land, and along with it the price of housing built on that land, rises. In many locations zoning restricts building multi-family housing, further restricting supply[101].

The United States is hardly an outlier in housing costs. According to OECD data, the US is towards the middle of the pack in terms of housing cost as a fraction of income at around twenty five percent on average[102]. However, "affordability" of housing very much depends on where you live and your income level. New York City dwellers, on average, spend about half their incomes on housing, and lower income people here and in other high-income countries spend a larger share of their already limited incomes on housing, often forty percent or more.

The Future of Services Productivity

The "Services Sector" includes a huge range of activities that are grouped together more by the fact that they aren't goods-producing rather than any other similarity. What do warehousing and logistics have in common with teaching and legal work? Looking at the future of "services productivity" really requires a detailed analysis of each one.

That said, for some time now we have been hearing about how artificial intelligence (AI) will any day now take over one or another service job. Trucks will be able to drive themselves, AI will write legal documents, and robots will take over the work of home health aides.

All these things may come to pass, but probably more as assistants to humans rather than full replacements at least at first. That will boost productivity in services, but at the same time cause some employment dislocations. Since services are widely distributed, it is unlikely we will see the same kind of regional trauma as has been the case in geographically concentrated

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[100] US Census Bureau. n.d. "Historical Census of Housing Tables: Gross Rents." Accessed May 2, 2022. https://www.census.gov/data/tables/time-series/dec/coh-grossrents.html. Gross rent is the monthly amount of rent plus the estimated average monthly cost of utilities (electricity, gas, water and sewer) and fuels (oil, coal, kerosene, wood, etc.).

[101] Zoning is of course a government (usually local) distortion of the free market. Without zoning, one could build a high-rise apartment building in an upscale single-family community, and that might very well be the optimal use of the land in simple free market terms.

[102] For the US the OECD report uses gross income, while for most other countries it uses disposable. See HC1.2. HOUSING COSTS OVER INCOME at https://www.oecd.org/els/family/HC1-2-Housing-costs-over-income.pdf

manufacturing industries. A bit tongue in cheek, it also seems that services are subject to a form of Parkinson's Law: they seem to expand as needed to achieve full employment.

In short, I think it is right to be optimistic about the future of services productivity, but we have to keep in mind that firms will only invest in automation when the cost is less than the cost of human labor to do the same job, or to offer a new service. The reading of mammograms by AI, for example, allows radiologists to read more mammograms while also providing a "second opinion". Humans are still irreplaceable when it comes to interacting with other humans. Japan has tried hard to introduce eldercare robots, but so far without success[103]. We should remember that enhanced productivity increases output per hour worked, so it always increases per capita income. The problem is in distributing the benefits. As with many services, the productivity impact of AI will in some cases be hard to measure. While the number of mammograms accurately read per hour of analyst time is quantifiable, how does an AI used to produce highly tailored sales emails or fake product reviews affect overall productivity?

[103] Wright, J. (2023, January 9). Inside Japan's long experiment in automating elder care. MIT Technology Review. Retrieved April 24, 2023, from https://www.technologyreview.com/2023/01/09/1065135/japan-automating-eldercare-robots/.

Global Productivity & Convergence

Up to now, we've looked at productivity in countries that are described as "advanced economies" meaning that by and large they have been able to adopt the latest productive technologies and production methods that minimize costs. These advanced economies include the countries of North America, Europe, Australia, Japan, Taiwan, and a few others. Most of the population of the world do not live in such economies, but rather in countries that are somewhere on a spectrum of economic development.

Countries which are not on the productivity frontier in all sectors of their economies clearly have room for catch-up growth since they could leapfrog to advanced production technologies. In countries where a large part of the population is still employed in agriculture, modernizing agriculture, and employing those workers in other ways, will grow GDP and hence productivity. Indeed, basic economic theory suggests that growth in productivity should be fastest where there is less capital per worker because adding machines produces the biggest productivity increases at first and less as more are added (declining returns to capital). And indeed, developing countries have higher rates of productivity growth than "advanced economies" as shown in this chart from the World Bank report on global productivity.

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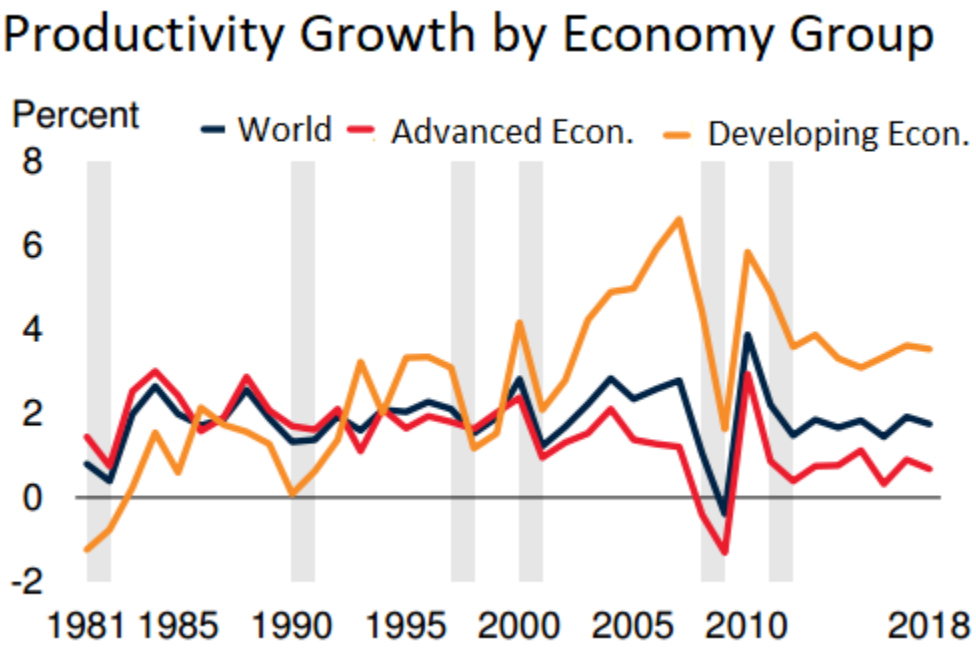


Figure 18: Source: Figure 1 from World Bank Group. 2022. "Global Productivity: Trends, Drivers, and Policies." World Bank Group. CC BY 4

The chart shows several things: declining productivity increases in advanced economies; productivity growth speeding up in developing countries starting in the late 1990s; the V-shaped dip in productivity in 2008 caused by the Global Financial Crises; and the relative stability of the growth rates in productivity since. The developing countries continue to have a higher

productivity growth rate than the “advanced” economies, which over time should reduce the difference in productivity between these groups. Economists refer to this shrinkage in productivity differentials as “convergence”.

The process by which countries modernize economically is called economic development, and the pace of such development varies widely. How has productivity grown worldwide in the last few decades, and what factors influence the rate of growth?

Development: From Agriculture to Industry to Services

Developing countries are following much the same trajectory of development that the advanced economies followed, although later, and the path they take is somewhat country and region dependent. China, for example, has a rapidly growing manufacturing sector, increasingly for its domestic market. This is hardly surprising; China’s large rural population continues to migrate to the cities and the demand for consumer goods continues to grow. While in the United States there are 910 vehicles on the road for every 1,000 people, there are only 37 vehicles per 1,000 people in China[104]. Even in China, though, manufacturing value added as a percentage of GDP and employment is falling. The GDP pie is growing rapidly, and along with it manufacturing: China’s GDP grew 7-fold between 2004 and 2019, but manufacturing value-added grew “only” 6-fold.[105] Manufacturing has been a way for less developed countries to earn trade revenue and build up capital. There is some evidence that this is no longer so true as manufacturing has fallen as a percent of GDP in many smaller economies as well.[106] The chart below shows how employment has changed in countries grouped by income over time.

[104] https://capitol-tires.com/how-many-cars-per-capita-in-the-us.html
[105] World Bank indicator data
[106] Rodrik 2016

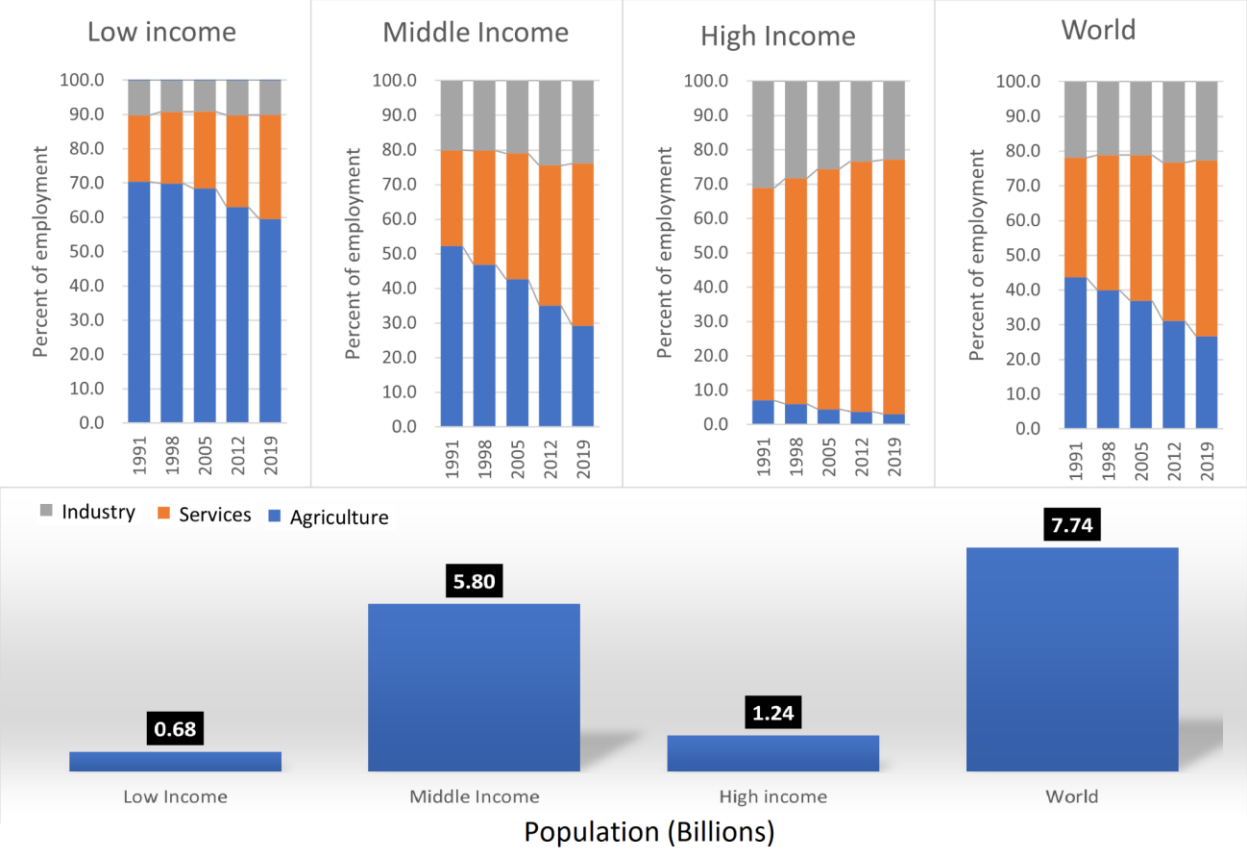


Figure 19: Employment by sector and country group in 2019. The industry sector consists of mining and quarrying, manufacturing, construction, and public utilities. Data Source: World Bank Indicator Data. My Chart: World % Emp WDI My Version.xlsx WW118

This chart makes clear that as development proceeds a country's employment shifts from low productivity agriculture to industry and services, and over time, the latter has become more important. It looks like industrial employment, which includes manufacturing, mining, construction, and utilities in this World Bank Data, stabilizes at around 20% of employment.

Globally, productivity varies enormously between countries, but has risen everywhere over time. The expression "a rising tide lifts all boats" certainly applies to rising productivity: the fraction of the world's population living in extreme poverty fell from 36% in 1990 to 10% in 2015. Extreme poverty fell most in countries with the highest rates of productivity growth[107].

Unfortunately, the fact that the productivity *growth rate* in developing countries is now higher than in advanced economies has to be checked against the still huge gap in average productivity, and consequently incomes, between the two sets of countries. Productivity in the emerging and developing economies is only around 20% of advanced economies, and low-income countries produce only about 2% as much output per worker[108]. At the current average rate of productivity convergence of half a percent per year it would take middle- and lower-

[107] World Bank Group. 2022. "Global Productivity: Trends, Drivers, and Policies." World Bank Group. https://www.worldbank.org/en/research/publication/global-productivity, page 25
[108] World Bank Group, 2022, page 201

income countries over 100 years to close *half* the productivity gap with advanced economies[109]. However, productivity increases are far from uniform among developing nations. Some, such as Singapore which now has higher per capita income than the US, managed to increase output dramatically over a period of many years. South Korea, another convergence success story, is now included among the developed high-income economies.

Why is it that some countries have improved productivity so much more quickly than others, and can other countries follow their trajectory? Economists have used statistical methods to group countries with similar productivity growth patterns to find factors that correlate with increased growth. They find that faster growing countries have been characterized by better initial education levels, greater political stability and governance, and greater or deepening economic complexity. “Economic complexity” refers to having a wider variety of industries and trading relationships. It should be noted that correlation does not equal causation, as statisticians like to say, but at least in the case of good governance and a higher initial education level the direction of causation seems intuitive. Both the amount of foreign direct investment and openness to trade also show some correlation with an increased growth rate. In general commodity exporting economies, especially those relying on agricultural exports, have lower productivity growth rates than commodity importing countries because income from commodities varies from year to year, and reliance on commodity income can stifle the development of other industries[110]. Finally, other things being equal, the rate of growth is faster when countries start poorer as one would expect from declining returns to capital.

What can we learn from these correlations about the ability of countries to rapidly increase productivity? Should they concentrate on education? On attracting foreign direct investment? On opening up to trade? On “governance”?

The answer is that these things go hand in hand. Stability and low levels of corruption are necessary to attract foreign investment, education is needed to support advanced manufacturing and service industries, and trade is needed to integrate with the global economy. With these factors in place, economies can grow by steadily increasing investment, both public and private. The Chart below shows a sample of countries, and their productivity increases over the last 30 years.

[109] World Bank, 2022, page 212.

[110] Oil exporting countries are sometimes among the highest in per capita income simply because they have large oil-fueled GDP and comparatively low populations. Their “productivity” in terms of GDP per capita is highly dependent on the price of oil.

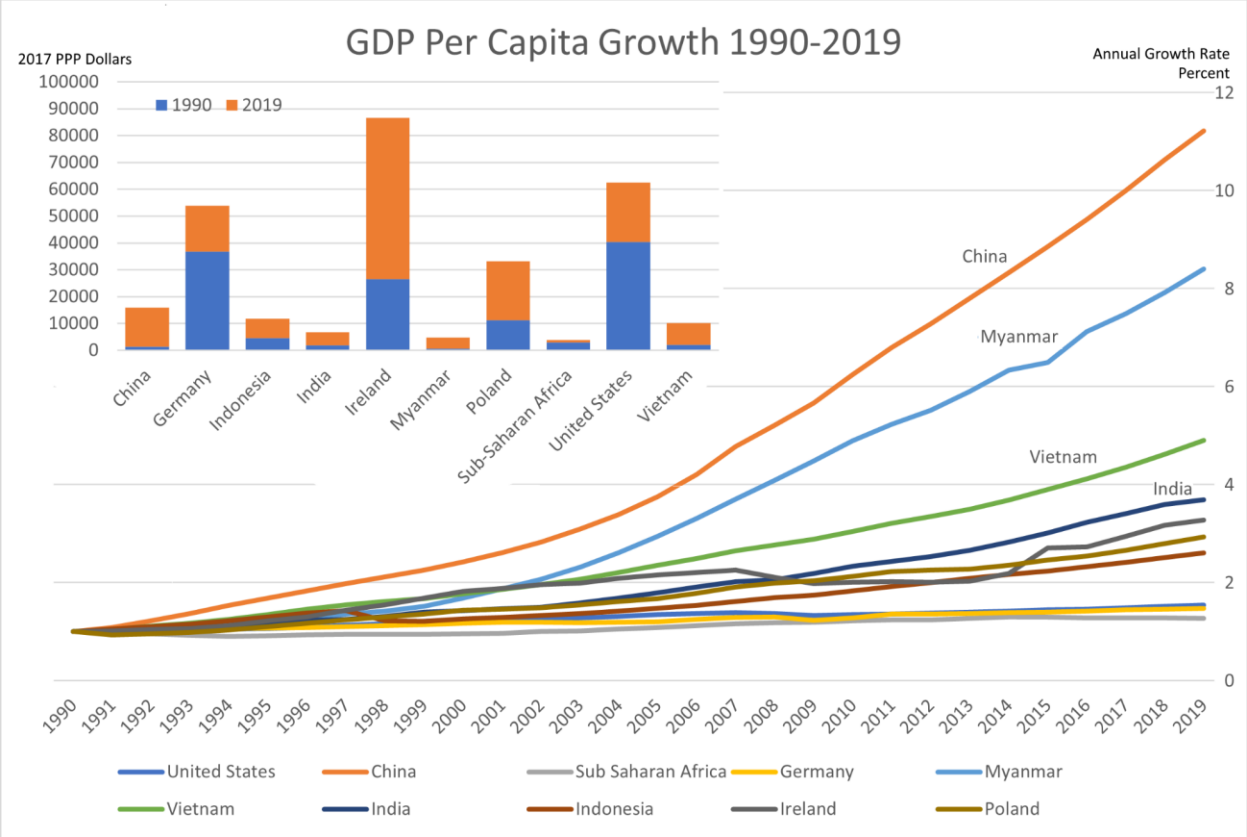


Figure 20 Annual GDP per Capita Real Growth Rates (large chart), and actual GDP per capita (small chart). Source: World Bank Indicator Data. This data is in 2017 dollars adjusted for both inflation and differences in purchasing power (PPP) between countries. WW120

China's GDP per capita grew nearly 12-fold in that time period, meaning that, if the benefits of GDP growth were distributed evenly, the average Chinese person's real income could have increased by a factor of 12. GDP includes investment, and the Chinese are big savers, investing nearly half of their GDP each year compared to a world (and US) average of around 20%. About half of China's savings is by households, the rest by companies and the government[111].

In the chart, productivity growth in the United States, Germany and Sub-Saharan Africa look to be a flat line at the bottom, but actually US real output per capita increased about 50% over the 29 years even though the rate of increase stayed flat at around 1.5% annually. Again, it is important to keep in mind that China and other high growth countries started with a very low comparative GDP per capita, the inset chart shows GDP per capita for the same set of countries. Despite high compound growth, actual dollar increases in advanced economies were higher than the developing ones, as is shown in the small inset graph. Some economists willing to go out on a limb predict it will take at 50 years for China's GDP per capita to catch up with the United States[112]. None the less this kind of growth is enviable. Can other countries reproduce it?

[111] These are "gross savings" rates. When depreciation is considered, the US savings rate is about 3.6%. Of course, when machines etc. are replaced, productivity can be increased.
[112] See https://www.cnbc.com/2021/03/26/us-will-remain-richer-than-china-for-the-next-50-years-or-more-eiu.html.

Will it continue? In the box below we look at how China achieved the amazing growth we've seen in the last 40 years or so.

China's Growth Example

China is an ancient country with a long and complex history. When the Communist party first came to power in 1949, it adopted a "Soviet" style development policy which stressed investment in heavy industry as the key to economic development. Agriculture was collectivized, although the size and administration of farming units underwent changes depending on the politics of the time. Despite the Chinese propensity to save and invest, output was inadequate to allow for investment in both agriculture and industry, and by the early 1960s, investment priority had shifted to agriculture because agricultural productivity growth was barely keeping pace with population growth. During the period from 1960 until the death of Mao Tse Tung in 1976 growth alternated with periods of political turmoil including the "Great Leap Forward" - which turned out to be a great leap backwards - and the Cultural Revolution.

The modern era of the Chinese economy is usually pegged as starting in 1978, although reforms had been ongoing. At the Party Congress of December 1978, a reform program was adopted that called for increasing use of market mechanisms to improve productivity. In agriculture, the "Household Responsibility System" let farm families lease land from the state and make their own decisions about what and how much to grow. Farm products could be sold at prices determined by the market.

By 1984, agricultural production had boomed following the institution of the household responsibility system, which replaced collective farming. Then-Premier Zhao Ziyang wrote in his memoirs that in the years following the institution of household responsibility system, "the energy that was unleashed … was magical, beyond what anyone could have imagined. A problem thought to be unsolvable had worked itself out in just a few years' time … [B]y 1984, farmers actually had more grain than they could sell. The state grain storehouses were stacked full from the annual procurement program."[113]

The market reforms made for better decision making and incentives, and the ensuing increase in output in Chinese agriculture was due to increased productivity on the 10% of arable land in China.

[113] https://en.wikipedia.org/wiki/Economic_history_of_China_(1949%E2%80%93present)

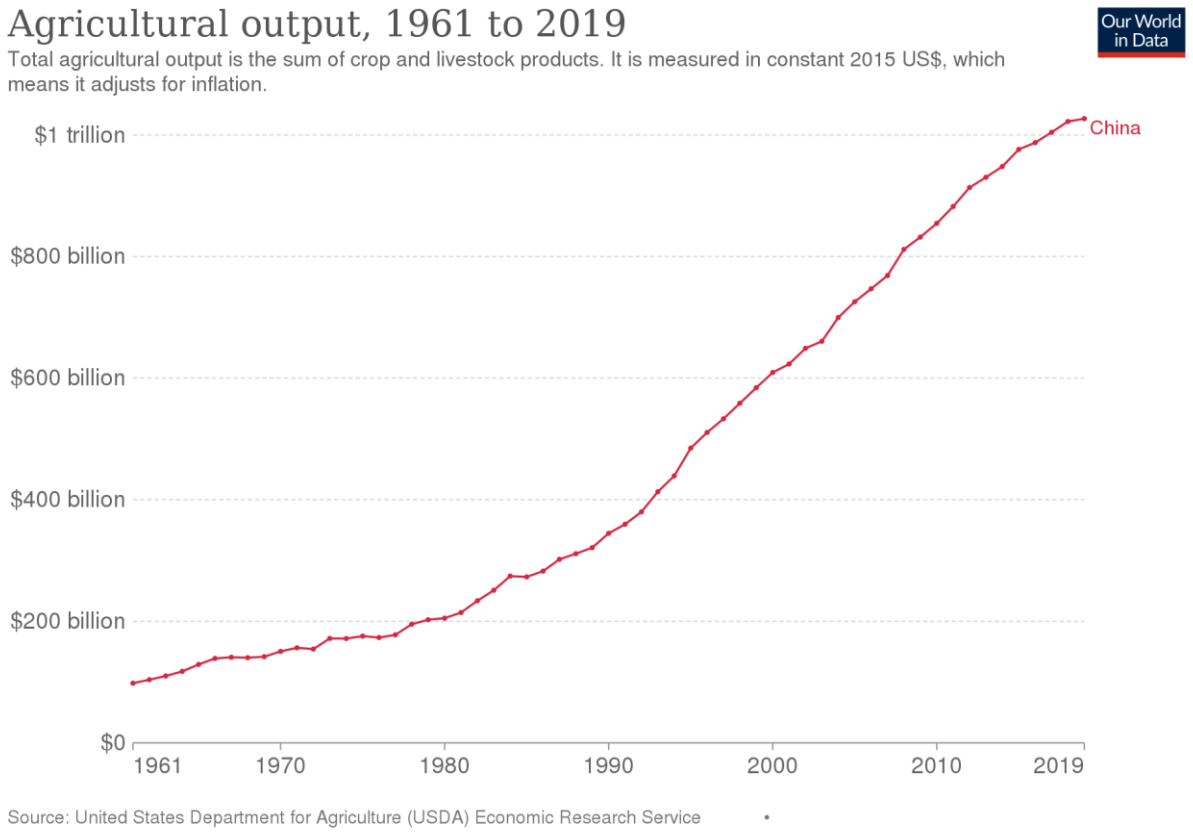


Figure 21: Chinese agricultural output in constant US dollars. Credit: Our World in Data

Industry too was reformed to allow for more management autonomy and market involvement by the state-owned enterprises. Private and "joint ownership" firms rapidly expanded in number and output. State owned enterprises, which still produce about 25% of GDP today[114], had to compete on the open market and had to borrow money at interest from the Bank of China rather than receiving direct budgetary allotments. Over time, price controls which had set prices for commodities were relaxed or eliminated. All these moves towards free markets had the desired result of increasing competition and productivity and expanding the range of goods and services available.

In trade, China moved from a policy of self-sufficiency to regarding trade as an important source of investment funds and modern technology. In the early 1980's, "special economic zones" were set up in which trade with foreign firms was encouraged. Protections for private property were instituted. Given the low cost of Chinese labor, foreign investment in manufacturing poured in, at first especially in clothing and textiles. In the special economic zones, which served as economic "laboratories", factories owned primarily by investors in Hong Kong and Taiwan produced mountains of clothes under conditions reminiscent of Britain's industrial revolution. By 2000, while textiles and apparel exports had continued to rise

exponentially, consumer electronics had grown even faster and constituted the largest export sector.

More recently China has undertaken major investments in infrastructure and housing. Public infrastructure such as roads, railroads, subways, power generation and transmission, water management, and telecommunications have a return on investment just as private investment does and are essential for growth. By some estimates, return on additional infrastructure investment is now roughly on par with returns on private investment[115].

China today has more or less balanced trade[116], a large and growing middle class, and is shifting from an export focused economy to one based largely on internal demand fueled growth. It is probable that China's growth rate will begin to slow in the near future if it hasn't already, the population is aging for one thing.

China's case provides some lessons. While there was substantial investment in heavy industry prior to economic liberalization, it wasn't until market forces and incentives were unleashed that productivity started to take off. The improvement in agricultural productivity allowed large numbers of workers to migrate to the cities where they were employed in the factories resulting from trade liberalization. The comparative advantage of China in labor combined with a high propensity to save, provided capital for investments both private and public, which in turn drove further productivity increases.

Developing World Productivity Growth

The map below shows the current GDP per capita of countries around the world. GDP per capita provides a good indication of relative labor productivity in the money (as opposed to barter or unofficial) economy. GDP for each country has been adjusted to account for differences in local purchasing power[117].

[114] "Zhang, Chunlin. 2019. How Much Do State-Owned Enterprises Contribute to China's GDP and Employment? World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/32306 License: CC BY 3.0 IGO."
[115] There currently appears to be a housing bubble in China resulting from overbuilding and speculation.
[116] While China has huge exports and imports, they are pretty close in size leaving a 0.7% trade surplus.
[117] Purchasing Power Parity, or PPP, adjusts for the fact that $10 converted to a country's native currency using market exchange rates may buy more consumer type goods than the same $10 would in the USA.

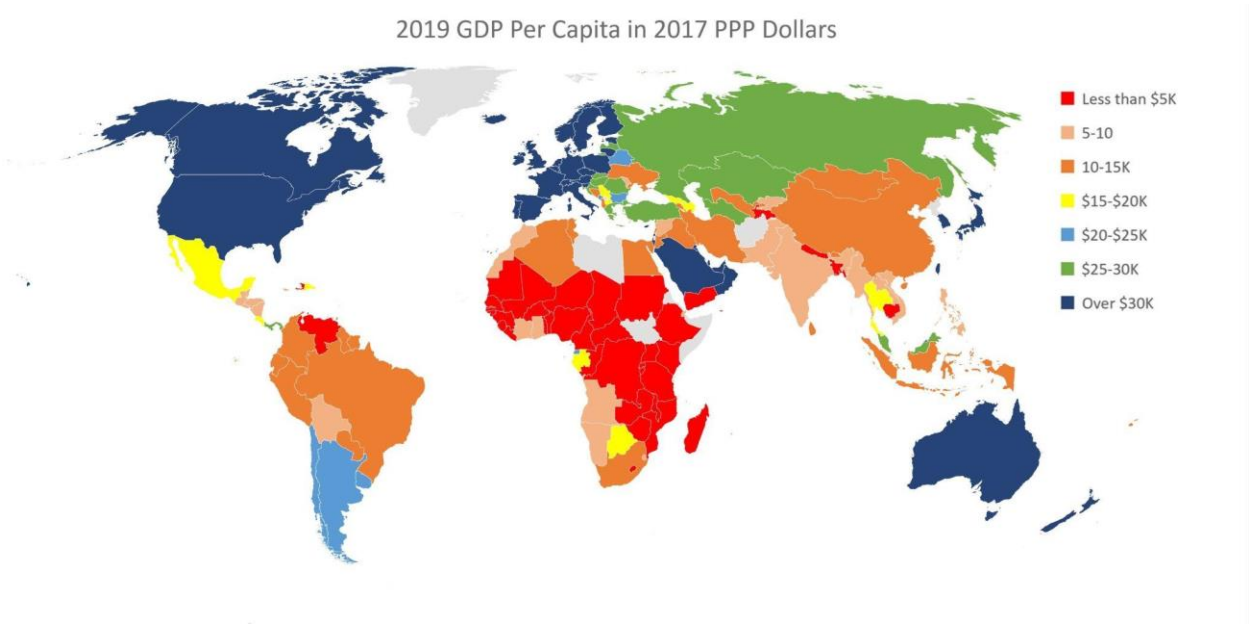


Figure 22: 2019 GDP Per Capita in 2017 Purchasing Power Parity (PPP) Dollars. Data Source: Penn World Tables.

If one looks instead at the growth rate of GDP by country in the map below, a contrasting picture emerges. Growth has been slow in richer countries including the US, Canada, Europe, and Australia, and higher as predicted in many poorer countries, such as China and Southeast Asia. However, some very poor countries have also had slow or non-existent growth since 1990. Countries with negative per capita growth over the period, shown in red, include the Democratic Republic of the Congo and Venezuela, which illustrate the disastrous economic effects of war and turmoil.

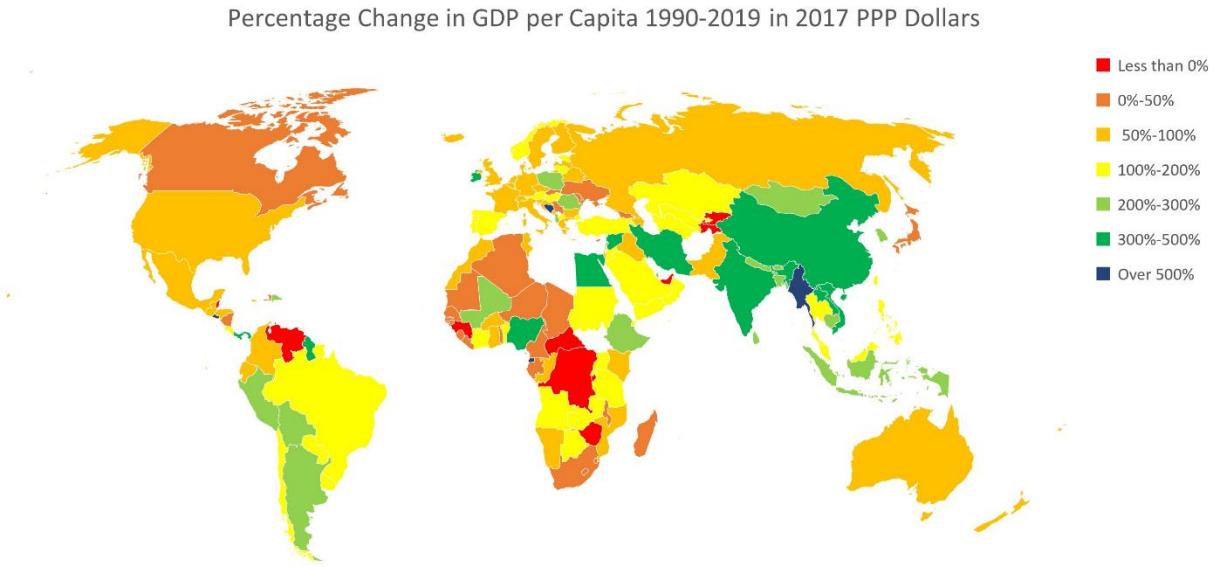


Figure 23: Growth in GDP per Capita in 2017 purchasing power dollars from 1990-2019. Source: Penn World Tables

We've seen that in China, agricultural productivity growth freed people to work in industries fueled by trade and financed by foreign investors. It is worth looking a bit more at how agricultural productivity has grown in the developing world.

Worldwide, agriculture still accounts for 27% of employment but only 4% of GDP, a fact which underlies the relationship between poverty (as measured by GDP) and widespread subsistence agriculture. Despite the advances of the Green Revolution, about 9 million people still die of malnutrition annually[118]. That said, increased agricultural productivity worldwide reduced the fraction of the world's population that is undernourished from 35% in 1970 to 13% in 2017 despite population doubling in that time period [119].

In the developing world, agricultural productivity growth varies by country and region. Growth of agricultural output is actually similar in Africa and China, for example, but labor and total factor productivity in agriculture has stagnated in Africa. Why?

[118] https://borgenproject.org/15-world-hunger-statistics/. India has the largest number of malnutrition deaths.
[119] https://ourworldindata.org/hunger-and-undernourishment

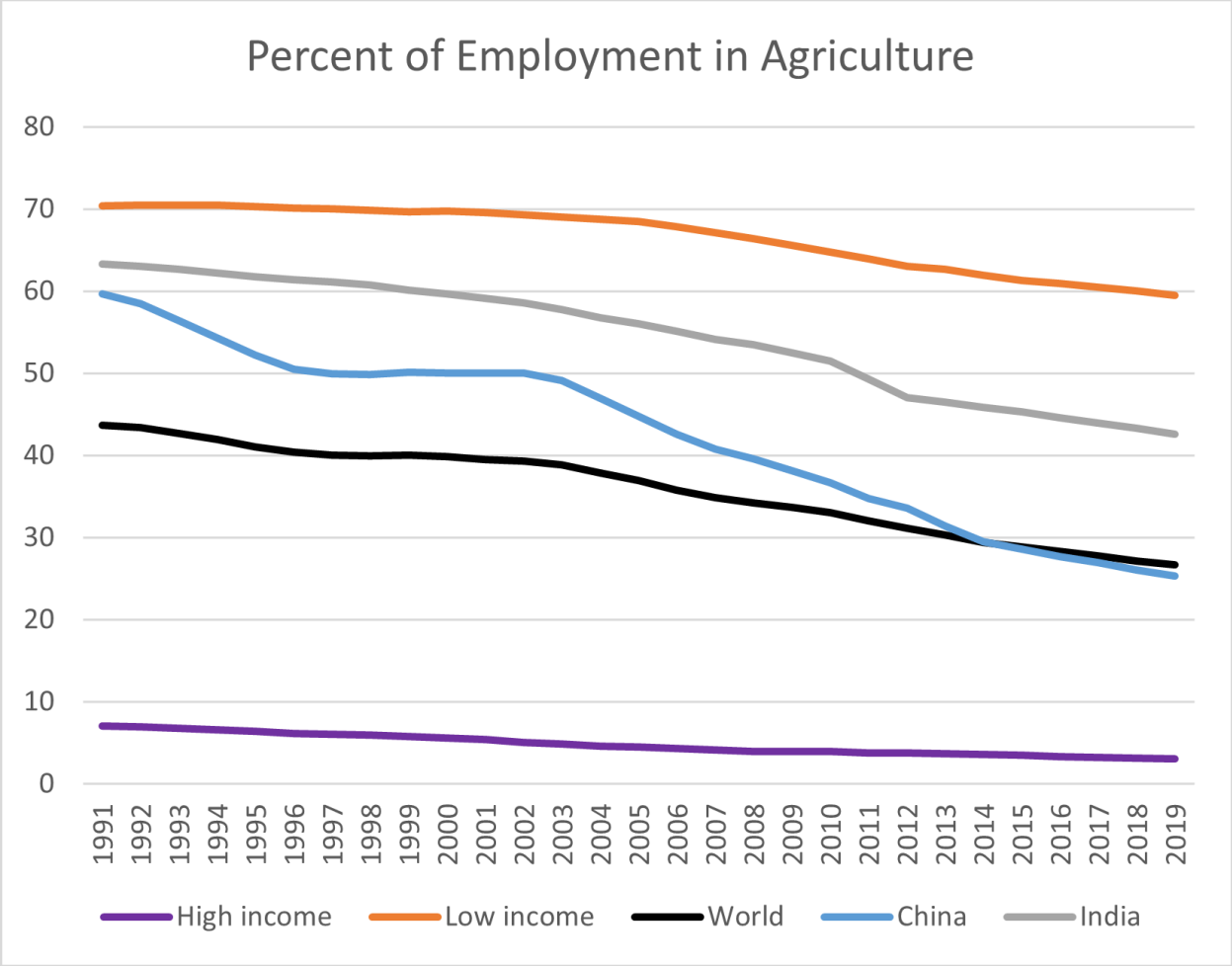


Figure 24: World employment in agriculture in 2019. Source: World Bank and International Labor Organization

In China, agricultural employment has fallen from 60% of the working population to about 25% since 1991 as shown on the chart. It's not just that people have migrated to cities: rural non-farm employment rose from 30 million in 1978 to over 200 million in 2007, and more than half of rural income now comes from non-farm employment[120]. Along with abandoning collectivized agriculture, this influx of money has encouraged farmers to invest in equipment and fertilizer and better crop varieties. The growth of agricultural productivity in China is all a story of increasing labor productivity, and more modestly yield increases, on the approximately 10% of the country that is farmable, rather than farming more cropland. In addition, there has been an increase in the production of meat. In contrast, in Sub Saharan Africa, much of the substantial increase in agricultural production has come through increases in land under cultivation. Labor productivity in African agriculture has changed little, in part because, despite rapid growth in urban areas, population growth is so high that agriculture still accounts for more than 50% of

[120] Bryan Lohmar, Fred Gale, Francis Tuan, and Jim Hansen. 2009. "China's Ongoing Agricultural Modernization." *USDA Economic Information Bulletin Number 51*, April. https://www.ers.usda.gov/webdocs/publications/44377/eib-51.pdf?v=0.

employment, primarily on small family farms[121]. Sub Saharan Africa's population has grown fivefold since 1960, compared to about doubling in China and tripling in India.

The charts below show how China has increased agricultural output by applying more capital and fertilizer while using the same amount of land and less labor. In Sub-Saharan Africa, on the other hand, increasing output has required using more land and labor to barely keep pace with an increasing population.

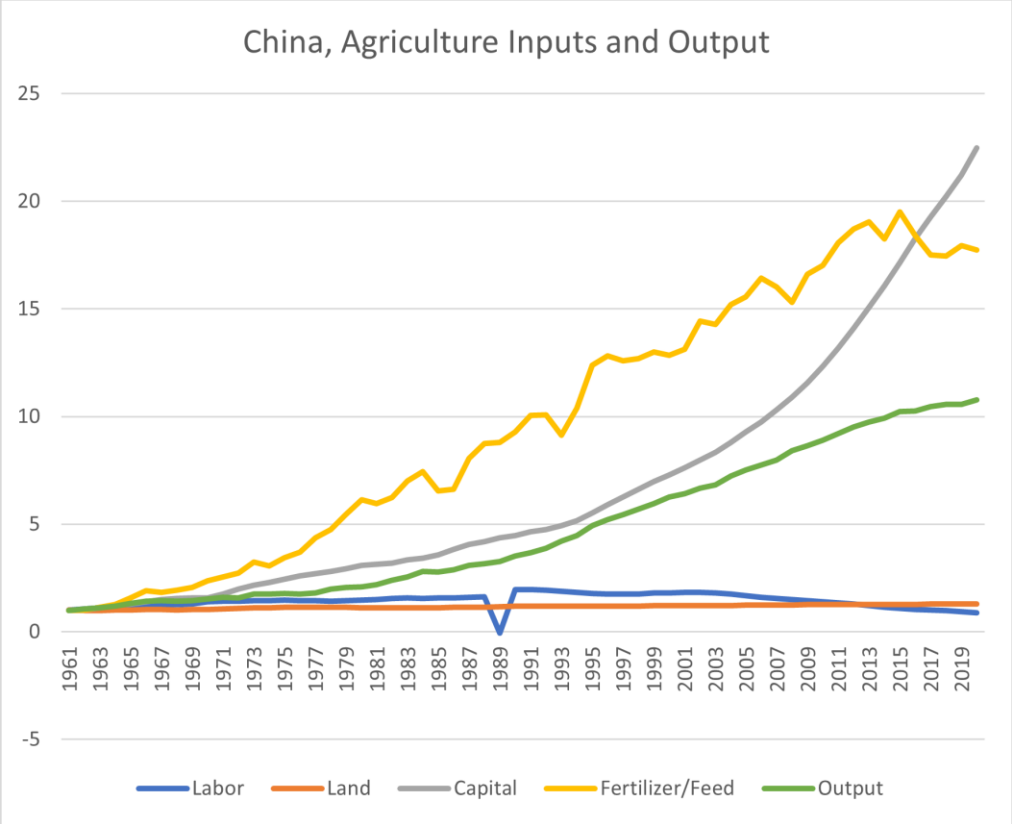


Figure 25: China, Agricultural Inputs and Outputs. Source: US Department of Agriculture World TFP Data

[121] Zuma-Chair, Nkosazana Dlamini. 2014. "Agriculture in Africa." *African Union - New Partnership for Africa's Development*. https://www.un.org/africarenewal/sites/www.un.org.africarenewal/files/Agriculture%20in%20Africa.pdf.

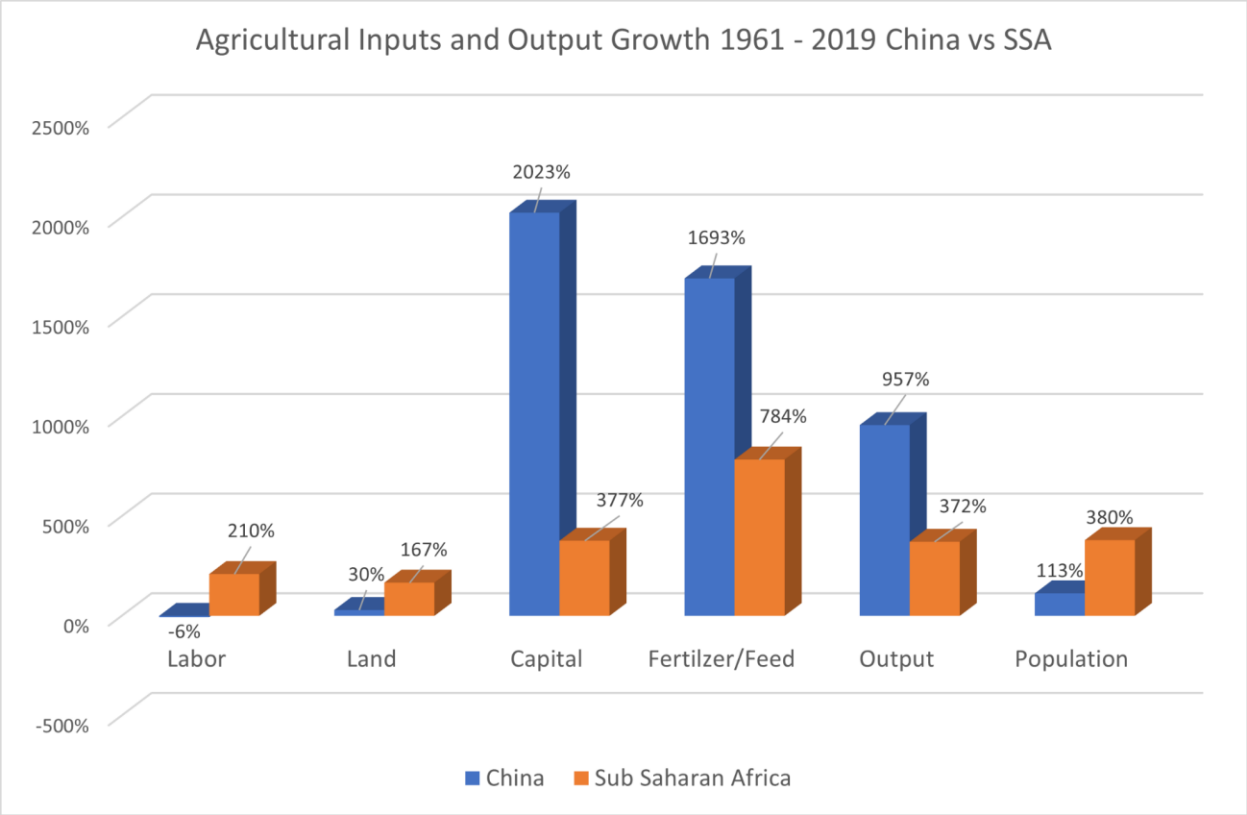


Figure 26: Agricultural Inputs and Output Growth 1961 - 2019 China vs Sub-Saharan Africa. Source: US Department of Agriculture World TFP Data

In both Africa and India capital accumulation and foreign investment have not been able to provide enough jobs to keep up with the growth in population, and young people unable to find other work end up working on inefficient family farms[122]. In low-income countries, agricultural productivity and scale production are affected as well by a lack of infrastructure and capital investment. In Nigeria, 45 percent of fresh produce rots due to the lack of refrigeration. Globally, 1.3 billion tons of perishable food goes to waste each year because of lack of proper post-harvest storage, almost all of it in poor countries[123].

Improvement in agricultural productivity and the growth of the industrial and service sectors are closely linked in a chicken and egg way. In low-income countries, agricultural productivity is still quite low, and shifting employment from agriculture to other sectors is the fastest way to improve overall productivity. As we saw in the case of China, profits from trade in manufactured goods can then finance further development in a positive feedback loop, and, as long as large

[122] For the situation in Africa, see the prior citation. In India the "demographic dividend" downside is discussed in Jha, Somesh. 2023. "World's Largest Population: Will India Gain or Lose?" Al Jazeera. April 18, 2023. https://www.aljazeera.com/features/2023/4/18/overtaking-chinas-population-will-india-gain-or-lose.

[123] https://foreignpolicy.com/2022/11/06/climate-cop27-emissions-adaptation-development-energy-africa-developing-countries-global-south/?utm_source=PostUp&utm_medium=email&utm_campaign=Flashpoints%20OC&utm_term=57271&tpcc=Flashpoints%20OC

income disparities exist in the world, it is possible for other countries to follow this growth model. As we'll see in the section on trade, as incomes have risen in China, much textile production has shifted to other countries such as Bangladesh, a poor country with an accelerating rate of GDP per capita growth.

Unfortunately, productivity growth is not guaranteed unconditionally for developing countries. In addition to the factors we noted earlier including stable government, low levels of corruption, and higher levels of education, World Bank case studies highlight the importance of export promotion, global value chain integration, and foreign direct investment (FDI) in transitioning to higher-productivity growth. But the authors also note that this development strategy hasn't always worked and there are indications that manufacturing led growth may be more difficult now:

"[Developing countries] that have successfully shifted into higher-level productivity clubs have often relied upon manufacturing- led development—efforts to enhance the complexity and diversity of exports can prove to have high rewards but have also frequently been costly failures. This strategy faces increasing challenges due to falling global manufacturing employment and slower trade growth.[124]"

Trade has been key in development success, particularly trade in manufactured items rather than commodities. Trade, as we've seen in the case of China, is often a story of foreign companies seeking to lower costs by sourcing manufacturing and tradable services in countries with lower labor costs. The resulting foreign investment helps build up the country's capital stock and educated workforce, setting the stage for rapid productivity growth. The form of government doesn't seem to be as important as stability, at least a partially free market, and openness to trade. Economic development is, perhaps paradoxically, key to sustainability. Continued growth of the human population past 10 billion is widely acknowledged to be unsustainable, and the only sure-fire method of reducing the birthrate we know of, aside from coercion, is by improving standards of living[125]. We've seen that trade is an important factor in helping developing countries grow their productivity and GDP. The next section looks at the scale and economic effects of international trade.

[124] World Bank Group. 2022. "Global Productivity: Trends, Drivers, and Policies." World Bank Group. https://www.worldbank.org/en/research/publication/global-productivity. Page 204

[125] We will discuss that topic in the section on sustainability.

Trade

World Volume and Patterns of Trade

The chart below shows imports, exports, and the trade balance of the US as a percentage of GDP.

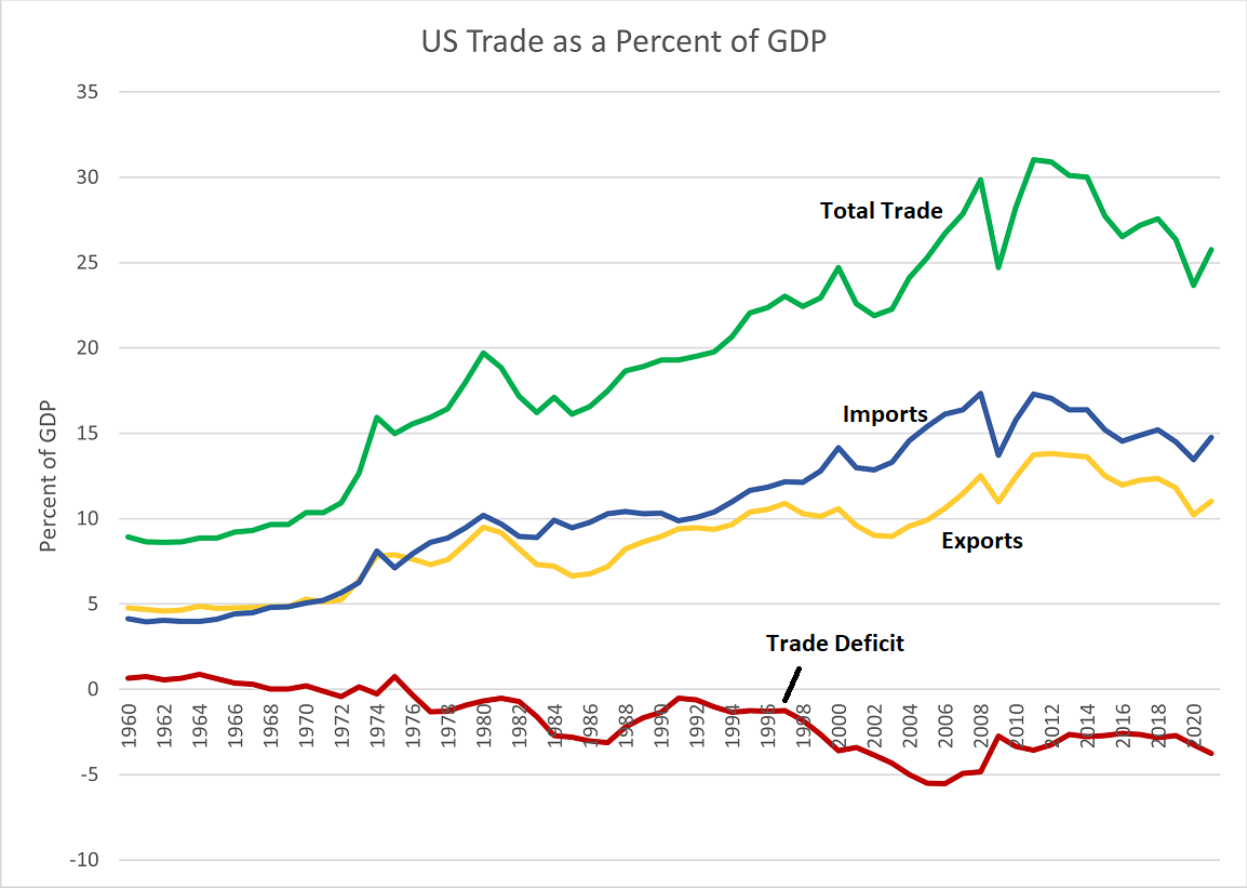


Figure 27: US Trade as a Percent of GDP. The trade deficit gets larger as it goes more negative. Data Source: BEA

US imports and exports totaled a combined $5.6 trillion in 2019, one quarter the size of the entire economy! While the US has the largest combined value of imports and exports in the world, on average most countries do even more trading compared to the size of their economies. The chart below shows trade as a percentage of GDP for the world, the US and China.

Figure 28: International Trade as a Percent of GDP Source: World Trade Organization, data from database: World Development Indicators. Note: trade includes both imports and exports. The World number is a weighted average of trade as a percent of GDP across countries.

Several things stand out. First is the high level of trade worldwide. In the case of the US, as we noted earlier, it is now around 25% of GDP, but for the world as a whole it is above 50% for imports and exports combined. Second, while the ratio of trade to GDP grew steadily until 2007, it has declined since then. In part this is due to economic conditions, the 2008 credit crisis caused a contraction in trade, but the decline continued after conditions improved. Finally, it is interesting to note the steep decline in trade as a percentage of GDP for China since 2004. China's internal demand has increased substantially, so more of its total output (GDP) is being consumed within the country. India shows a similar trend. The US GDP is the largest in the world, and it is also the largest importer in the world in dollar terms, followed by China and Germany. The US ranks second after China in exports, with Germany again in third place.

World GDP has increased enormously, and since trade has risen as a percent of GDP, it has grown even faster, in a steep logarithmic curve. A real time interactive map of the giant cargo ships and tankers that ply the oceans looks like thousands of ants on the march[126]. Why has trade increased as a percent of GDP? The main factors are lower transport costs, lower tariffs negotiated in trade agreements, countries such as China opening up to trade, computerized logistics, increased demand for resources such as oil, and the freer movement of capital which makes it easier to manufacture where costs are lower and ship the goods.

[126] There are many vessel trackers. See for example https://www.vesselfinder.com/. On the left you can choose the types of vessels shown. A "mega" cargo ship can haul as much freight as 3,800 trucks and 50 trains (https://shippingwatch.com/Ports/article11989745.ece). Ships account for over 80% of international shipping. There are over 50,000 large cargo carrying ships. For a great visualization see https://www.shipmap.org/

The chart below shows the largest goods exports by product worldwide. Services exports have increased in recent years and are now nearly a third as large as trade in goods.

Figure 29: World Exports by Product Type. Data Source: UN Comtrade extracted through World Bank WITS interface.

Total world goods trade in 2019 was around $19 trillion, or almost the size of US GDP. Service trade came to around $6 trillion. Worldwide, agricultural product exports were around $1.8 trillion, or around 10% of the total. It is clear that world trade is dominated by manufactured products. As the chart shows, the large electrical and machinery category[127] has the highest global trade volume followed by fossil fuels, vehicles, and chemicals.

It is interesting to look at trade between countries. Here, for example, are the major items traded between the United States and Canada

[127] This chart is aggregated using the Harmonized System 2017 coding, Electrical and machinery (Section 16) is very large, including everything from cell phones to nuclear reactors.

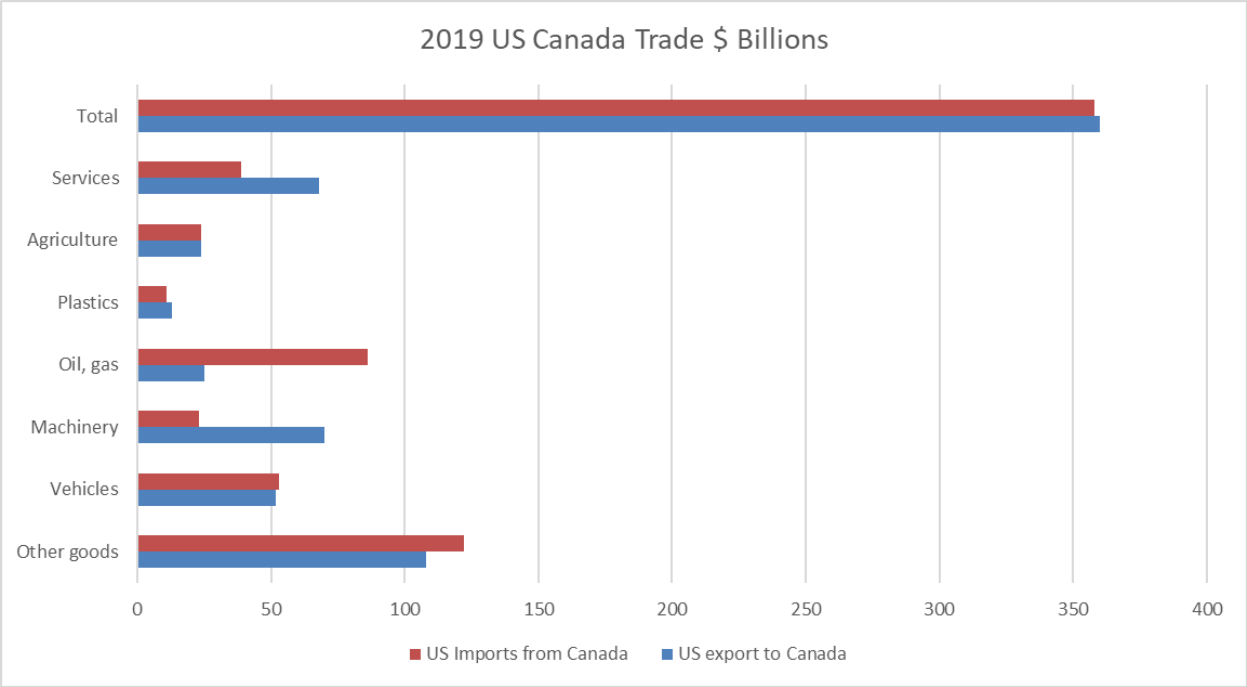


Figure 30: 2019 US Canada Trade. Data Source: US Trade Representative

Trade between the US and Canada was almost balanced at $350 billion in 2019, and each of the major goods traded is found on both sides of the exports and imports ledger. The US exports as much in cars and car parts as it imports, both countries' major exports to the other include machinery, fossil fuels, plastics, and agricultural products. It is almost as if the US and Canada are one large country from a trade perspective. That is no accident, the volume of trade between countries is highly influenced by proximity. The top three US trading partners in 2019 were Canada, Mexico, and China in that order. Shipping costs are lower when countries are close to each other, and tariffs and other trade barriers may be lower as well. This pattern is observed worldwide.

In looking at what gets traded between countries, detailed studies have shown that developed countries such as the US and Canada tend to trade similar types of products, often with a high level of technical sophistication. As trade barriers drop, fully developed countries tend to specialize in their bilateral trade: so, for example the US exports car parts to Canada where cars are assembled and then shipped back to the US. Trade between a developed country and a developing one also tends to be more complimentary than competitive, but in this case different types of products are traded, at least after trade barriers have been removed long enough for the dust to settle[128]. This is not particularly surprising if we recall the discussion of comparative advantage in the primer. In general, developing countries have a comparative advantage in labor and developed countries have an advantage in technology and capital intensity.

[128] Edwards, Lawrence, and Robert Z. Lawrence. 2013. Rising Tide, Is Growth in Emerging Economies Good for the United States? Peterson Institute for International Economics. See Table 4.1

China is among the largest exporting and importing countries in the world. Now an upper middle-income country with a per capita GDP of over $12,000, China has come a long way on the path to development. We already looked at how it achieved its amazing growth, but here are a few of its notable trade statistics from 2019[129]:

- China's largest trade partners in 2019 were the EU, the Asian countries (ASEAN), and the US in that order.
- In 2019, for the first time, China's domestic owned private companies trade, at 42.7%, was higher than trade by foreign owned companies at 39.9%. State owned enterprises accounted for the rest. Foxconn is an example of a foreign company (it's Taiwanese) with major investment in China[130].
- Electronics and machinery made up 58.4% of total exports. This included computers ($150 Billion), cell phones ($224 Billion), and integrated circuits ($102 Billion).
- Labor intensive industries including textiles and apparel made up 19.2% of exports.
- "Processing trade", or assembling products made from largely foreign components, made up 25.2% of total trade.
- China's trade is almost balanced, it had a net trade surplus of 0.7% of GDP in 2019.

Foreign companies have pumped huge amounts of capital into China to make use of its abundant lower-cost labor. Both foreign and domestically owned Chinese companies assemble products from imported components in what is called the "processing trade", a high-volume low margin business. The box below details one company built on the processing trade and gives a feel for trade flows between developing and developed countries.

Foxconn and Apple

The Taiwanese company Foxconn, the largest private employer in China, operates huge self-contained factory "cities" which produce almost all Apple products including the iPhone, Amazon's Kindle and Echo, Nintendo gaming systems, Nokia devices, Sony devices including PlayStations, Google Pixel devices, Xiaomi devices, every successor to Microsoft's first Xbox console. In 2012, Foxconn estimated that its factories manufactured an estimated 40% of all consumer electronics sold worldwide.

Some of the Foxconn factories employ hundreds of thousands of workers within self-contained walled "campuses". To quote from a recent article in Foreign Affairs Magazine:

At the gigantic Shenzhen Longhua "campus," as the Foxconn managers like to call it, there are multistory factories, high-rise dormitories, warehouses, two hospitals, two libraries, a

[129] Review of China's Foreign Trade in 2019, China Customs, http://english.customs.gov.cn/Statics/f63ad14e-b1ac-453f-941b-429be1724e80.html and data extracts from UN Comtrade through WITS

[130] The world recognizes Taiwan as part of China, but from an economic point of view it acts independently.

bookstore, a kindergarten, an educational institute (with the grandiose name "Foxconn University"), a post office, a fire department with two fire engines, an exclusive television network, banks, soccer fields, basket-ball courts, tennis courts, track and field, swimming pools, cyber theaters, shops, supermarkets, cafeterias, restaurants, guest houses, and even a wedding dress shop. Foxconn's campus is the very image of a modern company town. The assembly lines run on a twenty-four-hour basis, particularly when the production schedule is tight.

The workplace and living spaces are compressed to facilitate high-speed, round-the-clock production. The dormitory warehouses a massive rural migrant labor force isolated from family relations. Whether single or married, each worker is assigned a bunk space for one person. In contrast to the corporate image of "a warm family with a loving heart," Foxconn workers frequently experience isola-tion and loneliness—some of it seemingly deliberately created by managerial staff to prevent the formation of strong social bonds among workers.

Managers, foremen, and line leaders prohibit conversation during work hours in the workshop. New workers are often reprimanded for working "too slowly" on the line, regardless of their efforts to keep up with the "standard work pace." "Outside the lab," according to an ominous saying of CEO Terry Gou, "there is no high tech, only implementation of discipline."[131]

This sounds like a modern version of the early English textile mills, but in this case the factories run 24 hours a day. While China officially has a 40-hour work week, Foxconn requires workers to work overtime especially in preparation for a holiday season or the release of a new iPhone version.

Foxconn makes products for many big-name companies, but its tight relationship with Apple is particularly well known. Here is a comparison of the two companies:

Company	2019 Revenue $Billion	2019 Profit (net income) $Billion	Employees	Revenue per employee	Profit per employee
Foxconn	$178	$4	1,290,000	$137,984	$3,419
Apple	$260	$55	154,000	$1,688,312	$357,143

Apple outsources almost all of its manufacturing, primarily to Foxconn, preferring to concentrate on design, engineering, managing, branding, and selling which, as the chart indicates, is much more profitable than manufacturing. While Foxconn operates most of its factories in China, it has about 25% of its capacity in other low wage countries.

[131] Chan, Jenny. 2020. "Foxconn's Rise and Labor's Fall in Global China." American Affairs Journal. November 20, 2020. https://americanaffairsjournal.org/2020/11/foxconns-rise-and-labors-fall-in-global-china/.

In 2017, to great fanfare, Foxconn announced plans to build a $10 billion electronics factory to build high-def TV screens in Wisconsin. The state's then Governor had negotiated $3 billion in tax breaks and other subsidies. In 2020 Foxconn officially abandoned the plan[132]. The reasons are not hard to figure out: it is highly unlikely that US workers would accept the working conditions and starting pay of around $3 per hour that is endured by Foxconn's young rural Chinese workforce. While TV screens cost more to transport than iPhones, it is likely the deal was driven more by public relations and risk hedging than by rationalizing business operations.

None of this is to paint Foxconn or Apple or China as untypical, rather the reverse. If Apple didn't have its products manufactured at the lowest possible cost while still maintaining quality, it would be less profitable. If Foxconn didn't seek out the lowest cost workforce and highest productivity while still maintaining quality, it could lose contracts. Given the demands of the free market, it is only through political means such as unions or government that workers within a political jurisdiction can set the rules under which companies operate. Developing countries meanwhile strive to attract foreign capital to drive up productivity and hence wages in the long run.

Consumers of electronics all over the world benefit from low-cost electronics. Closing the door to imported electronics in the US would be next to impossible in the short run (Apple's experience in Texas is telling[133]) and would cause the costs of these products to skyrocket. Higher prices are the same as lower pay, so the vast majority of Americans would end up with effective pay cuts in exchange for the factory jobs created. As we noted in the primer, trade between two countries is almost always beneficial to both regardless of the differential in average productivity and hence wages between them. It is the equivalence of lower prices and higher pay that often obfuscates this fact, along with the pain of employment adjustments. We'll look at data on the "welfare" effects of trade a bit later.

A contrast to China with its huge (but diminishing) supply of labor is Germany, a country on the productivity edge. Some German trade highlights[134]:

- Germany has one of the highest trade surpluses in the world at 7.6% of GDP in 2019 compared to China's 0.7% surplus and the United States' 2.3% deficit.

[132] Isidore, Chris, and CNN Business. 2021. "Foxconn's Giant Factory in Wisconsin Sounded Too Good to Be True. Turns out It Was." *CNN*, April 22, 2021. https://www.cnn.com/2021/04/22/tech/foxconn-wisconsin-factory-scaled-down/index.html. Also see Nusca, Andrew. n.d. "Apple Wants to Make Products in U.S., but That's Not so Easy." CNET. Accessed May 23, 2022. https://www.cnet.com/tech/tech-industry/apple-wants-to-make-products-in-u-s-but-thats-not-so-easy/.

[133] Nicas, Jack. 2019. "A Tiny Screw Shows Why iPhones Won't Be 'Assembled in U.S.A.'" *The New York Times*, January 28, 2019. https://www.nytimes.com/2019/01/28/technology/iphones-apple-china-made.html.

[134] UN Comtrade accessed through World Bank WITS

- Germany's largest trade partners are the EU, the US, and China in that order.
- Germany's largest exports include motor vehicles and parts ($205 Billion in 2019) and medical products including pharmaceuticals and medical instruments ($101 Billion) which together account for about 20% of total German exports. Textiles account for a tiny 0.07 percent of exports.

While Germany makes a lot of cars domestically for export, German companies, like most other car companies, build their cars using parts from widely distributed suppliers and often assemble them closer to where they are sold. Cars, unlike electronics, are heavy and there are tax advantages in assembling cars where they are sold. The box below focuses on foreign automobile manufacture in the United States.

Made in America - Cars

Unlike the case for electronics, even "foreign" cars such as Honda or Toyota, sold in the United States are often assembled here and contain parts from suppliers all over the world.

An amusing 2015 article in Consumer Reports notes[135]:

The U.S. saw an increase in automotive employment in the 1990s and early 2000s. German, Japanese, and South Korean automakers covered the American South with hulking final-assembly and supplier plants and tens of thousands of nonunion jobs that paid just well enough to fend off the United Auto Workers. The idea: Build 'em where you sell 'em.

In an ironic turnabout from the years when naysayers decried made-in-Asia cars as little more than tin boxes built with cheap labor, the U.S. has become the low-cost labor source of choice for foreign brands. Korean automakers Hyundai and Kia jumped into the fray; even German luxury brands had little problem expanding outside home.

In some cases, the assembled cars from foreign owned factories in the United States are exported. The Consumer Reports article notes that in 2014 BMW exported 70% of the output of its assembly plant in Spartanburg, South Carolina.

Cars made by US automakers contain a lot of components made elsewhere, so the "Total Domestic Content" shown on new car window stickers is never 100%. In fact, because the large US automakers had assembly plants in Canada, just north of Detroit, back in 1994 when the American Automobile Labeling Act was passed, the act includes both US and Canadian content in the "domestic" tally. This explains the brisk two-way trade in vehicles and parts between the US and Canada we noted earlier.

While the profits of foreign owned car operations in the US "belong" to the parent company, much of it is reinvested here. We benefit from the huge capital investment in plants and equipment as well as the employment and payroll supported. As of 2019 Japanese car

[135] "What Makes a Car 'American'? - Consumer Reports." n.d. Accessed May 24, 2022. https://www.consumerreports.org/cro/magazine/2015/05/what-makes-a-car-american-made-in-the-usa/index.htm.

companies had invested $51 billion in US plants that created 94,000 manufacturing jobs, and several times that number of supplier jobs.

The difference in the employment picture between electronics and car manufacture comes down simply to cost minimization. For cars, the transportation costs of a finished vehicle are more than the labor cost savings from assembling the vehicle in a lower wage country such as China, so it is less expensive to assemble the car here. The reverse is true for lightweight electronics products. Many of the lighter components used in automobile assembly do in fact come from further away because their transportation cost is low. More recently Mexico, being close to the United States, has become a hub for automobile assembly.

These two examples show that, not surprisingly, stuff is made where the total cost of producing it for its intended market is lowest when all costs are considered. In the case of Apple, the company decided to outsource, while in the US automobile case foreign companies invested in manufacturing plants here as well as buying from local suppliers. The calculation of how to maximize profit is far from simple since it involves decisions about investing versus outsourcing, labor costs, transportation costs, tariffs, geographic sales prediction, supply chain organization, taxes, local subsidies, and risk evaluation. And when components are assembled, the analysis has to be done for each component as well as the point of final assembly. The comparative ease with which capital flows around the world now, and the use of software to help with planning and tracking has encouraged the development of complex supply chains regardless of where a company is headquartered. Companies source services in much the same way. US companies often locate much of their engineering and information technology staff in countries such as India to take advantage of lower pay rates.

Faster, cheaper, and more predictable delivery of goods worldwide, software that can predict when components and materials will be required, and suppliers who can rapidly produce components on demand has led businesses to reduce stockpiling of parts. This “just in time” management style reduces the cost of warehousing and reduces waste and allows for more flexibility in product changes.

With post-covid hindsight, one can see how these complex supply chains and “just in time” management style can lead to problems when anything goes wrong. Pandemics and wars being examples of what can go wrong. In a remarkably prescient 2014 article on US Manufacturing[136] the authors, Baily and Bosworth note:

... a strong domestic manufacturing sector offers a degree of protection from international economic and political disruptions. This is most obvious in the provision of national security, where the risk of a weak manufacturing capability is clear. Overreliance on imports and

[136] Baily, Martin Neil, and Barry P. Bosworth. 2014. “US Manufacturing: Understanding Its Past and Its Potential Future.” *The Journal of Economic Perspectives: A Journal of the American Economic Association* 28 (1): 3–26.

substantial manufacturing trade deficits increase Americans' vulnerability to everything from exchange rate fluctuations to trade embargoes to supply disruptions from natural disasters.

That said, globalization and complex supply chains are here to stay, although developing countries' lower cost labor is far from the only determinant of where goods and services are produced. A recent article notes:

Yet counter to popular perceptions, today only 18 percent of goods trade is based on labor-cost arbitrage (defined as exports from countries whose GDP per capita is one-fifth or less than that of the importing country). In other words, over 80 percent of today's global goods trade is not from a low-wage country to a high-wage country. Considerations other than low wages factor into company decisions about where to base production, such as access to skilled labor or natural resources, proximity to consumers, and the quality of infrastructure[137].

Both of these articles note the importance of a skilled, educated workforce and good infrastructure as being factors in a country's competitiveness.

China has grown its GDP per capita rapidly and is now classified as an "upper middle income" country. Leveraging trade was one important factor in this growth, but while China still manufactures nearly half of the world's clothing, that sector accounted for only 4% of China's exports by value in 2022, down from 18% in 1994. Meanwhile other countries such as Bangladesh and Myanmar with lower GDP per capita do far more of their trade in clothing. The chart below shows the relationship between the fraction of exports to the US that are clothing and 2019 GDP per capita for some Asian countries.

Table 6: Fraction of exports to the US that were clothes in 2019. These percentages are similar to each country's world exports. Myanmar also exports some oil, so the percentage of its remaining exports in clothes would be higher. Data Source: World Bank WITS interface to UN Comtrade data.

	Korea, Rep.	China	Bangladesh	Myanmar
GDP Per Capita 2019	$ 31,902	$ 10,143	$ 2,122	$ 1,295
Percent of exports to US that are clothing 2019	0%	6%	86%	33%

[137] Lund, Susan, James Manyika, Jonathan Woetzel, Jacques Bughin, Mekala Krishnan, Jeongmin Seong, and Mac Muir. 2019. "Globalization in Transition: The Future of Trade and Value Chains." McKinsey & Company. January 16, 2019. https://www.mckinsey.com/featured-insights/innovation-and-growth/globalization-in-transition-the-future-of-trade-and-value-chains. Note that China has less than one fifth the GDP per capita of the US, so trade between the pair would be included in the labor cost arbitrage grouping.

Before we leave this section on trade flows, let's look at the international transactions of the United States as reported by the Bureau of Economic Analysis in its summary of the national accounts.

Table 7: International Trade Transactions of the United States, 2019

Item	Exports $ Billions	% of Exports	Imports $ Billions	% of Imports	Net $ Billions
Total trade and foreign income	$3,812	100%	$4,285	100%	($472)
Goods	$1,652	43%	$2,514	59%	($862)
General merchandise	$1,632	43%	$2,502	58%	($869)
Foods, feeds, and beverages	$131	3%	$152	4%	($21)
Industrial supplies and materials	$526	14%	$526	12%	$1
Capital goods except automotive	$548	14%	$679	16%	($131)
Automotive vehicles, parts, and engines	$163	4%	$376	9%	($213)
Consumer goods except food and automotive	$205	5%	$656	15%	($451)
Other general merchandise	$59	2%	$114	3%	($55)
Non-Monetary gold	$19	1%	$12	0%	$7
Services	$876	23%	$591	14%	$285
Maintenance and repair services n.i.e.	$28	1%	$9	0%	$19
Transport	$91	2%	$113	3%	($22)
Travel (mostly tourist spending)	$199	5%	$133	3%	$66
Construction	$3	0%	$1	0%	$2
Insurance services	$19	0%	$52	1%	($33)
Financial services	$136	4%	$41	1%	$95
Charges for use of intellectual property n.i.e.	$116	3%	$42	1%	$74
Telecommunications, computer, and information services	$55	1%	$43	1%	$12
Other business services	$186	5%	$113	3%	$73
Personal, cultural, and recreational services	$22	1%	$20	0%	$2
Government goods and services n.i.e.	$22	1%	$24	1%	($2)
Primary income receipts	$1,125	30%	$893	21%	$232
Investment income	$1,118	29%	$874	20%	$244
Direct investment income	$569	15%	$233	5%	$336
Portfolio investment income	$424	11%	$507	12%	($82)
Other investment income	$123	3%	$134	3%	($11)
Compensation of employees	$7	0%	$19	0%	($12)
Secondary income (current transfer) receipts	$159	4%	$287	7%	($128)

Table Notes: International Transaction of the US. This shows a net trade deficit of $472 billion. "Exports" is money earned by trade or investment from overseas, while "Imports" are amounts paid for imported items or money paid on investments by foreigners. Travel "export" mostly refers to tourist dollars spent here by foreign visitors, and imports refers to money spent by US tourists abroad. Secondary income includes remittances sent overseas by people working here (e.g. immigrants).
Source: BEA Table 1.2. U.S. International Transactions, Expanded Detail for 2019

From this table we can see that the US ran a substantial goods trade deficit, mostly for consumer goods, but ran a surplus in services. The US had a net positive income from overseas investments which helped reduce the trade deficit. Still the overall “current account” deficit (net trade plus net foreign income) was $472 billion.

The deficit in trade in goods and services has to be balanced somehow, either as debt or by selling an asset. The BEA also publishes a balance sheet for the “financial account” which records these transactions. Here are the financial transactions for 2019 at the national level.

Table 8: International Financial Transactions of the United States, 2019. Source: BEA Table 1.2. U.S. International Transactions, Expanded Detail for 2019

Item	US Bought $ Billions	% of Assets Bought	US Sold $ Billions	% of Assets Sold	Net $ Billions
Net U.S. acquisition of financial assets excluding financial derivatives (net increase in assets / financial outflow (+))	**$317**	**100%**	**$756**	**100%**	**($439)**
Direct investment assets	**$122**	**39%**	**$302**	**40%**	**($180)**
Equity	**$157**	**49%**	**$262**	**35%**	**($106)**
Debt instruments	**-$34**	**-11%**	**$40**	**5%**	**($74)**
Portfolio investment assets	**-$13**	**-4%**	**$177**	**23%**	**($191)**
Equity and investment fund shares	**-$163**	**-52%**	**-$244**	**-32%**	**$81**
Debt securities	**$150**	**47%**	**$421**	**56%**	**($271)**
Short term	**$136**	**43%**	**-$33**	**-4%**	**$169**
Long term	**$14**	**5%**	**$454**	**60%**	**($440)**
Other investment assets	**$204**	**64%**	**$276**	**37%**	**($73)**
Other equity	**$1**	**0%**	**$0**	**0%**	**$1**

Currency and deposits	**$132**	**42%**	**$204**	**27%**	**($72)**
Loans	**$69**	**22%**	**$62**	**8%**	**$7**
Trade credit and advances	**$1**	**0%**	**$10**	**1%**	**($9)**
Financial derivatives other than reserves, net transactions					**($42)**
Total Financial Transactions listed					**($481)**

The financial accounts balance at $481 billion is pretty close to the trade balance of negative $472 billion. In other words, the US sold stocks, government and corporate bonds, US companies and new investments such as factories to balance the trade deficit. The difference between the trade (aka current account) balance and the financial account balance is explained by a few small items left out of the table (there is a small “capital account” also), and a statistical “error” caused by the difficulty of accounting for every last transaction. Without these offsetting sales of assets, the US, or any country, could not sustain a trade deficit. In the absence of such sales, the value of the US dollar would fall, making imports more expensive and exports cheaper, until trade again balanced.

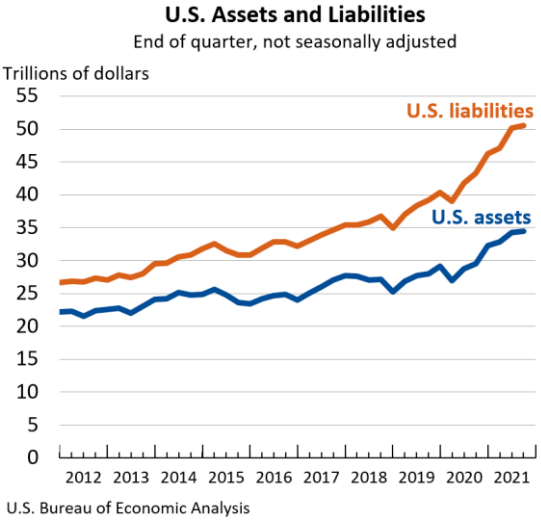
Let’s look in more detail at the US trade deficit. The US has a somewhat unique position in the world due to the size of its economy and the status of the dollar as the premier reserve currency, but much of what applies to the US also applies to other large economies.

The US Trade Deficit

In our look at employment by sector we saw that manufacturing employment has declined in developed countries even when, like Germany, they run a large trade surplus. Germany would clearly lose out if it closed its borders to all trade, but displaced manufacturing workers there still face the economic hardship of finding new jobs as productivity increases. The switch to electric vehicles, for example, is expected to cause massive layoffs in Germany’s powerhouse auto industry as it takes less labor to produce electric cars. Since manufactured goods dominate trade by value but are declining in employment relative to services due to these productivity increases, we saw that trade deficits represent fewer “lost jobs” now than in the past. At the end of the last section, we looked at the international transactions of the US and saw that we ran an overall trade deficit of around half a trillion dollars in 2019. As we discussed earlier the employment content of this deficit might be around 3 to 5 million jobs, which is significant but not game changing when stacked up against total employment of 150 million. However, in addition to employment concerns, continuing trade deficits have other consequences.

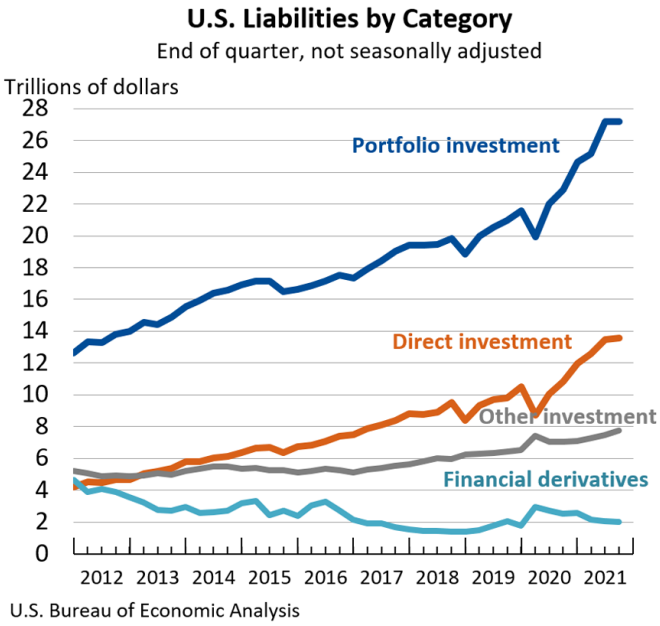
How can the US as a country continue to buy more than it sells? The answer is that in fact we don't. There is no such thing as a free lunch. Nobody is going to sell you goods and not expect something in return, and as explained in Balance of Trade in the primer, when you have a deficit in trade in goods and services, the difference is made up by the sale of other assets. In the case of the United States, that includes our large public debt, our stocks, our companies and property. Let's say, for example, that we buy more goods and services from Germany than we sell to Germany. German companies will get more dollars from us in exchange for goods and services than they spend buying our goods and services. The German companies, or the German government, can then use those dollars to buy US Treasury securities, thus financing the US debt which we have chosen not to finance ourselves through taxes. In effect, we've traded US Treasuries, which are a promise to pay back money with interest in the future, for the excess in German goods we consume. It's essentially a loan to us which gives us the ability to spend more now than we earn, but we will have to pay that money back in the future. From the German side, the loan to us is savings which cuts into current consumption but will allow higher future consumption. Another way to look at it is that, intergenerationally, we in the US are consuming now and passing at least part of the bill on to our kids.

In addition to selling Government debt, we sell other assets to balance the trade deficit. Foreign companies can buy US bonds and stock directly themselves, but they can also buy such assets as real estate and US companies. They can also build manufacturing facilities in the US. US Companies and individuals have huge investments abroad. We used to be the largest net holder of foreign assets, but the trade deficit has turned that around. The charts below show that foreign governments and companies now hold 16 trillion more in US assets than we own in foreign assets.



The chart on the left shows how much more foreign countries have invested in the US than the other way around. It is the difference between US holdings of foreign assets of $35 trillion. and foreign holdings of US assets (liabilities to us) of $53 trillion at the end of 2021. For comparison, US GDP is about $20 trillion.

Foreign investment is classified into several forms, the two largest being “portfolio investment” consisting of such items as US Treasury bonds, US Corporate bonds, and US Stocks, and “foreign direct investment” (FDI) which includes part or full ownership of US companies, real estate, factories, and other non-financial assets by foreigners.



While foreign governments are large holders of US government debt, the largest share of portfolio investment by foreigners is in US stocks.

Foreign Portfolio Holdings (Jun 2021)	**Trillions of $$**
Government debt	$8.75
Corporate debt	$4.73
Equity	$13.71
Total foreign portfolio holdings	**$27.19**

Source: US Treasury numbers for year end 2021[138]

[138] Department of the Treasury/Federal Reserve Board
Treasury International Capital System
https://home.treasury.gov/data/treasury-international-capital-tic-system/us-liabilities-to-foreigners-from-holdings-of-us-securities
For release April 29, 2022

In fact, foreigners own about 40% of US stocks compared to about 30% of US stocks which are held in domestic retirement accounts[139]!

It is interesting to see which countries have the largest portfolio stakes in the United States. The chart below shows the countries that hold more than $1 trillion in US portfolio assets (bonds and stocks etc.) according to the Treasury, along with their 2019 GDP.

[139] "Who Owns US Stock? Foreigners and Rich Americans." 2020. Tax Policy Center. October 20, 2020. https://www.taxpolicycenter.org/taxvox/who-owns-us-stock-foreigners-and-rich-americans. This includes shares held in financial portfolios and shares acquired through FDI.

Table 9: Foreign Holdings of US Securities valued at the end of June 2021

Countries with largest US holdings	US Securities in Trillion $	GDP of country in Trillion $	US Portfolio % of GDP
Canada	$1.98	$1.74	114%
Cayman Islands	$2.47	$0.01	24652%
China	$1.57	$14.28	11%
Ireland	$1.50	$0.34	441%
Japan	$2.76	$5.06	55%
Luxembourg	$2.30	$0.07	3287%
Switzerland	$1.18	$0.73	162%
United Kingdom	$2.62	$2.83	92%
Total all countries	$27.19		

Sources: US Treasury, World Bank[140]

Note that more US Securities are "owned" by Cayman Islands entities than China. The high multiples of holdings to GDP for the Cayman Islands, Luxembourg, and even Ireland and Switzerland give some idea of the huge amount of money being sheltered in tax havens, including money sheltered by US Corporations and wealthy individuals[141].

The second largest category of foreign held assets in the US, foreign direct investment (FDI), totals about $15 trillion. This includes the plants of foreign owned companies such as Toyota and BMW, foreign real estate holdings in the US, and US companies acquired by foreign ones. For example, in 2002, the Mexican company Bimbo acquired the US brands Sara Lee, Entenmann's, and Thomas' along with the other assets of Weston Foods, which was then a subsidiary of the large Canadian company, George Weston, Ltd. Many "iconic" US brands are owned by foreign companies, and of course vice versa. US FDI in other countries amounts to around $11 trillion leaving a balance of around $4 trillion more direct investment held by foreigners in the US than the other way around.

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140 https://home.treasury.gov/data/treasury-international-capital-tic-system/us-liabilities-to-foreigners-from-holdings-of-us-securities (June 2021 data) and https://wits.worldbank.org/CountryProfile/en/country/by-country/startyear/LTST/endyear/LTST/indicator/NY-GDP-MKTP-CD (2019 data). GDPs were higher in 2021.

141 These "offshore financial centers" are popular for a variety of reasons and tend to specialize. They are low or no tax, have minimal reporting requirements, provide secrecy, and have streamlined set up and administration requirements. Most of the world's hedge funds and many US mutual funds are Cayman based.

In summary, continued trade deficits are financed by selling our debt in the form of treasury and corporate bonds, equity in the form of stock, US companies and their assets, real estate, and in building new productive facilities here for foreign companies. The debt will have to be paid back in the future and foreign ownership of US assets sends income and profits abroad. Annual flows of these transactions are shown on the International Financial Transactions of the United States table shown earlier on page 108.

Selling US debt and assets to finance current spending might not be something we want to continue doing indefinitely. Balancing trade would balance the financial accounts and would result in increased employment in "tradable" goods and services. However, economists differ on how bad a trade deficit is for the US and indeed whether it is bad at all[142]. And reducing the trade deficit would certainly require sacrifices in consumption, such as reducing government debt by raising taxes, for which there seems no political will.

We should note that not all countries have the luxury of maintaining large trade deficits over a period of time without consequences. As we saw in the primer, currencies are subject to the same law of supply and demand as any product or service. For example, if Argentinians buy a lot of German cars using the Argentinian Peso, Germans will accumulate a lot of Pesos. If there is insufficient demand for Argentinian products in Germany, a trade deficit will develop. As we have seen, this can be balanced by the sale of other Argentinian assets to Germans and Germany. But if Germany doesn't want to hold Argentinian portfolio assets, the glut of Pesos being traded for the German currency (the Euro) will cause the value of the Peso to fall. That in turn will make Argentinian products cheaper in Germany, and German product more expensive in Argentina which will in turn decrease German sales to Argentinians (e.g. fewer German cars will be sold in Argentina) and increase the sale of Argentinian products in Germany (because they are cheaper in terms of Euros). And that in turn will reduce the trade deficit.

However, it can take quite a while for trade deficits to devalue currencies even in smaller countries, and for a really large economy such as the United States, especially since the dollar is currently the world's main "reserve currency", the situation can go on for a truly long time. We have a lot of assets to sell and are trusted to pay off our loans.

[142] See for example https://www.cfr.org/backgrounder/us-trade-deficit-how-much-does-it-matter and https://www.investopedia.com/articles/investing/051515/pros-cons-trade-deficit.asp#:~:text=A%20trade%20deficit%20is%20neither,running%20country%20in%20the%20future.

International Trade Benefits and Costs

Advanced Economies - Benefits and Costs of Trade

Benefits of Trade

Trade has enormous potential economic benefits as we showed in the primer, regardless of whether it is within a country or between two countries (bilateral trade). Those benefits come in the form of lower prices, greater overall productivity, and an increased selection of goods and services. Without trade, there wouldn't be bananas available in Pittsburgh and iPhones and televisions would cost much more. Trade is in fact what brings us the advantages of free markets: "optimal" resource utilization under the constant balancing of supply and demand and the drive to productivity under the pressures of competition. However, trade can, and does, create winners and losers. While in economic theory, the winners could compensate the losers and still come out ahead, in practice workers will suffer if competition costs them their job, whether that competition is from Huntsville, Alabama or Hunan, China. In short, the benefits of trade, such as lower prices and greater selection, are widespread, while the pain is borne by those displaced by trade competition. The box below shows how trade can cost jobs but benefits consumers through lower prices and selection.

Prices Versus Jobs

"In 1960, an average American household spent over 10 percent of its income on clothing and shoes - equivalent to roughly $4,000 today. The average person bought fewer than 25 garments each year. And about 95 percent of those clothes were made in the United States.

Fast forward half a century.

Today, the average American household spends less than 3.5 percent of its budget on clothing and shoes - under $1,800. Yet, we buy more clothing than ever before: nearly 20 billion garments a year, close to 70 pieces of clothing per person, or more than one clothing purchase per week.

Oh, and guess how much of that is made in the U.S.: about 2 percent."

From Article "Why America Stopped Making Its Own Clothes" by Stephanie Vatz May 24, 2013, on WQED. https://www.kqed.org/lowdown/7939/madeinamerica

Because of the distributed nature of the benefits of trade, and the difficulty of separating out other factors, such as productivity increases, calculating those benefits is subject to a high degree of uncertainty. Nonetheless economists have undertaken a number of studies to attempt to do just that. If we remember that GDP per capita is a measure of average income in a country, the question can be asked "does increased trade raise GDP per capita". Below we look

at two such studies which also provide a glimpse into how economists try to answer such questions. You can skip the next couple of paragraphs if you don't want the details.

One of the often-quoted studies of the benefits of trade, "Does Trade Cause Growth?"[143] looked for a relationship between how close countries are to each other and their per capita GDP. Why physical proximity? Looking directly for a relationship between per capita GDP and the volume of trade as a percent of GDP has the problem that one can't be sure whether high GDP per person causes a high level of trade per person or vice versa. However, as we saw earlier, countries do most of their trading with neighboring or close by countries, so trade volume can be predicted based on how close countries are to each other, and a few other factors such as the size and population of the countries. The important point is that it seems *unlikely* that GDP per person will depend on how close countries are to each other except through this trade effect. If countries with less trade as measured through this proxy have lower GDP per capita than countries with more trade, it indicates that it is trade that explains the increase in GDP, not the other way around.

The authors first looked at how well their physical proximity (and size) measure correlated with actual trade volumes as a percent of GDP and they found a strong positive (and highly significant) correlation, not surprisingly - the closer countries are to each other the more they trade for the most part. They then used the proximity measure to look for a correlation with per capita GDP. They found a strongly positive correlation indicating that indeed increased trade volume "explains" higher GDP when all other factors stay the same. Below are the author's conclusions based on their statistical analysis:

The results of the experiment are consistent across the samples and specifications we consider: trade raises income. The relation between the geographic component of trade and income suggests that a rise of one percentage point in the ratio of trade to GDP increases income per person by at least one-half percent. Trade appears to raise income by spurring the accumulation of physical and human capital and by increasing output for given levels of capital.

The results also suggest that within-country trade raises income. Controlling for international trade, countries that are larger - and that therefore have more opportunities for trade within their borders - have higher incomes. The point estimates suggest that increasing a country's size and area by one percent raises income by one-tenth of a percent or more. And the estimates suggest that within-country trade, like international trade, raises income both through capital accumulation and through income for given levels of capital.

Unfortunately, as the authors note, there is a pretty wide envelope of statistical uncertainty about the result, which is typical of all the studies that try to isolate the overall effects of trade.

While some studies, such as the one above, try to correlate trade with changes in GDP statistically, others use elaborate models (think weather forecasting) in which various scenarios

[143] Frankel, Jeffrey A., and David H. Romer. 1999. "Does Trade Cause Growth?" The American Economic Review 89 (3): 379–99.

can be computed to predict how the economy would respond to more or less trade and different trade policies. The results of those models can then be used to compute the contribution of trade to GDP.

While the computed addition to GDP for these studies varies widely, they all show an increase in overall wealth resulting from an increase in trade, including those studies that look specifically at advanced economies such as the United States or Europe.

A review of several of these "econometric" studies of the possible size of the net economic benefits of trade to the US is given in a 2015 Peterson Institute for International Economics post which concludes:

increased trade between 1988 and 2008 provided an estimated $720 billion boost to the US 2008 GDP. However, over that same time period, competition from imports and outsourcing suppressed US wages to the tune of $140 billion[144]

The estimated $720 billion boost is an *ongoing per year addition to overall wealth* (i.e. GDP) and includes the benefit of lower prices, both directly from imports but also from increased productivity in the US as companies compete against imports. The report goes on to estimate that from 1988 to 2008, "average annual wages received a boost of over $2,000 per worker owing to expanded trade. After subtracting the losses due to increased competition, the net average boost in wages was about $1,000 per worker." Using a statistical household size of 2.5, that translates to a net annual income increase of $2,500 per family from 1988 to 2008. Over the longer period of 1950 to 2015 the per household net benefit of trade has been estimated at $18,000[145] although "what ifs" over such a long period of time are highly uncertain.

This of course is an average number. How were these gains distributed? Again, without looking only at workers directly affected by trade, the authors find that the less well-off benefited most from the relatively lower prices brought by trade (as well as productivity increases of course). That's because poorer households spend proportionately more on goods than services than wealthier households, and goods prices are much more affected by trade[146]. On the other hand, if one considers that lower income workers' wages were more impacted by trade than wealthier workers and that wealthier people earned more from trade related corporate profits and income, the net effect of trade was to increase income inequality somewhat. To quote the already mentioned paper, which uses some simplifying assumptions:

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[144] "Does Foreign Trade and Investment Reduce Average US Wages and Increase Inequality? (Part 2)." 2015. PIIE. November 10, 2015. https://www.piie.com/blogs/trade-investment-policy-watch/does-foreign-trade-and-investment-reduce-average-us-wages-and.

[145] Gary Clyde Hufbauer and Zhiyao (Lucy) Lu. 2017. "The Payoff to America from Globalization: A Fresh Look with a Focus on Costs to Workers (Brief 17-16)." Peterson Institute for International Economics, May. https://www.piie.com/system/files/documents/pb17-16.pdf. Quoted by the US Chamber of Commerce.

[146] Fajgelbaum, Pablo D., and Amit K. Khandelwal. 2014. "Measuring the Unequal Gains from Trade." Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w20331.

Richer households did enjoy a disproportionate share of benefits from globalization, because of their dominant claim on corporate profits and proprietors' incomes and the very small impact of foreign competition on the wages of highly skilled workers. Even so, the globalization boom cannot explain 90 percent of the rise, between 1988 and 2008, in the share of household income captured by the top 20 percent[147].

We often overlook the benefits of globalization (i.e. freer international trade and financial flows), because they show up as lower costs, primarily for manufactured goods. But as the studies above suggest, considering the country as a whole, international trade is, on net, a substantial net economic plus to the economy. The chart below shows that the rise of trade in the US, as in most other advanced economies, has actually coincided with an extended period of high employment (blue line below) and continued per capita GDP growth (red line) as many authors have pointed out. It is easy to see the effects of the recessions, but impossible to pick out the trade "shocks", or large increases in trade, which occurred since 1995.

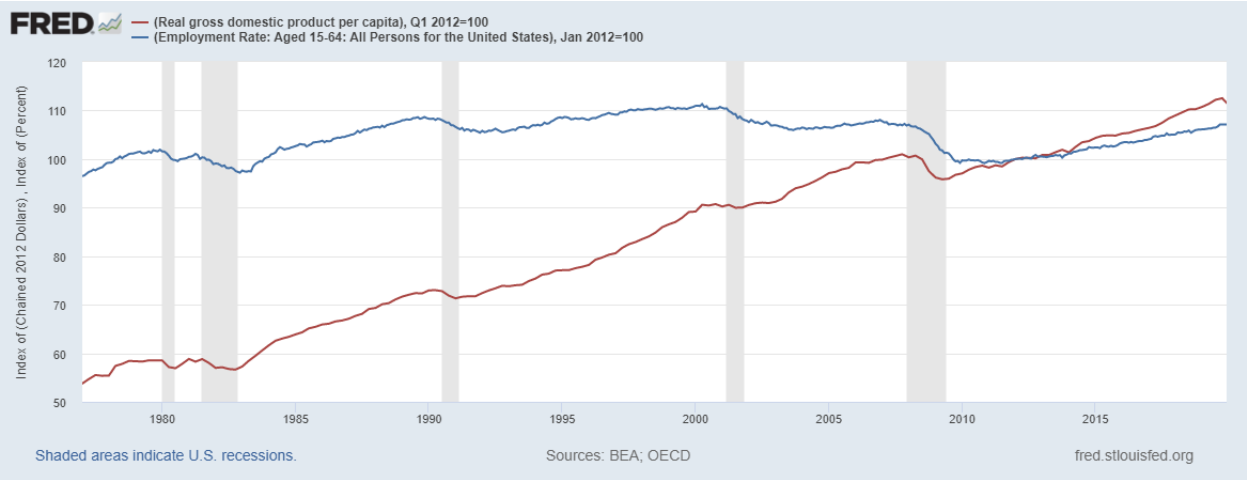

Figure 31: Employment Rate (index, blue) and GDP per capita real growth (index, red). Recessions shaded in gray. Source: BEA, OECD via FED. Indexes don't show actual values but rather show how values change over time.

Costs of Trade

So, if international trade is beneficial for advanced economies, why has it been a contentious issue in some advanced economies, and in particular the US?

The answer is that the costs of trade, primarily employment dislocations, are much easier to see than the benefits (unless you're involved in the huge export sector) and can be concentrated geographically. Additionally, trade probably gets the blame for "job losses" that are really caused by the large increases in manufacturing productivity we noted earlier, and industry movement within the country itself. Studies of the "costs of trade" try to tease out the trade

[147] "Does Foreign Trade and Investment Reduce Average US Wages and Increase Inequality? (Part 2)." 2015. PIIE. November 10, 2015. https://www.piie.com/blogs/trade-investment-policy-watch/does-foreign-trade-and-investment-reduce-average-us-wages-and.

specific job dislocations from these confounding factors. Before we look at the studies themselves, let's consider these confounding factors.

First, we need to note that nobody blames trade for the huge decline in agricultural employment in the US or other advanced countries. Clearly greater productivity is responsible for these declines, since we run a small surplus in agricultural trade and produce more now than ever before[148]. There can be no doubt that agricultural productivity gains have forced farm families to seek alternate employment and depopulated rural areas, but nobody blames these job losses on trade. The same is largely true of manufactured goods: productivity increases explain most of the job dislocations and losses in that sector as we'll see in the section below on trade and manufacturing.

As noted, the great increase in trade over the last 30 years or so, largely involved manufactured goods, and in particular manufactured goods from low wage countries, and even more particularly the huge increase in manufactured imports from China. A massive change in trade like this is called a "shock" by economists, since it represents a departure from the long-term trend. In a 2016 paper, David Autor and his coauthors, survey the economic literature (including their own papers) that seeks to identify the impact of this shock on workers in the US and other advanced economies[149]. They conclude that:

Alongside the heralded consumer benefits of expanded trade are substantial adjustment costs and distributional consequences. These impacts are most visible in the local labor markets in which the industries exposed to foreign competition are concentrated. Adjustment in local labor markets is remarkably slow, with wages and labor-force participation rates remaining depressed and unemployment rates remaining elevated for at least a full decade after the China trade shock commences.[150]

It should be noted that the "China shock" was a onetime event that greatly expanded the trade between the advanced economies and a low wage economy. The adjustment to that shock in terms of what is made where is mostly complete, however the authors conclude that the negative impacts on affected workers and, to a lesser extent regions, dissipated only slowly.

What were these impacts? In a 2013 paper, the authors divided the US into "commuting zones" in which workers are clustered[151]. They then compute how "exposed" the businesses in these commuting zones were to competition from Chinese imports. This lets the authors see how the level of import exposure correlates with wages, employment, and transfer payments such as unemployment and disability insurance. They find that between 1992 and 2007 manufacturing

[148] The EU nations substantially subsidize their agriculture, as does the US.
[149] Autor, David H., David Dorn, and Gordon H. Hanson. 2016. "The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade." Annual Review of Economics 8 (1): 205–40.
[150] Autor et al, p 205
[151] Autor, David H., David Dorn, and Gordon H. Hanson. 2013. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States." The American Economic Review 103 (6): 2121–68.

employment job losses in highly exposed commuting zones are not balanced by gains in other local employment and instead lead to greater unemployment, and workers dropping out of the workforce, including through increased permanent disability claims. Meanwhile wages are negatively impacted generally within the commuting zone, mostly in non-manufacturing jobs for which displaced workers compete. To quote:

Despite the responsiveness of local transfer payments to local import exposure, on the whole there appears to be limited regional redistribution of trade gains from winners to losers. Comparing again the residents of [commuting zones] at the 75th and 25th percentile of import exposure, those in the more exposed location experience a reduction in annual household wage and salary income per adult of $549, whereas per capita transfer income rises by approximately $58, thereby offsetting just a small portion of the earnings loss[152]*.*

"Transfer income" refers to Trade Adjustment Assistance (TAA) and unemployment payments which are short term, and disability insurance (SSDI) and other public assistance. Basic economic theory often assumes for simplicity that workers migrate freely around a country, thus equalizing wages, but labor migration has actually substantially slowed in recent decades, as this result indicates. Some economists cite transfer payments as a partial possible cause of lower mobility: some people don't to leave areas negatively affected by trade or lower demand for agricultural workers because of transfer payments.

As to how the China trade related effects are distributed between higher and lower wage workers, the paper concludes:

Although trade shocks disrupt the careers of both high-wage and low-wage individuals, there is also substantial heterogeneity in patterns of adjustment. Workers whose pre-period wage falls in the top earnings tercile of their birth cohort react to the trade exposure of their initial firm primarily by relocating to firms outside the manufacturing sector. They do not experience an earnings loss relative to their peers who started out in less trade-exposed industries. By contrast, workers in the bottom tercile of pre-period earnings relocate primarily within the manufacturing sector, and often remain in industries that are hit by subsequent increases in import competition. These low-wage workers suffer large differential earnings losses, as they obtain lower earnings per year both while working at the initial firm and after relocating to new employers.[153]

Similar results were found in studies of the effects of the China trade in Norway and Spain, and in an earlier study on the effects of NAFTA. In the latter, high school dropouts in formerly "protected" (i.e. protected by tariffs) industries, had wage growth that lagged 17 percent behind similar workers in industries that had not been formerly protected[154].

[152] Autor et al 2016, p231
[153] Autor et al 2016, p233
[154] McLaren J, Hakobyan S. 2016. Looking for local labor market effects of NAFTA. Rev. Econ. Stat as summarized in the Autor 2016 paper.

Finally, the 2016 survey paper mentions a National Bureau of Economic Research study that uses a computer model to quantify the "welfare effects" of the China shock.[155] In economics, overall "welfare" is not the simple addition in dollars of how much each person gains and loses from trade, it considers the relative importance of such gains and losses to each person. So, when a low wage person loses $1,000 of income, they have lost more "welfare" than a person who is better off gets from an extra $1,000 of income. This model implicitly includes factors such as the costs to a worker of moving to a different locality. The model calculates that the China shock initially produced very little if any overall welfare benefit or loss to US families but delivered a strong positive welfare benefit across all states in the long run. Given the weighting that "welfare" calculation gives to the losses to workers in affected industries, this indicates an even larger purely dollar gain from increased trade. By the way, this model has some other interesting results. Which state do you think had the largest initial job losses from increased trade with China? It was California followed by Texas**!** Why? The computer and electronics, and furniture industries each contributed about 25% of the China shock related decline in manufacturing employment, followed by the metal and textiles industries. California and Texas had large computer and electronics sectors, which were heavily impacted by Chinese imports. These are hardly the first states that come to mind when one thinks of depressed US regions, and indeed both states eventually benefited from China trade as much as other states.

Finally, to put trade shock employment dislocations in context, every year in the US, since 2003, there have been about 29 million jobs lost and 30 million gained[156]. Manufacturing, which has borne the brunt of dislocations due to trade shocks, has lost an average of about 2 million jobs annually and gained 1.85 million for a net loss of about 123,000 annually. As we will see shortly about 20% of the job losses in manufacturing over the period can be attributed to trade shocks. Churn is normal and widespread in employment as firms come and go, automation proceeds, and companies move around the country and the world.

To sum up, we've seen that international trade has a large net positive overall impact on US and other advanced economies, but that trade shocks have caused job dislocations that harm affected workers and regions.

Loss of Manufacturing Jobs - "Deindustrialization" - and Trade

In the section on the productivity frontier, we saw that the enormous shift in employment from manufacturing to services could mostly be explained by higher labor productivity increases in manufacturing. However, we noted that trade could explain part of the decline, with a third factor being a relative decline in demand for manufactured goods. Indeed, trade is often mentioned as a major contributing factor in the relative decline of manufacturing employment in advanced economies such as the US.

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[155] Caliendo, Lorenzo, Maximiliano Dvorkin, and Fernando Parro. 2015. "The Impact of Trade on Labor Market Dynamics." Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w21149. Note that working papers are not peer reviewed.

[156] These are private, non-farm, averages for the period from 2003-2023 from https://www.bls.gov/charts/business-employment-dynamics/gross-job-gains-gross-job-losses-industry.htm.

A brief review of theory can help put trade-related manufacturing job dislocations into context. In balanced trade between a high productivity, high wage, country and another such country one would expect gradual specialization and little job dislocation when trade barriers are lowered. This is largely what is observed. On the other hand, in balanced trade between a high productivity/wage country and a low wage country, one would expect the high wage country to export capital intensive goods and high value services and import labor intensive goods and services. A trade "shock" that increases trade between a high wage country and a low wage country will displace workers from labor intensive, lower wage, jobs and increase employment in higher wage higher productivity jobs. This is pretty common sense and is what is observed: trade with low wage countries essentially wiped out the US domestic clothing industry. One would expect such trade to require fewer workers since, due to higher labor productivity, the exported goods will require less labor per dollar of output than was required in the old labor-intensive industries. Since trade is still largely in manufactured goods, the effect will be to reduce manufacturing employment in the high-income country, even with balanced trade. Of course, overall productivity and total income will go up in the long run in both countries as a new trade equilibrium is reached. We should note that opening up to trade is largely a one-time occurrence in the modern world with low transportation costs. "Shocks" only occur when there is a drastic change in barriers to trade[157]. Once barriers have been reduced, trade patterns evolve over time between countries much as they do internally within a large country or trading block such as the European Union. Clothing manufacturing is a major industry now in the low wage countries of Vietnam and Bangladesh, and less important to China, but that drift has had no impact on US domestic employment which has already adapted to low-cost clothing imports.

In sum, when trade is balanced and trade shocks have worked their way through the economy, overall productivity and total income will be higher than in the absence of trade, but trade shocks will have caused job displacements and lower overall manufacturing employment.

Trade *deficits* also affect the mix of jobs, and manufacturing in particular. Since manufactured goods are the largest component of trade, a shortfall in exports means that fewer manufacturing jobs will be created in the export sector than would be the case with balanced trade. A trade deficit is thus sometimes said to have "employment content" but since we have full employment now in 2023 that really translates not to lost jobs, but fewer manufacturing jobs compared to service jobs. Unlike trade shocks, a trade deficit will continue to suppress manufacturing employment as long as it continues.

So much for the theory. What does the data say about the relationship between trade and manufacturing employment declines and dislocations?

As we saw in the section on the productivity frontier, all the high wage countries have seen declines in manufacturing employment as a percentage of total employment, even when, like Germany, they run substantial trade surpluses. As the chart below from that section shows,

[157] In addition to tariffs and transportation costs, shocks can include price fixing ala OPEC, natural disasters such as Covid, wars, and economic trade sanctions.

there is no perceptible change in the downward slope of US manufacturing employment declines as a result of either NAFTA or the “China shock”. While this is hardly scientific, it does suggest that manufacturing jobs lost to increased trade in labor intensive industries were largely offset by increased manufacturing employment elsewhere and that the decline has more to do with labor productivity increases.

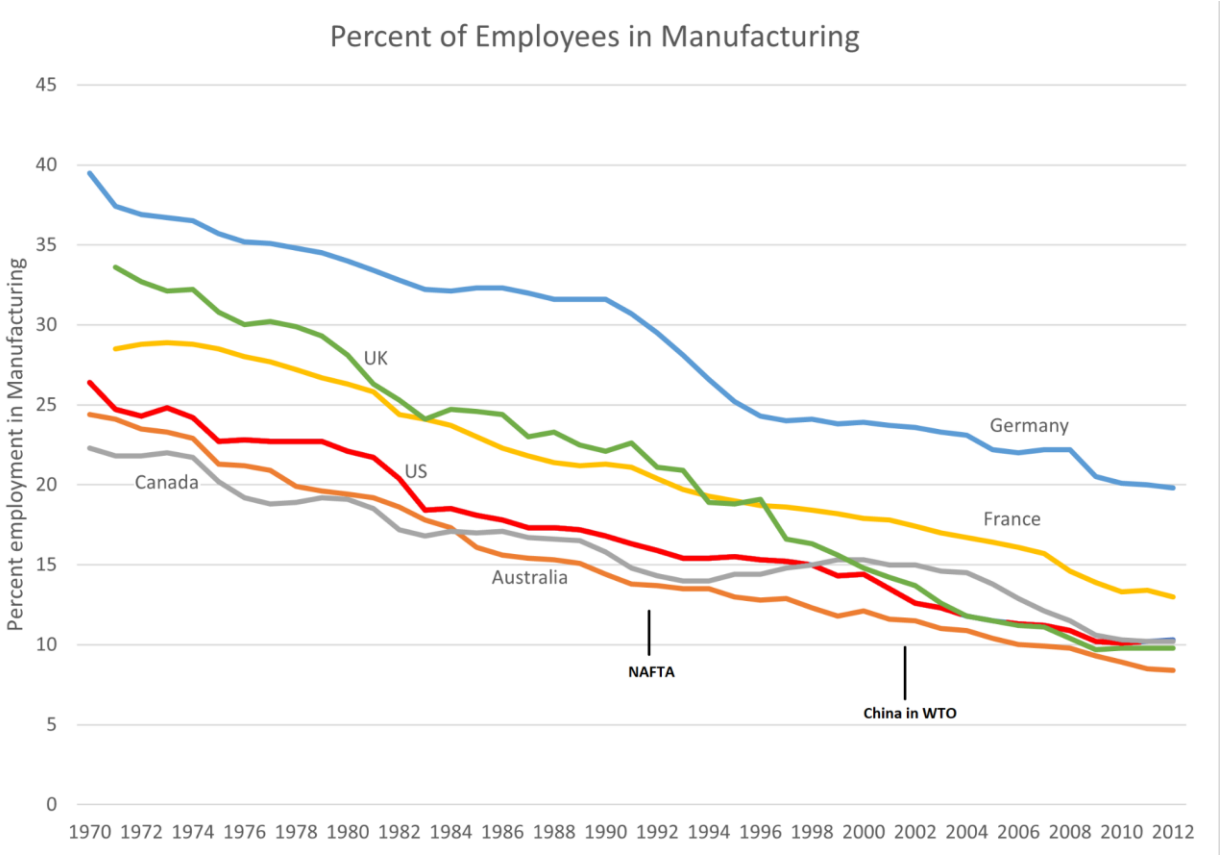


Figure 32: Figure: Percent of employees in manufacturing, some rich countries. The dates of a couple of trade agreements are shown. Source: International Comparisons of Annual Labor Force Statistics, 1970-2012 Bureau of Labor Statistics

Above we discussed a study of the local effects of the “China shock” within commuting zones. Applying this econometric analysis to manufacturing as a whole, the study finds that between 1990 and 2007, 21% of manufacturing job losses could be attributable to the China trade shock[158]. Which means that 80% of manufacturing job losses during the period have other explanations, and as we’ve seen, the rapid growth of labor productivity in manufacturing as in agriculture provides that explanation... mostly. In the special case of the US, it is important to note that the trade deficit ballooned during this period as consumers gorged on inexpensive imported goods and businesses sourced components from overseas. If trade had been balanced, manufacturing jobs would have been created that would have helped balance out the

[158] Autor et al 2013, page 2,140. Acemoglu et al. (2016) find 10% direct and another 10% indirect losses, so similar results.

job losses. The manufacturing “employment content” of the trade deficit has been estimated as 1.65 million full-time equivalent jobs in 1990, rising to 3.3 million jobs in 2000 and staying roughly at that level through 2010[159]. The fraction of the workforce in manufacturing would have declined due to productivity increases as it has in wealthy countries running trade surpluses, but the US has lost more manufacturing because of its increased trade deficit. A final contributor to “deindustrialization” is simply saturation. While people buy more manufactured goods, these goods cost less, and overall people now spend more of their incomes on services than they used to[160].

Adding it all up, in the absence of trade shocks, manufacturing employment as a share of total employment has fallen because of greater labor productivity gains in manufacturing than services. The dollar output of manufacturing as a fraction of GDP in the US has hardly changed at all despite this decline in relative employment, once again indicating the importance of productivity growth[161]. The rapid increases in trade enabled by lower transportation costs, better logistics, lowered tariffs, financial flows, and the rapid expansion of manufacturing in low wage countries caused many to lose manufacturing jobs in affected industries in wealthy countries, but these job losses were largely offset by increased employment in export manufacturing in countries with balanced trade. In the US, closing the ongoing trade deficit would boost manufacturing employment perhaps by 3 million jobs which is a sizeable when measured against current manufacturing employment of 12 million[162]. Closing a trade deficit is easier said than done.

Developing Economies - Benefits and Costs of Trade

The above discussion focused on trade in advanced economies, what about developing ones? The general benefits of trade apply to any country, rich or poor. Trade allows countries to increase their productivity by focusing on areas where they have a comparative advantage. This helps explain the observed correlation between freer trade and an increased rate of productivity growth in developing countries. A 2003 study found that over the 1950–98 period, countries that liberalized their trade policies experienced average annual growth rates that were about 1.5 percentage points higher than before liberalization. This is a large increase given that a “good” growth rate is around 3%. After trade liberalization, investment rates rose 1.5 to 2.0 percentage points, supporting the idea that increased trade fosters growth in part through physical capital

[159] Lawrence, Rising Tide, 2013 p 101.
[160] Lawrence 2013 p 95
[161] See chart in Baily et al 2014 p 4.
[162] Recent US trade deficits have been around $800 billion. Using a rough rule of thumb of 5,000 jobs per billion dollars in manufacturing, closing the trade deficit would result in 4 million jobs. This is an upper limit: it assumes trade would be balanced entirely through manufacturing. The mix also matters, only about 3,000 jobs are created per billion dollars in high tech.

accumulation[163]. We have already noted the studies relating economic growth to trade volume, but this chart from "Our World in Data" provides a visual representation of this relationship[164].

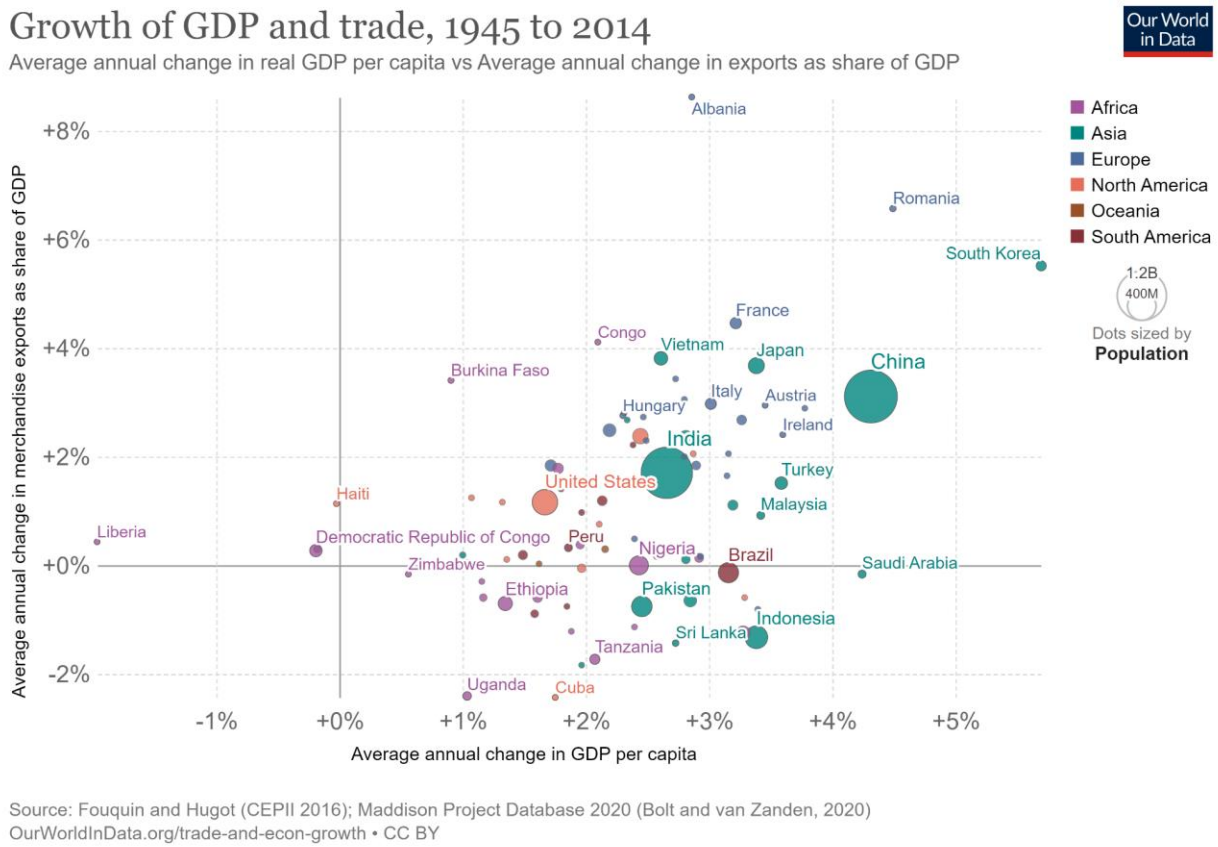


Figure 33: GDP per capita vs growth in trade Source: https://ourworldindata.org/trade-and-econ-growth.

This chart shows correlation not causation, increasing wealth can lead to increased trade or the other way around. Since countries differ in so many ways, it is hard to draw statistical conclusions about the relationship between trade and development, but in the World Bank study "Global Productivity: Trends, Drivers, and Policies" we cited in the section on productivity convergence, a number of country case studies found that export promotion, global value chain integration, and foreign direct investment (FDI) were important in transitioning to higher-productivity growth and development. These are all trade related. In our brief case study of China, trade and FDI were key factors in providing funding for development, and other initially poor countries have taken the same path.

Increasing trade is often cited as a major factor in lifting people out of extreme poverty and expanding the middle class in developing countries. It can also have a positive effect on

[163] Wacziarg, Romain, and Karen Horn Welch. "Trade Liberalization and Growth: New Evidence." The World Bank Economic Review, November. https://elibrary.worldbank.org/doi/abs/10.1093/wber/lhn007. This is actually a 2003 NBER paper http://www.nber.org/papers/w10152 The analysis shows considerable variance in results between different countries and when the trade liberalization took place.
[164] https://ourworldindata.org/trade-and-econ-growth.

inequality. A study of 27 countries with advanced economies and 13 developing countries finds that shutting off trade would deprive the richest of 28 percent of their purchasing power, but the poorest would lose 63 percent because they buy relatively more imported goods[165]. Studies of some countries have shown that exporting firms tend to hire more women (not surprising when the export is clothing and textiles) which leads to greater economic empowerment for women.

There can be negative effects from trade in developing countries as well. As usual, those employed in trade competitive industries can suffer. In developing countries, agriculture often faces trade competition, and inefficient farmers may find themselves underpriced by imports. Countries that specialize in exporting commodities are subject to the volatility of commodity prices. In fact, any country which depends on exporting a limited number of products is subject to market swings. And the benefits of trade are highly dependent on how a country is governed. If the profits of trade are skimmed off for the enrichment of a few rather than being reinvested and passed along as higher wages, growth will be stymied.

Despite the varied paths to growth taken by different countries, trade is generally seen as an important spur to economic growth by leading to a virtuous cycle of specialization, capital accumulation, technology transfer, and increased productivity and higher incomes. Higher incomes in turn lead to better health, higher levels of education, improvements in productivity and increased domestic demand. This is in addition to the lower costs and greater selection that are usual benefits of trade.

Income and Wealth Distribution

As we have seen, modern productivity in agriculture and manufacturing is sufficient to supply everyone with a decent material standard of living while employing a little over 10% of the population directly. When one includes transportation, warehousing, food processing, wholesale and retail trade, total employment in goods production and distribution is probably between 30 and 40%.

In the discussion on world productivity convergence, we saw that the vast majority of people live on less than $30 per day in local purchasing power. Even in countries on the productivity frontier, such as the United States, 20% of the population survives on less than that.

As we also saw in the section on productivity convergence, productivity in developing countries can increase rapidly as agriculture and industries are brought up to date, while income growth in advanced economies is more dependent on advancing the productivity frontier through technological innovation.

[165] Fajgelbaum, Pablo D., and Amit K. Khandelwal. 2014. “Measuring the Unequal Gains from Trade.” Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w20331.

Average personal income in a country is determined by total income divided by population size (aka GDP per capita), and how that income is actually distributed. In short, the size of the pie and how the slices are cut.

Here are the sizes of some economic pies.

Table 10: GDP per capita, selected countries. Source: Data from the World Bank as presented in the Investopedia article: Silver, Caleb. 2021. "The Top 25 Economies in the World." July 16, 2021. https://www.investopedia.com/insights/worlds-top-economies/#citation-92.

Country	GDP (in trillions)	Annual Growth (%)	GDP Per Capita (in thousands)	GDP Per Worker
United States	$21.43	2.20%	$65,298	$131,047
China	$14.34	6.10%	$10,262	$31,416
Japan	$5.08	0.70%	$40,247	$74,993
Germany	$3.86	0.60%	$46,445	$103,013
India	$2.87	4.20%	$2,100	$19,270
United Kingdom	$2.83	1.50%	$42,330	$84,206
France	$2.72	1.50%	$40,494	$103,891
Italy	$2.00	0.30%	$33,228	$102,101
Brazil	$1.84	1.10%	$8,717	$34,684
Canada	$1.74	1.70%	$46,195	$94,188

How are these "pies" sliced?

US Income Distribution

US Current Income Snapshot

Gross Domestic Product measures the value of all output produced by a country for final sale. Because all such output is either sold or added to inventories, output in national accounting equals income. Sales are income to companies and most of that is passed on in the form of wages, while the much smaller additions to, or subtractions from, inventories are included in

investment. So Gross Domestic Product can, and is, also referred to as Gross Domestic Income. Here is how the US national income was distributed in 2019.

Table 11: How National Income Was distributed in 2019. Source: BEA Tables 1.1.5 and 6.5D

How National Income Was Distributed in 2019	% of 2019 GDP	Per Person	Per FTE Worker
Total Gross domestic product in 2019 ($21 trillion) aka national income	100%	$65,101	$152,909
Personal consumption expenditures	67%	$43,950	$103,230
Gross private domestic investment	17%	$11,655	$27,375
Net exports of goods and services	-3%	-$1,816	-$4,266
Government consumption expenditures and gross investment	18%	$11,313	$26,571
Federal	7%	$4,310	$10,123
National defense	4%	$2,581	$6,063
Nondefense	3%	$1,728	$4,059
State and local	11%	$7,003	$16,448

The value of all the stuff produced in the US in 2019 was around $21 trillion, and if one divides that by the population of 328.3 million, including children and retirees, one gets a per person output of about $65,000. Output is nearly $153,000 per full time worker equivalent[166]. But not all of that money can be spent on personal consumption, machines need to be replaced, businesses need to build new plants, houses and roads have to be built, we need a military and research, and schools and teachers have to be paid for if our economy is to continue functioning and growing. These necessary expenses come out of total national income through private investment and government spending financed by taxes and borrowing. The trade deficit is shown as “net exports of goods and services” in Table 11, and as we have seen in the section on trade, represents borrowing money and selling assets to finance current consumption. At -

[166] Full time worker equivalent (FTE) means dividing the total hours worked by what is considered full time hours (think 40 hours per week) in an industry. So, two workers working 20 hours per week might count as one full time equivalent worker.

3% of GDP the trade deficit is about as large as Federal Government spending without defense. Social Security and other social programs are not directly spent by the government, these "transfer" programs redistribute money, so the spending shows up in personal consumption expenditures.

"Personal consumption expenditures" in Table 11 do not tell us how much Americans earned on average because part of personal income is saved. The Bureau of Economic Analysis also publishes data on total personal income and its sources as shown in Table 12 below.

Table 12: 2019 Sources of Personal Income. Source: BEA Table 2.1

2019 Sources of Personal Income	% of income	Per Person	Per FTE Worker	Per Statistical Household
Personal income ($18.6 trillion)	100%	$56,616	$132,980	$177,774
Wages and salaries	50%			
Supplements to wages and salaries	11%			
Employer contributions for employee pension and insurance funds (not SS)	8%			
Employer contributions for government social insurance (SS, Medicare)	4%			
Business Income ("Proprietors' income with inventory valuation and capital consumption adjustments")	9%			
Farm	< 1%			
Nonfarm	8%			
Rental income of persons (net)	4%			
Capital Income ("Personal income receipts on assets")	17%			

Personal interest income	9%			
Personal dividend income	8%			
Transfers ("Personal current transfer receipts")	17%			
Social security	6%			
Medicare	4%			
Medicaid	3%			
Unemployment insurance	0%			
Veterans' benefits	1%			
Other	3%			
Less: Personal contributions for government social insurance, domestic	8%			
Less: Personal current taxes	12%	$6,696	$15,728	$21,026
Equals: Disposable personal income	88%	$49,920	$117,252	$156,747
Less: Personal outlays	80%	$45,513	$106,902	$142,912
Equals: Personal saving	8%	$4,406	$10,350	$13,836
Personal saving as a percentage of disposable personal income	9%			

This table tells us a lot about income in the US. For one thing if you divide total personal income of $18.6 trillion by the number of people in the US in 2019, you get a per capita personal income of $56,616 for every man, woman, and child working or not. That amounts to $177,774 for a

statistical household of 3.14 people[167]. Dividing instead by full time worker equivalents (FTE, roughly all the hours worked divided by 40 hours per week for a year) and you get $132,980 for a full-time worker. Using disposable, after tax, income instead, the number is $117,252 per full time worker. The US is a very rich country.

The table shows where this income comes from. Interestingly only 50% of personal income comes directly from wages and salaries, but another 11% is in benefits. Nine percent of all income is earned by business owners. Transfer payments from Social Security, Medicare, and other programs provide 17% of all income but of course reduce aggregate personal income by a similar amount through contributions, also called payroll taxes, as shown in the table.

Absent from this table are capital gains, realized or not. So, if you sell a stock that has gone up $10,000, that is not included as income on this table[168]. The BEA doesn't include capital gains because they represent a change in value rather than a product or service that adds to the economy. But of course, when you sell something that is appreciated in value, you do have more money to spend which is equivalent to earning more. We will include a discussion of capital gains later when looking at income distribution and certainly also wealth distribution.

Without considering capital gains, how was total disposable income of $16 trillion distributed amongst the population? There are a number of ways to slice income distribution. At a high level we can look at the income "pie" and ask how the slices are distributed. Are they all more or less equal? We know that isn't the case, but how unequal are they and how has that changed over time? Below is a graph, admittedly not a pie, which shows the distribution of income in 10 groups of equal numbers of households. The 10% of households with the lowest income are in the first group, the next lowest 10% in the second group, and so on. Because the groups have the same number of households, this chart also shows the relative portion of total personal income each group gets, as well as the 2019 mean income for the group.

Because the number of households are the same in each group in Figure 34 , one could shave $10,000, say, off the household income for each household in the 90-100% group and add that to each of the households in the lowest income group. Given our rule of thumb of $30/day per person, and a statistical household size of three, a household income of around $36,000 is required to eliminate extreme poverty. Given that the lowest income group already has a median income of around $26,000, our $10,000 transfer would do the trick. To illustrate this, Figure 1 below has a pair of $10,000 sized rectangles in black on the 1st and last bars.

[167] Households include everyone living together. Families are all *related* people living together. Family size was 2.52 in 2019, while household size was 3.14.
[168] Capital gains taxes on the other hand are shown.

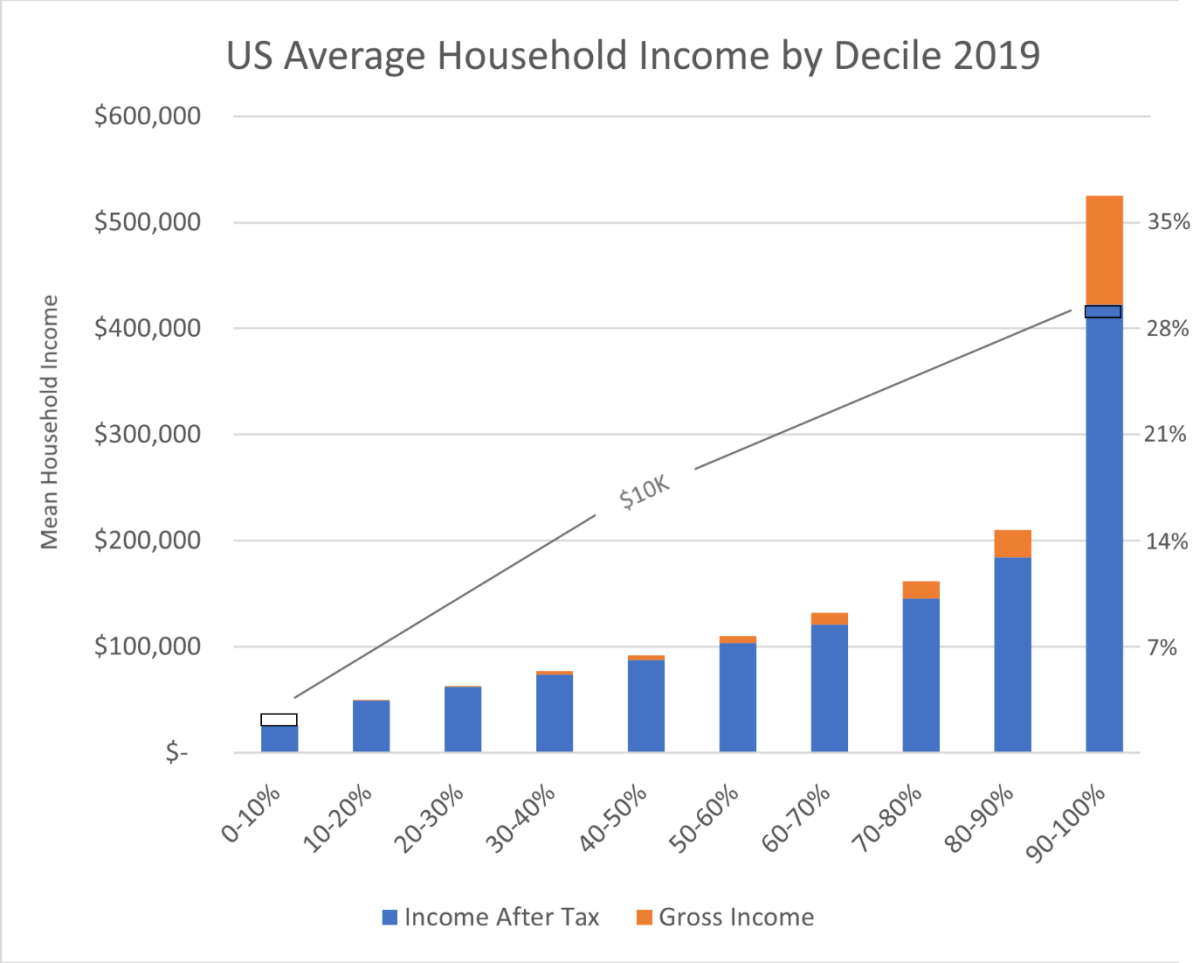


Figure 34: US mean (average) household income by decile group. Note that since the groups include the same number of households, this also shows the distribution of income: the 0-10% group has 1.8% of the total income while the 90-100% group has 36.6% pre-tax. The small black rectangles on the first and last bars are $10,000. Data source: https://www.bea.gov/data/special-topics/distribution-of-personal-income WW126

From this chart it is readily apparent that the bar representing the 10% of households with the highest incomes is out of proportion to the other bars. The bars from 0 to 90% of households go up in a sloped line, but the last bar sticks out way above that line. One reason is that that last bar includes a small percentage of households with truly huge incomes which brings up the mean (aka average) for that bar. If one takes out the very top 1%, the average household income in the highest income decile goes down from $525,070 to $383,743 indicating the skewed nature of the distribution. That distribution at the high end is illustrated by the Congressional Budget Office graphic below.

Average Household Income Before Transfers and Taxes, 2019

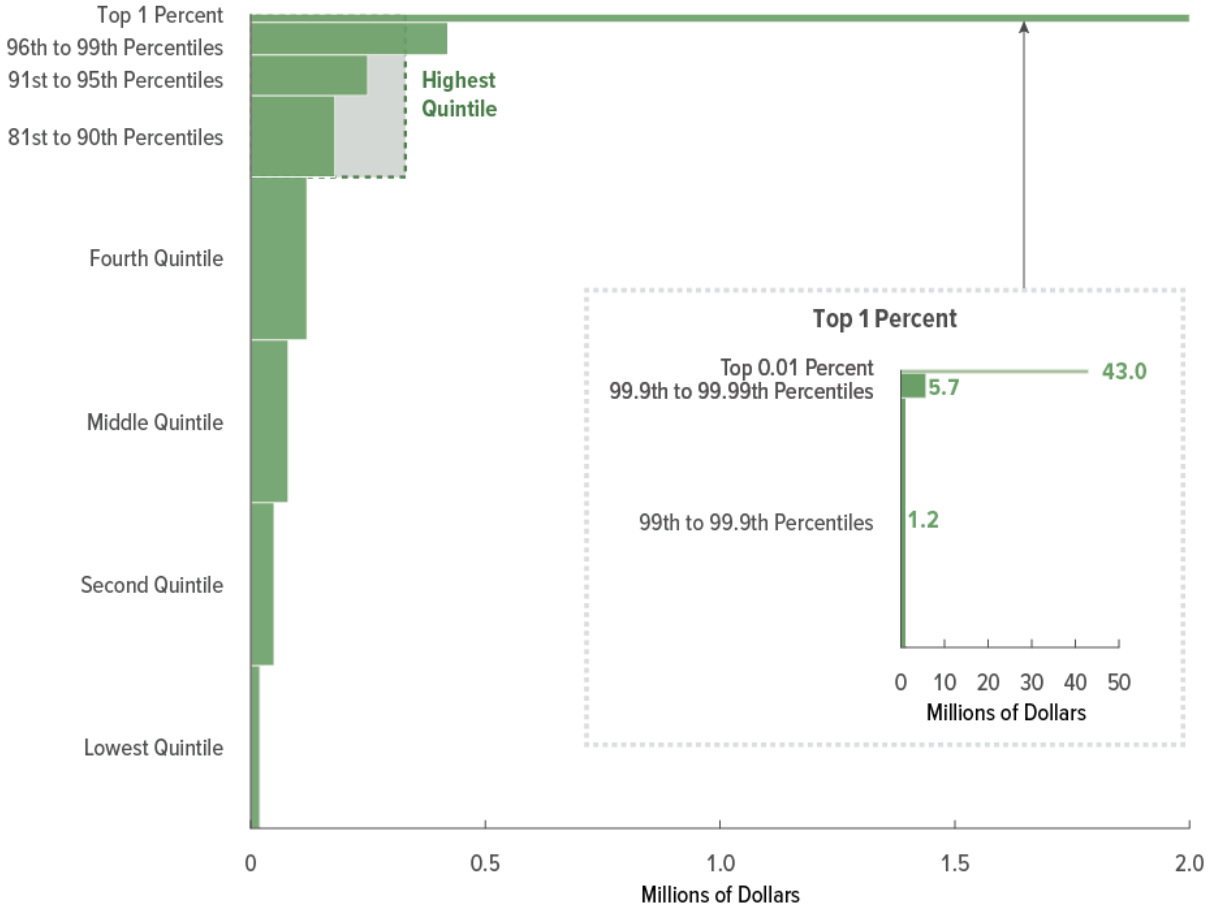


Figure 35 Average Household Income Before Transfers and Taxes, 2019. Includes capital gains. Source: "The Distribution of Household Income, 2019." Congressional Budget Office. July 29, 2022

The chart below, which includes realized capital gains, shows where income comes from for households grouped by quintiles, with details for the very top of the distribution.

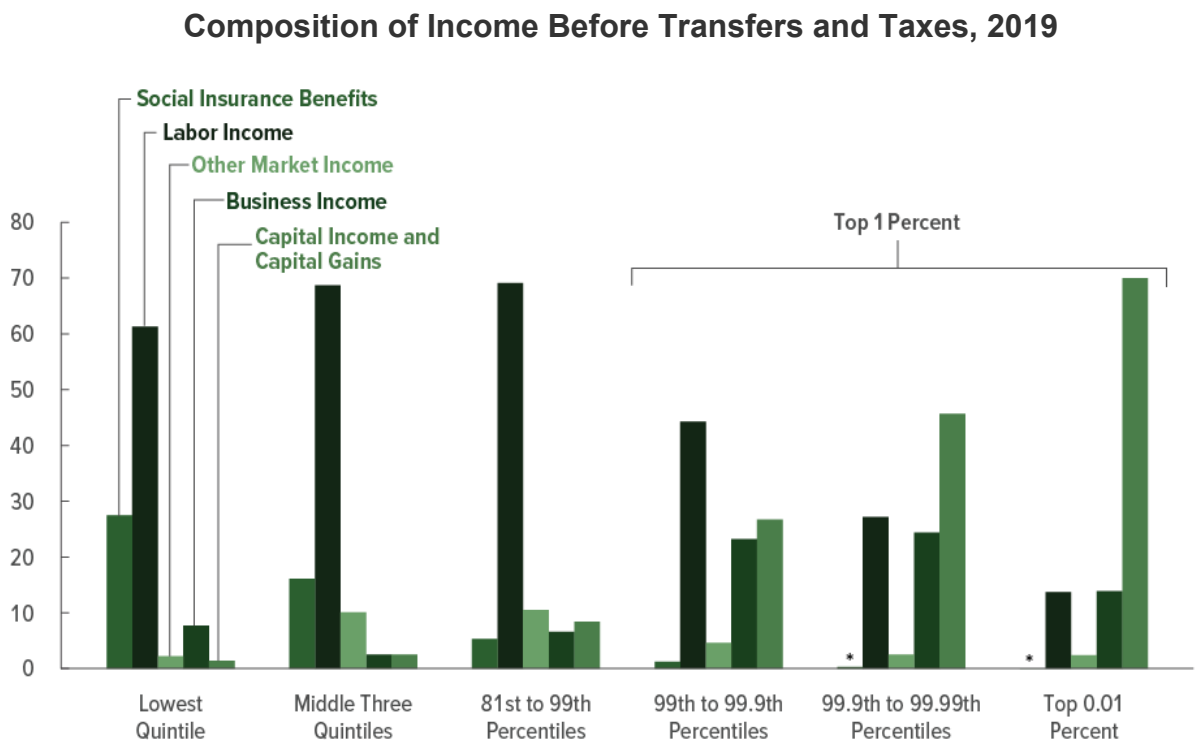


Figure 36: Percent Composition of Income Before Transfers and Taxes, 2019. Source: "The Distribution of Household Income, 2019." Congressional Budget Office. July 29, 2022

Most income, right up to the 99th percentile, comes from labor, while the truly extraordinary top incomes come mostly from capital income and realized capital gains. We should note in this chart that while the percentages from labor are similar in the quintiles up to the 99th percentile, the total incomes for each quintile are not, as we have seen. Means-tested transfers such as Medicaid, CHIP, SSI, and SNAP are not shown on this chart, but they add considerably to the incomes of the lowest quintile, most of that, 80%, is Medicaid which is somewhat different from disposable income.

Here are some other ways to slice income, including transfers but excluding unrealized capital gains:

2019 Income Bracket	Number of households	Income	Percent of Income
All households	128 million	$18.6 trillion	100%
Lower 50%	64 million	$4.0 trillion	22%
Top 10%	12.8 million	$6.7 trillion	36%
Top 1%	1.28 million	$2.56 trillion	13.7%

Top .1% (but not top .01%)	128 thousand	$730 billion	3.9%
Top .01%	12,800	$550 billion	3%

The charts we've just looked at give a pretty comprehensive account of the current distribution of income in the US, but don't really tell one about who falls in each group, how they make their income (other than the top 0.1%), or how the distribution has changed over time. We'll take a look at the various components of income with a view to answering those questions.

Wages and Salary Income

Except at the very top, most income still comes from labor. Looking just at labor, who makes the most today? The table below shows the highest paid occupations, lowest paid occupations, and some occupations from the middle.

Table 13: Mean 2019 annual income for selected occupations. Source: Occupational Employment Statistics (OES) Survey, Bureau of Labor Statistics, Department of Labor. https://www.bls.gov/oes/

Occupation	Employment 2019	Annual Mean Income 2019
Top 15 occupations		
Anesthesiologists	31,010	$261,730
Surgeons, Except Ophthalmologists	36,270	$252,040
Oral and Maxillofacial Surgeons	4,650	$237,570
Obstetricians and Gynecologists	18,620	$233,610
Orthodontists	5,990	$230,830
Psychiatrists	25,530	$220,430
Family Medicine Physicians	109,370	$213,270

Physicians, All Other; and Ophthalmologists, Except Pediatric	390,680	$203,450
General Internal Medicine Physicians	44,610	$201,440
Chief Executives	205,890	$193,850
Pediatricians, General	29,740	$184,410
Dentists	127,200	$183,060
Nurse Anesthetists	43,570	$181,040
Dentists, General	110,730	$178,260
Airline Pilots, Copilots, and Flight Engineers	84,520	$174,870
Petroleum Engineers	32,620	$156,780
Computer and Information Systems Managers	433,960	$156,390
Architectural and Engineering Managers	194,250	$152,930
Employment and average income top 15 occupations	**1,929,210**	**$184,165**
Some Selected Middle-Income Occupations		
Project Management Specialists and Business Operations Specialists, All Other	1,279,390	$80,220
Accountants and Auditors	1,280,700	$79,520
Logisticians	182,050	$78,680
Insurance Underwriters	100,050	$77,640
Registered Nurses	2,982,280	$77,460
Dental Hygienists	221,560	$77,230

Loan Officers	308,370	$76,200
Social and Community Service Managers	156,460	$72,900
Compliance Officers	317,600	$72,850
Electrical Power-Line Installers and Repairers	111,660	$71,960
Property, Real Estate, and Community Association Managers	220,750	$71,720
Market Research Analysts and Marketing Specialists	678,500	$71,570
First-Line Supervisors of Construction Trades and Extraction Workers	626,180	$71,440
Cost Estimators	210,000	$71,350
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	1,344,530	$71,110
First-Line Supervisors of Mechanics, Installers, and Repairers	485,700	$70,550
Public Relations Specialists	244,730	$70,190
Buyers and Purchasing Agents	421,280	$69,680
Instructional Coordinators	176,690	$69,180
Sub-total employment, selected middle occupations shown	**11,348,480**	**$75,208**
More Selected Middle-Income Occupations		
Firefighters	324,620	$54,650
Sheet Metal Workers	131,300	$54,480
Operating Engineers and Other Construction Equipment Operators	405,750	$54,210
Carpenters	734,170	$52,850

First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	103,580	$52,340
Postal Service Mail Carriers	339,650	$52,180
Mental Health and Substance Abuse Social Workers	117,770	$51,670
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	342,040	$51,420
Postal Service Mail Sorters, Processors, and Processing Machine Operators	102,390	$51,190
Child, Family, and School Social Workers	327,710	$51,030
Legal Secretaries and Administrative Assistants	168,140	$50,900
Production, Planning, and Expediting Clerks	370,380	$50,640
Drywall and Ceiling Tile Installers	102,850	$50,560
Water and Wastewater Treatment Plant and System Operators	123,730	$50,490
Bus and Truck Mechanics and Diesel Engine Specialists	266,330	$50,360
Correctional Officers and Jailers	423,050	$50,130
Surgical Technologists	109,000	$50,110
Sub-total employment, selected middle occupations shown	**4,492,460**	**$51,935**
Lowest Paid 14 Occupations		
Food Servers, Nonrestaurant	277,580	$26,080
Hotel, Motel, and Resort Desk Clerks	267,940	$25,950
Food Preparation Workers	863,740	$25,820

Childcare Workers	561,520	$25,510
Laundry and Dry-Cleaning Workers	209,330	$25,420
Lifeguards, Ski Patrol, and Other Recreational Protective Service Workers	143,940	$25,380
Dining Room and Cafeteria Attendants and Bartender Helpers	477,270	$25,020
Ushers, Lobby Attendants, and Ticket Takers	138,160	$24,870
Dishwashers	514,330	$24,410
Cashiers	3,596,630	$24,370
Amusement and Recreation Attendants	338,110	$24,330
Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	423,380	$24,010
Cooks, Fast Food	527,220	$23,530
Fast Food and Counter Workers	3,996,820	$23,250
Sub-total employment 14 lowest paid occupations	**12,335,970**	**$24,246**

The top nine occupations with the highest average income in this data are all medical professionals. Chief executives are next, but CEO pay is dramatically skewed depending on the size of the business. We can see that the average annual income at the top of the occupation range is about 10 times the mean annual income at the bottom, before taxes. That doesn't explain the difference we noted in Figure 34 which showed the highest decile households as having almost 20 times the average household income as the lowest decile. The explanation is again the long tail of extremely high incomes, much of that from sources other than labor. Occupations at the 1% level include executives, managers, finance professionals, lawyers, medical professionals, real estate professionals, skilled sales, and a few others in declining percent of income[169].

[169] "Jobs and Income Growth of Top Earners and the Causes of Changing Income Inequality: Evidence from U.S. Tax Return Data." https://web.williams.edu/Economics/wp/BakijaColeHeimJobsIncomeGrowthTopEarners.pdf.

Business Income

The national accounting of personal income includes a category for Business Income, and we've seen that it's a major component of income at the 1% level. Business income is earnings from "closely held" companies often organized as "pass through" entities such as "S corporations", partnerships, and limited liability companies. What that means is that there are few shareholders (often from one family), shares don't trade publicly, and income passes through to the shareholders rather than the entity itself. While numerically most S corps, for example, are tiny mom and pop operations, there are also many large ones. In aggregate, S corps alone employ over 29 million people in the US. Here are a few of the largest closely held companies and their revenue:

- Mars (the candy co) with revenues of $45 billion
- Publix (supermarkets) $48 billion in revenues
- Cargill (food, agriculture, etc.) $165 billion in revenue
- Enterprise (car rental) $30 billion

The list of large, closely held, companies is quite long and clearly the earnings of these companies when passed through to their small pool of shareholders can generate a lot of business income on tax returns. It is perhaps surprising that business income is only 9% of total personal income as noted in Table 12, but business owners often prefer to grow a business by investing rather than taking out most earnings as income. The fact that capital gains, when taken, are taxed at a lower rate than income helps encourage this.

Capital Income and Capital Gains

Capital income and capital gains are the dominant sources of income at the .01% level. Capital income in national accounting includes interest, mostly from bonds, and dividends, which are corporate profits distributed to stock owners. By themselves, interest and dividends account for 17% of personal income, or a little over $3 trillion in 2019. Needless to say, you need to own bonds or stock to collect these payments, and not surprisingly wealthy people own the largest share as we will see when we look at wealth distribution[170]. Capital gains, realized or not, are not included in Table 12, or in the graph of income distribution based on the national accounting of personal income. Owners of capital, such as stock or property, can decide when they want to sell and often match losses with gains to limit tax liability. For this and other reasons, realized capital gains vary pretty widely from year to year. The IRS tells us that declared, taxable, net capital gains amounted to around $880 billion net in 2019 on several trillion dollars of sales (the net is the amount the stock or other asset sold for, minus its original cost). That number was

[170] In 2019, the top 10% had a mean net worth of $5.7 million and owned 80% of stock and a similar percent of bonds. In round numbers that implies that $2.4 trillion of interest and dividends went to the top 10% in 2019.
https://www.federalreserve.gov/econres/scf/dataviz/scf/table/#series:Stock_Holdings;demographic:nwcat;population:1,2,3,4,5;units:mean;range:1989,2019

$1.7 trillion in 2021 reflecting higher stock prices. Since 1980, taxable realized capital gains have averaged about 4% of national income, but a lot of realized capital gains are exempt from taxes: the gain on the sale of a principal residence, and gains made that are sheltered by retirement plans, for example[171]. Adding realized (not net worth) capital gains to the income distribution makes the top 10% and above stand out even more.

Rental Income of Persons

To quote the Bureau of Economic Analysis:

Rental income of persons is the net income of persons from the rental of property. It consists of the net income from the rental of tenant-occupied housing by persons, the imputed net income from the housing services of owner-occupied housing, and the royalty income of persons from patents, copyrights, and rights to natural resources. It does not include the net income from rental of tenant-occupied housing by corporations (which is included in corporate profits) or by partnerships and sole proprietors (which is included in proprietors' income). Like other measures of income in the national income and product accounts (NIPAs), rental income of persons measures income from current production and excludes capital gains or losses resulting from changes in the prices of existing assets[172].

At first it is quite surprising that this is only about 4% of total personal income, or $698 billion in 2019, given that it includes the "imputed" value of owner-occupied housing. Imputed value is roughly how much an owner would have to pay for their home if they rented it. However, the operative word is "net". In effect, every homeowner is treated as a business and all expenses, including mortgage interest, are deducted from the rental value. Of the $698 billion "rental income of persons" in 2019, $532 billion was for owner occupied housing.

Transfers

The final income item shown on Table 12 is transfers, which includes the big entitlement programs of Social Security, Medicare, and Veterans benefits, and the means-tested transfers of Medicaid, CHIP, SNAP, and SSI. These are income to those that receive them and of course costs to those that pay them. At 17% of Personal Income, or over $3 trillion in 2019, they are quite significant. Social Security and Medicare are programs for the elderly and are evenly distributed among the elderly across income levels. Medicaid and the other means-tested transfers are by design geared toward those with lower incomes. They have helped boost incomes of the poorest quintile, but mostly through the provision of medical coverage. Social security benefits are paid from current Social Security payroll taxes, with any surplus or deficit going into, or coming out of, the Social Security Trust Fund. Social Security is financially stand-

[171] Robbins, Jacob A. 2018. "Capital Gains and The Distribution of Income in the United States." In *2019 Meeting Papers 202, Society for Economic Dynamics.* Brown University. https://users.nber.org/~robbinsj/jr_inequ_jmp.pdf.
[172] https://www.bea.gov/help/faq/64

alone and does not receive money from other sources[173]. The Social Security tax has a cap: in 2019 you paid the same amount whether you made $132,000 (the cap in 2019) or $10 million. It's one of the reasons some rich people acknowledge that they pay a lower tax rate than their assistants[174]. The other big entitlement is Medicare which also has a payroll tax source. However, Medicare runs a deficit of almost 50% which is made up through general revenue. Medicaid is financed from general Federal and State revenues.

US Income Changes Since 1970

How has income distribution changed in the last 50 years? There are three major trends.

1) Wages in the aggregate have increased slowly but were essentially flat in inflation adjusted terms for most occupations over an extended period from the early 1970's until the late 1990's, with slow growth since.

2) Labor's share of GDP has decreased as the use of capital has increased. Business profits have increased.

3) Wage and income inequality has increased.

We'll look at these three interrelated trends in some detail.

Wages For Most Have Grown, but Slowly Since 1970

One often noted statistic is that, for most occupations, inflation adjusted wages have not kept up with labor productivity increases. When discussing productivity and trade we made the case that both tended to reduce the costs of goods and services and that would show up as inflation adjusted increases in people's incomes. Indeed, after World War II and until about 1970, labor productivity and wages of non-supervisory employees grew at the same rate[175].

[173] During the Baby Boom working years, Social Security ran a surplus which was added to the Social Security trust fund which grew to over 2 trillion dollars. The trust fund is limited to investing in Treasury bonds which, while secure, pay a low rate of interest. In short, to finance debt spending, we "borrowed" our own Social Security savings. Social Security is projected to be able to pay full benefits until around 2037.

[174] Warren Buffett has stated this on several occasions over the years.

[175] https://www.epi.org/productivity-pay-gap/

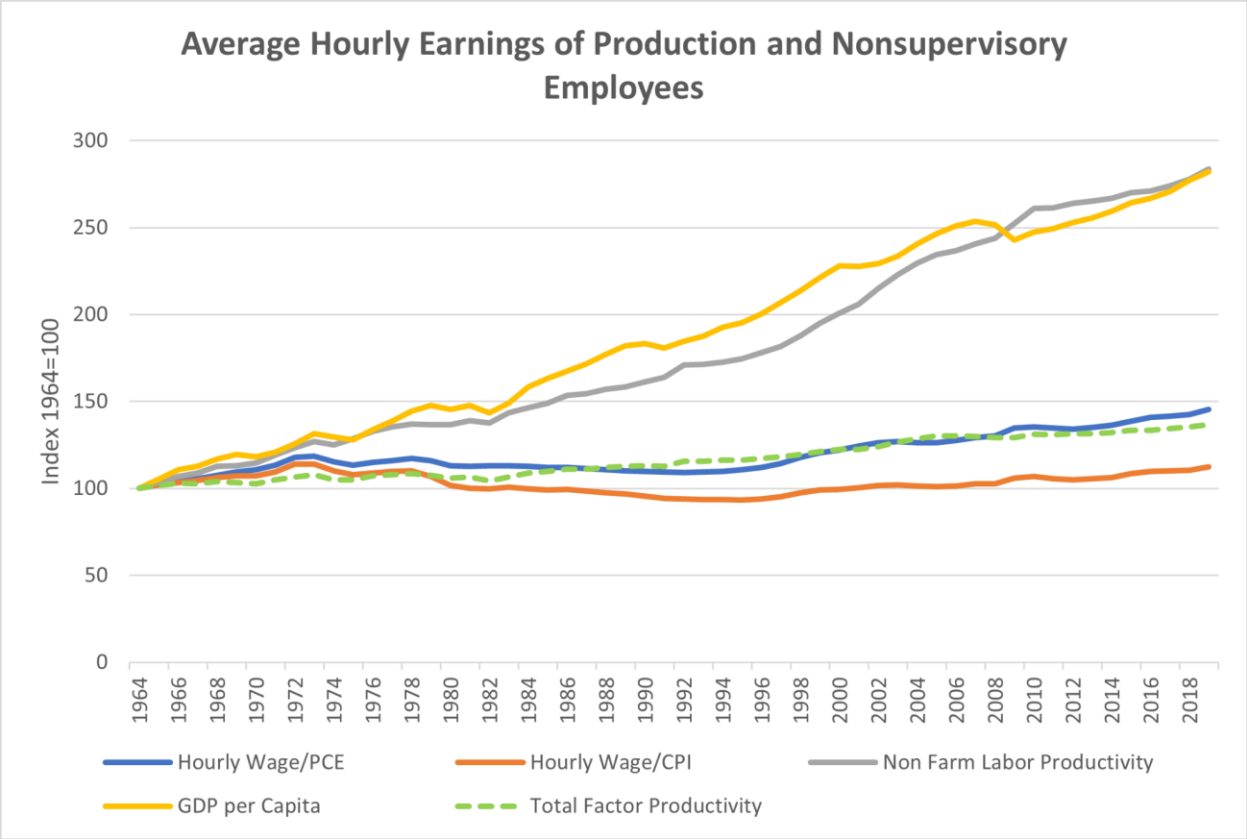


Figure 37: Average hourly earnings of production and nonsupervisory employees adjusted for inflation two ways, labor productivity growth, real GDP per Capita, and total factor productivity growth. Data sources: BEA table 2., FED from Penn world table 10.1 WW122

However, the chart above shows that hourly wages for non-supervisory employees adjusted for inflation using two different inflation measures (the orange and blue lines), stagnated from the early 1970's through the late 1990's even though labor productivity (the gray line) grew enormously. The chart also shows total factor productivity as a dashed green line. As explained in the primer, total factor productivity is designed to capture the increase in output that is not explained by increases in inputs such as labor, capital, and energy. If one looks just at labor productivity one might well think that the value of an hour of labor should increase along with the additional value of output from that hour of work. After all, in inflation adjusted dollars, the same hour of work produces over 2.5 times the value of output. But total factor productivity (TFP) hasn't risen nearly as much. How are both possible?

Here it helps to do a thought experiment. Let's say a factory employs 200 people. Newer technology makes it possible for the owner to replace 100 of these workers with machines, but the machines cost the same amount to finance and maintain as the employees they are replacing. Total output remains the same, and so do costs. Since there are now only 100 employees producing the same output as 200 before, labor productivity, which is output divided by work hours, has doubled. But the factory owner can't afford to pay the remaining workers more because neither output nor costs have changed. Total factor productivity change might very well be zero in this case, and wages wouldn't change, but labor productivity doubles.

This helps explain the seeming paradox in the chart. We already know that in manufacturing many workers have been replaced by automation. These machines cost money to buy and run and so wages can't go up as much as labor productivity. The workers let go create a surplus of labor which holds wages down, which in turn can reduce the incentive for further automation depending on the cost.

In the chart, the fact that labor productivity has grown enormously but total factor productivity has grown only slightly, points to a substitution of machines for humans as a major driver of labor productivity gains, something we saw earlier in Figure 13 . How much could real wages have risen? If we assume, reasonably, that the cost of buying and operating the machines is less than the cost of the labor they replace, then in the chart above, all I think we can safely say is that average wages could have grown at a pace between the dashed green line for total factor productivity and below the one for labor productivity. Looking at actual profits is a much better way to determine whether labor is fully sharing in productivity gains since it relies on real world total productivity decisions by businesses which weigh all the costs, including various types of labor. We'll look at profits shortly.

Figure 37 can't tell us how much wages could have gone up over the period from 1964 to 2019, but it clearly shows that for an extended period real (inflation adjusted) wages languished for most workers and suggests that this is at least partly because overall total factor productivity grew only slowly[176].

Labor's Share of GDP Has Decreased as the Use of Capital Has Increased

In Table 12, we saw the sources of personal income in 2019. Labor income consists of wages and salaries plus benefits, and an estimated portion of business income that can be attributed to the proprietor's own labor. Here's how labor's share of GDP has fared over the last 50 years:

[176] Income usually rises with seniority, which may tend to hide wage stagnation in our personal lives. The chart shows averages.

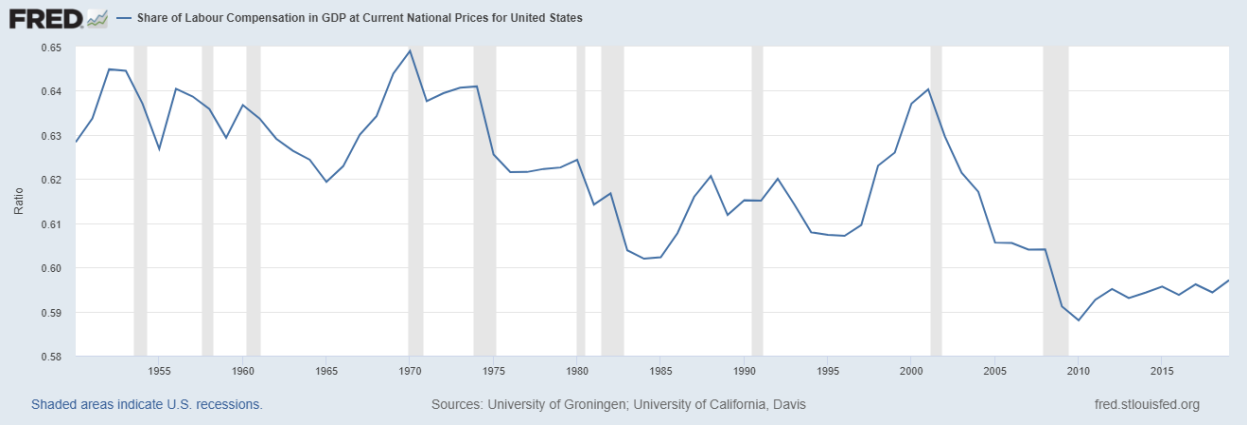


Figure 38: Labor share of GDP. Source: FED data from Penn World Table 10.1

From 1970 to 2019, labor's share has fallen by 5% of GDP. Correspondingly, capital's share has increased. Five percent of 2019 GDP is just over $1 trillion, or about $7,000 per worker per year. However, as we saw above, it's not so simple. Some of the increased gross (not net) capital share is explained by the fact there is simply more capital per worker and consequently more depreciation. However, there are also other factors[177], including increased business profits, which we look at below. Before doing so, it is worth noting that not all sectors of the economy showed an equal decline in labor share of income. In the chart below, extracted from a BLS article, are estimates of employee share of income for major sub-sectors of the economy.

Table 14: Employee-only labor share, nonfarm business subsectors, 1997 to 2014 Source: Giandrea, Michael D., and Shawn Sprague. 2017. "Labor Share of Output - BLS Article and Estimation Methodology." February 24, 2017. https://www.bls.gov/opub/mlr/2017/article/estimating-the-us-labor-share.htm.

Sector	1997	2014	Change, 1997 to 2014
Mining	37%	22%	-15%
Utilities	24%	26%	2%
Construction	67%	64%	-4%
Durable goods	62%	57%	-6%
Nondurable goods	49%	34%	-15%
Wholesale trade	50%	47%	-3%
Retail trade	58%	55%	-3%
Transportation and warehousing	65%	58%	-7%
Information	43%	37%	-6%

[177] For a quantitative analysis see "A New Look at the Declining Labor Share of Income in the United States." n.d. Accessed July 4, 2023. https://www.mckinsey.com/featured-insights/employment-and-growth/a-new-look-at-the-declining-labor-share-of-income-in-the-united-states?cid=eml-web.

Finance, insurance, real estate, rental and leasing	23%	23%	0%
Educational services, health care, and social assistance	41%	42%	1%
Professional and business services	70%	74%	4%
Arts, entertainment, recreation, accommodation, and food services	56%	59%	3%
Other services (except government)	39%	44%	5%

Again, we see the pattern familiar from our look at productivity: goods producing and some services that deal in physical goods, such as transportation and warehousing, show declining labor shares, while many services have seen an increase. Professional and business services employ more than all the goods producing sectors combined and had twice the average hourly compensation in 2019[178], so these changes in labor share add to income inequality.

We mentioned increased business profits as a partial explanation of the decline in labor share. If one is looking for what portion of increased productivity could have gone to wages, but didn't, "excess" profits are the most direct measure.

The chart below shows corporate profits compared to a steady 5% of GDP.

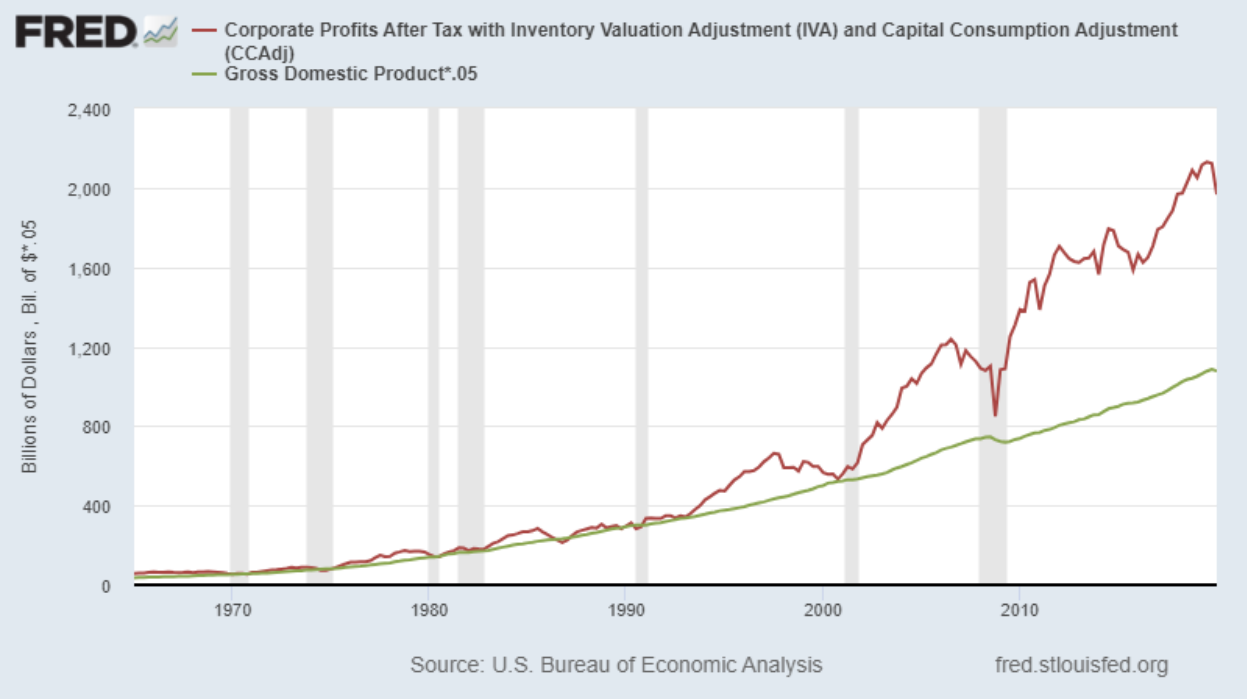


Figure 39: US corporate profits (all corporate types including C, S and REIT but not partnerships). Source: BEA via FRED (CPATAX series).

[178] See BLS series CMU201540A120000D, CMU201G000510000D. Roughly $60 vs $30 per hour.

The profit measure graphed is quite conservative, accounting for taxes, depreciation of capital (machines wearing out for example), and any changes in inventory. Of course, profits are also net of salary and bonus payments to the CEO and management.

To quantify, a pair of economists who work for an investment advising firm write:

Yet, economics is about trade-offs: corporate profits' increased share of GDP has been roughly offset by a decline in employee wages, which have fallen from 56% of GDP from 1970 through 2000 to around 53% over the past decade. In tandem, the share of capital has surged from 18% to over 21%. Stated differently, earnings that now amount to roughly $600 billion a year have been transferred from labor to capital.[179]

$600 billion a year is about $4,000 for every worker. Where has this money gone?

The curve of distributed dividends closely resembles the corporate profits curve. In 2019 US corporate dividend payments were $1.5 trillion dollars[180] and 7% of GDP. In contrast, in 1990, dividend payments were 3% of GDP[181]. The additional 4% of GDP going to stockholders represents an increase of $855 billion in 2019. In addition to dividends, public companies use profits to buy back their own stock, thus increasing the value of outstanding shares (and the value of CEO stock options). Companies of any type can also reinvest profits back into the business through expansion or by buying other companies. Any use of profits to grow the business increases the value of shares and thus the wealth of shareholders, without any personal taxes being paid[182]. Not to belabor a point but the large majority of stock is held by upper income households, as we've seen. Finally on labor share, let's look at some of the most profitable large publicly traded companies. The table below shows data for the year from the second quarter of 2022 through the 1st quarter of 2023 for US companies with over 50 thousand employees.

Table 15: Earnings (i.e. profits) and revenue for US publicly traded large companies Q2 2022 through Q1 2023. The top 15 are ranked by earnings per employee. Source: https://companiesmarketcap.com/most-profitable-companies/

Company Name	Employees	Earnings millions	Revenue millions	Earnings per Employee	Revenue per Employee
Exxon Mobil	62,000	$86,000	$394,585	$1,387,097	$6,364,274

[179] Sheets, Nathan. n.d. "The Evolution of US Corporate Profits: Dissecting 70 Years' of Performance." Accessed June 13, 2023. https://cdn.pficdn.com/cms/pgim-fixed-income/sites/default/files/2021-04/The%20Evolution%20of%20U.S.%20Corporate%20Profits_2.pdf.
[180] Source: FRED (B056RC1A027NBEA series). Not all of that went to US owners, we learned in the section on trade that about 40 percent of US stock was owned by foreign investors in 2019.
[181] https://fred.stlouisfed.org/series/B056RC1A027NBEA
[182] Pass-through entities can deduct the cost of acquisitions, c-corps pay corporate taxes (if any). There are additional incentives relating to the basis.

Apple	164,000	$112,304	$385,095	$684,780	$2,348,140
Pfizer	83,000	$33,184	$92,952	$399,807	$1,119,904
Microsoft	221,000	$85,071	$207,591	$384,937	$939,326
Alphabet (Google)	190,711	$70,953	$284,612	$372,045	$1,492,373
Meta Platforms (Facebook)	77,114	$27,648	$117,346	$358,534	$1,521,721
QUALCOMM	51,000	$12,539	$41,069	$245,863	$805,275
Merck	67,000	$16,466	$57,869	$245,761	$863,716
Verizon	117,100	$28,688	$136,193	$244,987	$1,163,049
Cisco	83,300	$14,672	$54,897	$176,134	$659,028
JPMorgan Chase	296,877	$52,070	$136,327	$175,393	$459,204
Procter & Gamble	106,000	$18,401	$80,968	$173,594	$763,849
Deere & Company	82,200	$13,458	$59,677	$163,723	$725,998
Coca-Cola	82,500	$13,353	$43,493	$161,855	$527,188
Morgan Stanley	82,000	$13,261	$49,927	$161,720	$608,866

Companies such as these have very high value added per worker and so will tend to boost aggregate labor productivity which is the ratio of value added in dollars to employee hours[183]. The high levels of profit per employee, means that even though they may pay quite well (thus increasing income inequality), much of the profit does not go back to employees but rather is

[183] We always have to be careful to note that revenue is not the same as value added since intermediate products are included in the former. This list is based on companies with top profit to employee ratios.

paid out to shareholders, in CEO incentives and pay, or reinvested in the business. That reduces labor's share of GDP.

Many of these companies have some sort of market "edge". The resource companies have benefited from the increasing prices of energy and minerals, Apple and Pfizer can profit from exclusive "intellectual property", Coca-Cola has a valuable brand, and Google and Meta benefit from what is called "network effects" which means that, in their businesses, having many users makes it very difficult for competitors to catch on. What are called "superstar" firms that command a large share of corporate profits worldwide, come from many sectors of the economy, but now account for a larger share of profits than 20 years ago[184]. We should also note that "downsizing" and "maximizing shareholder value" became a management fad in the 1980s and 1990s and boards of directors tried to align CEO incentives with shareholder interests through the use of stock incentives which ended up ballooning CEO pay in a rising stock market[185]. Mergers and acquisitions allowed by lax antitrust enforcement have reduced competition. Finally, union membership, which gives labor greater bargaining power, has declined. It has been shown that union membership boosts lifetime earnings significantly, almost entirely by reducing CEO pay and profits, while generally not negatively affecting productivity[186].

Wage And Income Inequality Have Increased

As we've just seen, the substitution of capital for labor can increase wage inequality, and higher corporate profits increase income inequality.

The chart below shows some occupations and how they have done in terms of earnings. These are personal incomes, not household incomes. The selection of occupations is somewhat random: the data is from the census, and I chose a few professions for which data is available over the 50-year period. Data over that period isn't available for computer programming, and many other professions,

[184] https://www.mckinsey.com/featured-insights/innovation-and-growth/superstars-the-dynamics-of-firms-sectors-and-cities-leading-the-global-economy
[185] https://hbr.org/2014/09/profits-without-prosperity
[186] See https://theconversation.com/unions-do-hurt-profits-but-not-productivity-and-they-remain-a-bulwark-against-a-widening-wealth-gap-107139 which reports on the results of a survey of studies, Also see https://www.nber.org/papers/w24587

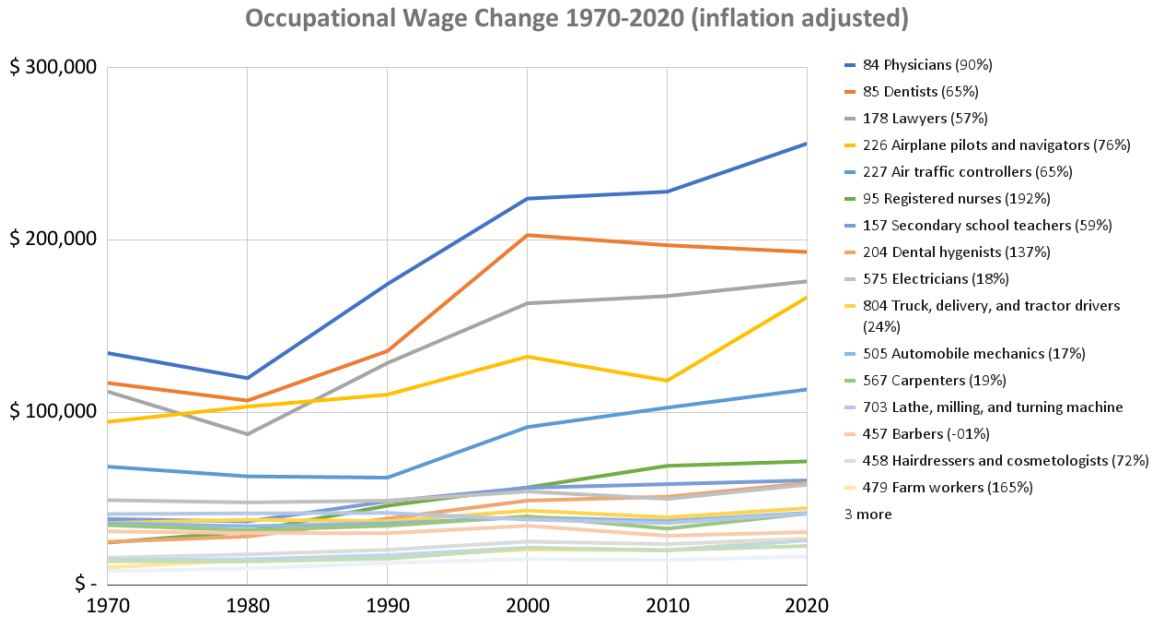


Figure 40: Occupational wage changes 1970-2020 inflation adjusted (PCE) to 2020 dollars. The legend on the right is ordered by wage in 2020, the percentage in parentheses shows the increase in income over the period. Source: Census data: INCTOT via IPUMS

The number in parentheses shows the inflation adjusted increase in pay. The starting point is important in determining actual dollar increases. For example, airline pilots have seen only a 76% increase in their incomes, but they started at a higher level, so their inflation adjusted income was $72,236 more than in 1970, while farm workers had a 165% increase that amounted to only $16,594 in 2020 dollars. In short, if everyone's real incomes increased by the same percentage, the entire wage pie would grow and everyone's slice would remain the same proportion of the whole, but a percentage of a bigger piece is always going to be more than that same percentage of a smaller piece. So, in that sense, yes, it's good the pie grows, but even with equal percentage wage growth, spending power grows unequally. Unfortunately, good occupational compensation data is only available for the last 20 years or less, and the occupational landscape changes over time, so economists generally look at highly aggregate wage data or household income to figure out what's going on.

The chart below shows how household income distribution has changed.

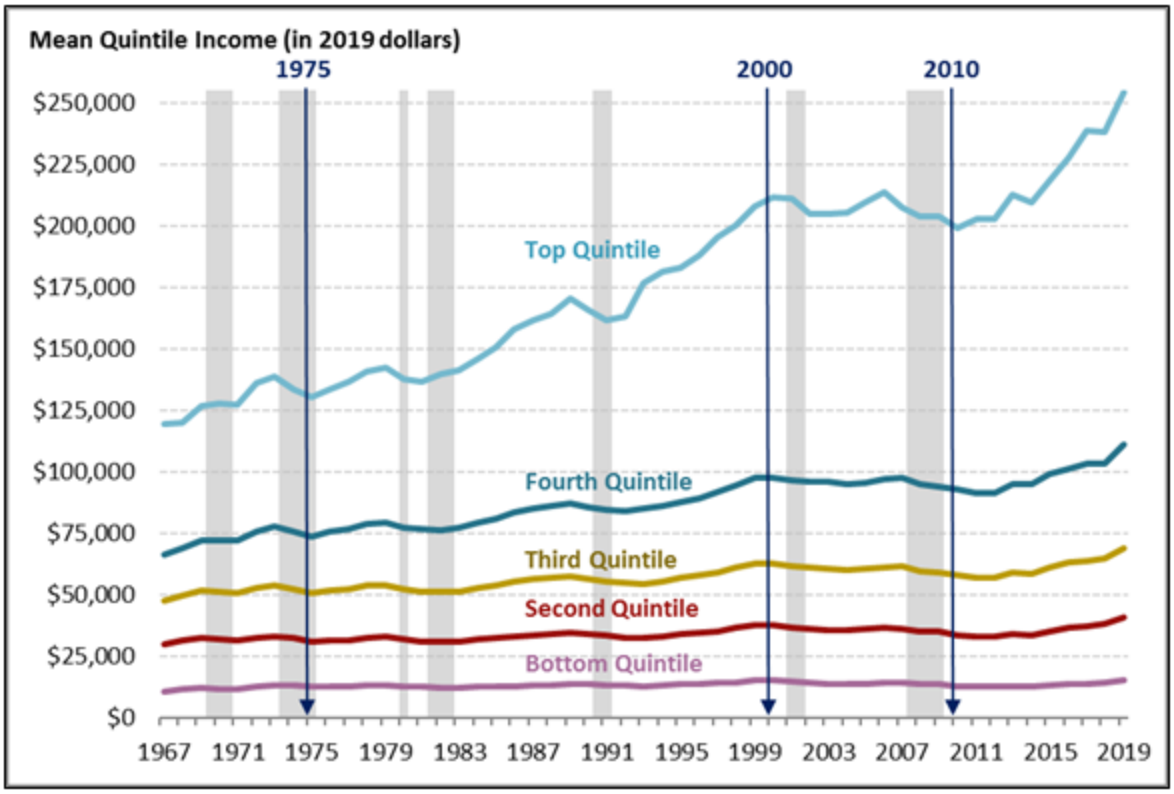


Figure 41: Inflation adjusted household income by quintile. Source: Figure created by the Congressional Research Service (CRS) based on data from U.S. Census Bureau, Current Population Survey (CPS), Annual Social and Economic Supplements (ASEC). Recession data (in gray) are from the National Bureau of Economic Research.[187]

What factors have kept wages in check for lower- and middle-income workers relative to higher-income workers? If we refer back to basic economics, wages will be determined largely by supply and demand factors. As labor productivity increased, especially in farming and manufacturing, the need for general labor dropped, reducing wages. Trade too resulted in worker dislocations which led to an excess of labor. At the same time, and possibly related to the soft labor market, unionization declined which gave labor less bargaining power. At the lower end of the wage spectrum, declining real minimum wages and competition from immigrants took a toll. Meanwhile demand increased, and along with it wages, for IT workers, doctors, workers in finance and investment banking, and legal professionals. In addition, pay went up substantially for top managers. The result has been a shrinking of the middle class, with fewer middle-class households and more low- and high-income households as a percent of the total as shown below[188].

[187] Inflation is adjusted using the Consumer Price Index (CPI-U-RS). Census data understates top incomes. Source: Sarah A. Donovan, Joseph Dalaker, Marc Labonte, Paul D. Romero. 2021. "The U.S. Income Distribution: Trends and Issues." Congressional Research Service. https://sgp.fas.org/crs/misc/R44705.pdf.

[188] See https://www.pewresearch.org/short-reads/2022/04/20/how-the-american-middle-class-has-changed-in-the-past-five-decades/ for the data and how middle class is defined.

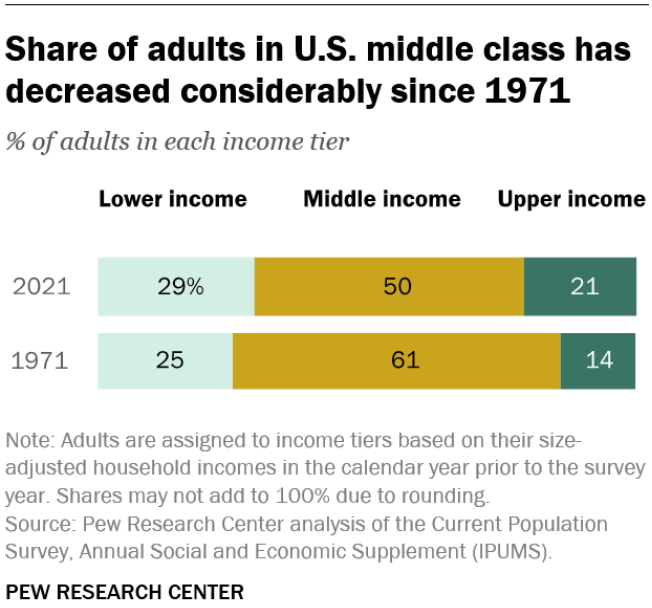


Figure 42: US Middle Class Population Share. Source: PEW Research

So, some of the increase in income inequality we've seen can be attributed to uneven changes in the labor market due to increasing productivity which is ongoing, and trade where the dislocations are largely behind us. However, the increase at the very top of the income distribution cannot be attributed entirely or even mostly to uneven wage growth. Very few "salaries" amount to $28,721,820 as shown for the top .01% in Figure 43 below[189].

[189] Or the $43,000,000 in household income for the .01% as we saw in Figure 35. This data mostly comes from tax returns, so it reflects declared income.

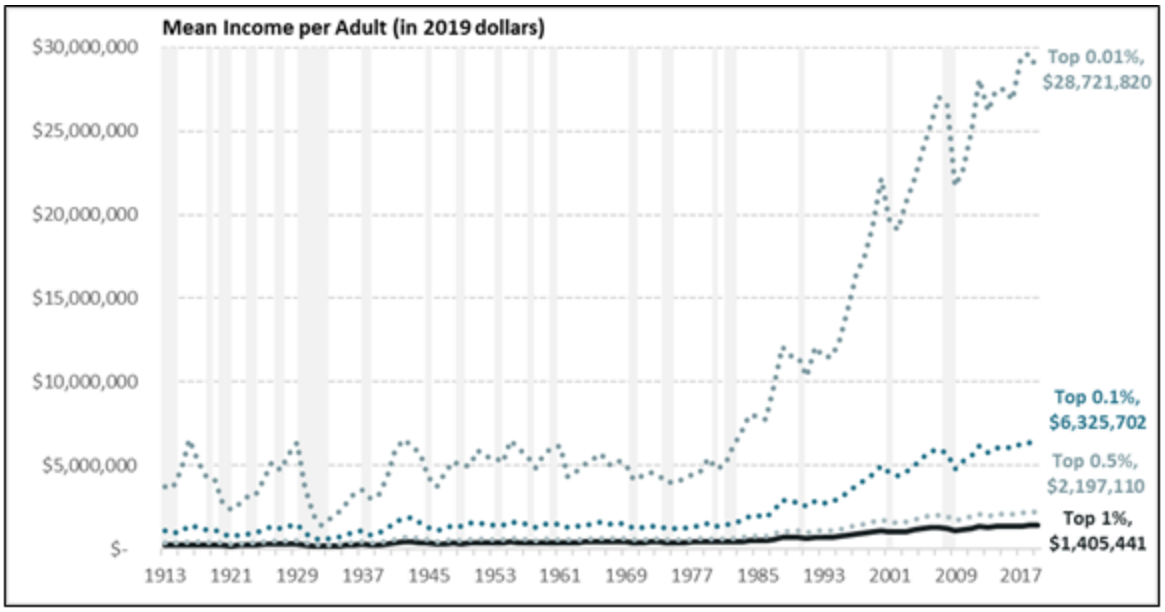


Figure 43: Mean Income Per Adult, Top 1%, 1913 to 2017 - Note that lower income groupings include higher ones (e.g. top 1% includes top .5% and .01%). Source: Sarah A. Donovan, Joseph Dalaker, Marc Labonte, Paul D. Romero. 2021. "The U.S. Income Distribution: Trends and Issues." Congressional Research Service.

The extreme increase in the very top of the income distribution coincides with the period in which corporate profits soared as shown in Figure 39. Who makes these extreme incomes and how? We've already encountered one major group of high-income earners: the owners of closely held companies. These folk take home 14% of the income in the top 0.1% of earners[190]. Another group that has gotten a lot of attention is CEOs. CEO pay at the largest 350 public US companies grew 1,460% from 1978 to 2021 to $28 million, adjusted for inflation, while typical workers saw an increase of 18%[191]. The median CEO compensation for the broader Russell 3000 firms was $4.5 million in 2019[192]. The curve of CEO compensation at these companies looks very much like the growth of top-level incomes we see in Figure 43.

The final group of high-income earners we need to mention is simply wealthy folk, a larger group that includes most of the two just mentioned. As we saw in Figure 36, the very top incomes come from capital income and gains. Capital income largely varies with corporate profits, which increases dividends on stock, as well as stock prices. Stock and bond ownership is concentrated at the top of the income distribution, so this income is as well.

[190]Boar, Corina, and Virgiliu Midrigan. 2023. "Should We Tax Capital Income or Wealth?" *American Economic Review: Insights, 5 (2): 259-74.*

[191] https://www.epi.org/publication/ceo-pay-in-2021/

[192] https://corpgov.law.harvard.edu/2021/10/07/ceo-and-executive-compensation-practices-in-the-russell-3000-and-sp-500/

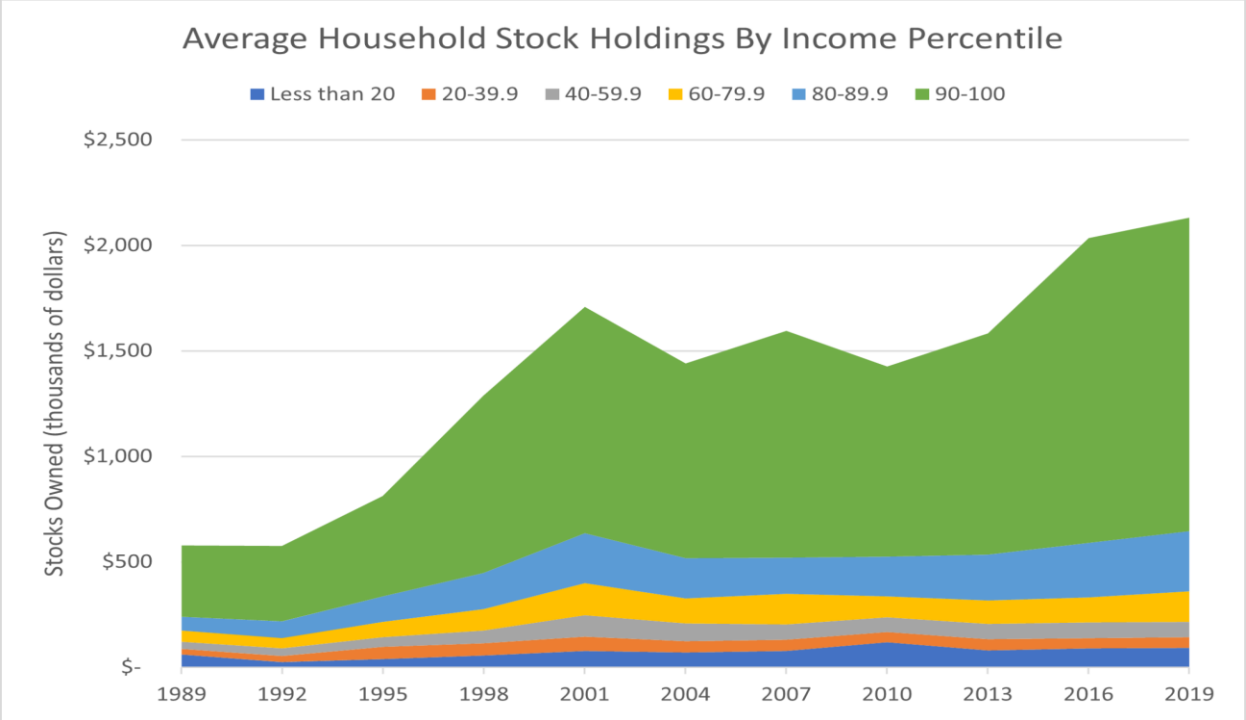


Figure 44: Stock holdings by income percentile group. This includes stock held in 401Ks. Source: Federal Reserve, Survey of Consumer Finance[193].

US Income Summary

We've covered a lot of ground in looking at US income distribution and how it has changed, let's summarize some of the key points.

- The US is a very wealthy country with a statistical household income of $177,774 in 2019, according to the national accounts Table 12: 2019 Sources of Personal Income. Source: BEA Table 2.1 [194].
- Income distribution is skewed; most households earn incomes well below the statistical mean (Figure 45 below), but there is a long "tail" of high-income households. There is a small group of households with truly huge incomes that gives the upper 10%, and especially the upper 1%, a disproportionate share of national income (Figure 34 and

193
https://www.federalreserve.gov/econres/scf/dataviz/scf/chart/#series:Stock_Holdings;demographic:inccat;population:1,2,3,4,5,6;units:mean;range:1989,2019

194 This is pretax, based on an average statistical household size of 3. 14. Disposable income is lower as shown in Table 12. You may note the HUGE discrepancy between household personal income as reported by the Census from surveys (Figure 45) and the national accounts tables prepared mostly from administrative sources. Such differences are the bane of researchers or even writers simply trying to report "facts". There are papers that explain some of these differences. See for example https://www.census.gov/content/dam/Census/library/working-papers/2004/demo/CPS-BEA.pdf.

Figure 35).

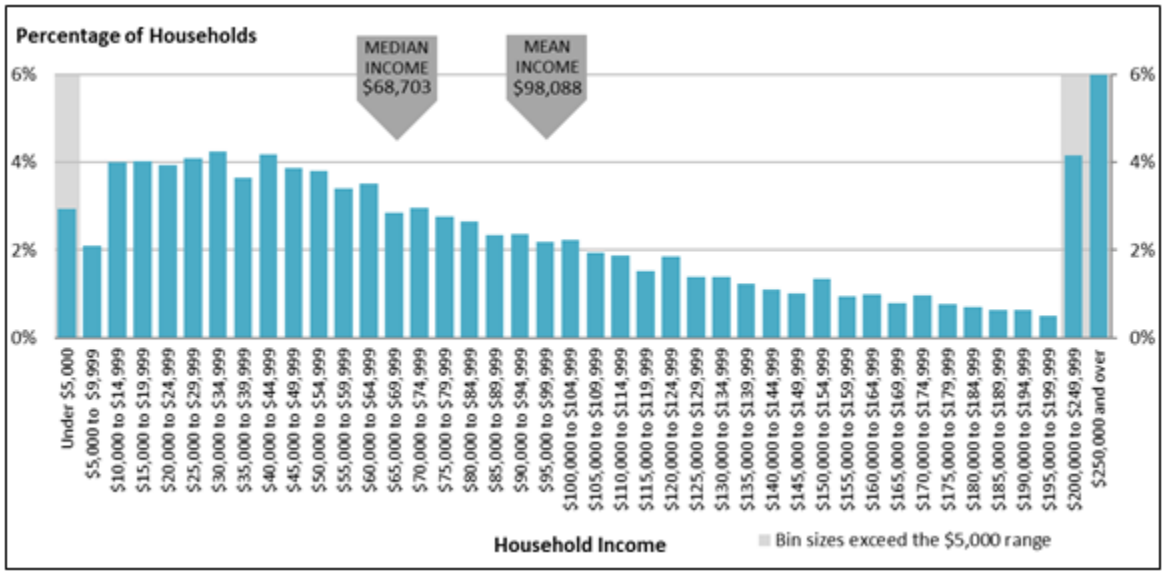
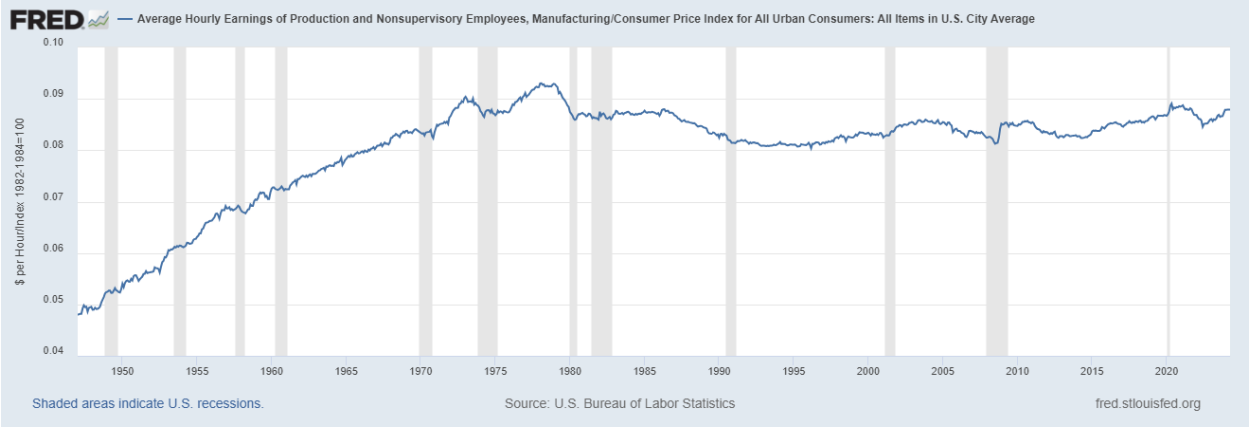
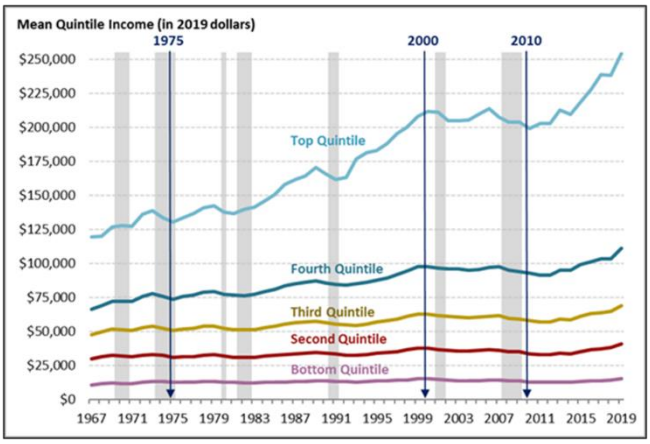


Figure 45: Distributions of Households by Income 2019. Source: Sarah A. Donovan, Joseph Dalaker, Marc Labonte, Paul D. Romero. 2021. "The U.S. Income Distribution: Trends and Issues." Congressional Research Service. https://sgp.fas.org/crs/misc/R44705.pdf. See the notes there. Their source is the U.S. Census Bureau, Annual Social and Economic Supplement

- Over the last 50 years, wages for most jobs have grown in purchasing power, but quite slowly. Labor productivity has grown far more, but much of that increase can be attributed to replacing workers with machines which improves the productivity of the remaining workers.



- Wages in some occupations have grown faster than others, resulting in greater wage inequality.



- Since the turn of the 21st century, declared corporate profits have increased to nearly $1 trillion a year in 2019, increasing income inequality because profits flow to stock and bond holders. The wealthy hold large portfolios of stocks and bonds.

World Income Distribution

Income Distribution Between Countries

Worldwide, income varies widely between countries and also within countries. GDP per capita gives us an idea of how much income per person each country has, but of course the distribution of that income within the country can be more or less skewed as it is in the United States. In the section on worldwide productivity convergence, we showed this map of world GDP per capita:

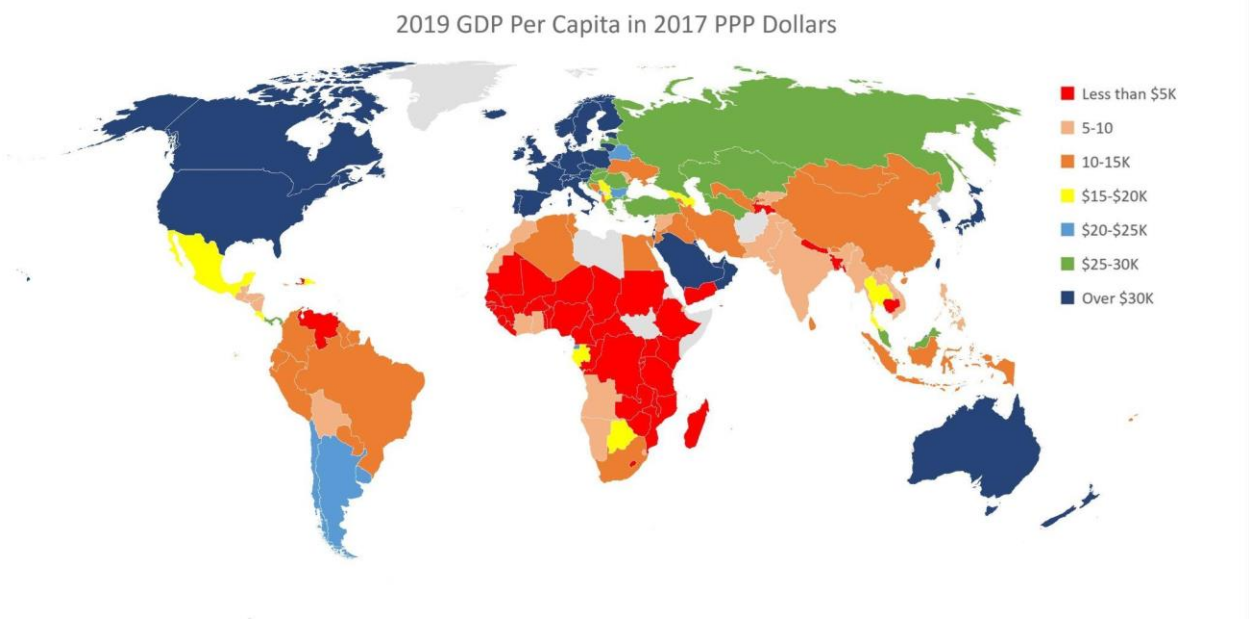


Figure 46: GDP per capita in 2017 purchasing power parity dollars Data Source: Feenstra et al. (2015), Penn World Table (2021) (2021) – with major processing by Our World in Data[195] WW103

This chart shows per capita gross income in "purchasing power parity" (PPP) dollars, which corrects for local prices. Keep in mind that gross GDP includes investment and other spending that doesn't flow through to current personal incomes, in the US 67% of GDP is personal consumption[196]. Some of the most densely populated countries in the world (India, many in Africa) have quite low GDPs per capita. Even if income was distributed evenly in those countries, everyone would be very poor by rich country standards.

[195] https://ourworldindata.org/grapher/gdp-per-capita-penn-world-table

[196] Personal income is higher because it includes taxes and savings, however that statistic is not available for worldwide comparisons. Personal consumption as a percent of GDP varies by country and can tell some interesting stories. In some really poor countries, personal consumption is greater than GDP because of foreign aid & remittances, while in Ireland it's about 30% because Irish (stated) GDP is pumped up by Ireland's tax shelter status. Here are some other personal consumption share of GDP numbers from 2019: Brazil 65%, India 61%, Japan 55%, Germany 52%, and China 39%. For the world as a whole it's 56%. The US has the highest consumption percentage of any major economy. Source: World Bank https://data.worldbank.org/indicator/NE.CON.PRVT.ZS

Purchasing Power Parity Dollars

To make GDP per capita and other comparisons meaningful between countries, they are generally given in terms of "purchasing power parity" or PPP. Purchasing power parity adjusts for differences in price levels between countries in much the same way that the Consumer Price Index adjusts for inflation between years. To calculate PPP, a basket of goods and services is priced in the country's currency and compared to the price of that basket of goods in the United States. This gives a conversion rate which can be used to meaningfully compare the purchasing power of incomes around the world in terms of the US dollar. Purchasing power parity prices are sometimes referred to as being in "international dollars". From a US perspective, an international dollar is just a US dollar, so when we say that half the population of the world earns less than $7.50 a day (roughly the case in 2019[197]), that is in US purchasing power. Of course, it is virtually impossible to live on $7.50 a day in the US or any other advanced economy, so many of the basic needs of people around the world are met through non-market means such as subsistence agriculture. Note that poorer country GDPs quoted in PPP dollars are considerably higher than if they were quoted in exchange rate US dollars.

Clearly differences in productivity between countries is a major factor in world income distribution. The chart below shows the distribution of average per capita income if 67% of GDP went to personal income in each country. The blue bars are the percent of the world population in each group of countries with the given average GDP per capita, and the orange bars show the percentage of total world GDP in that country group.

[197] This includes income distribution. 2017 PPP dollars. Source: https://pip.worldbank.org/home. Move the slider to $7.50. 3.87 billion people, roughly half the world's population in 2019, earn less than that.

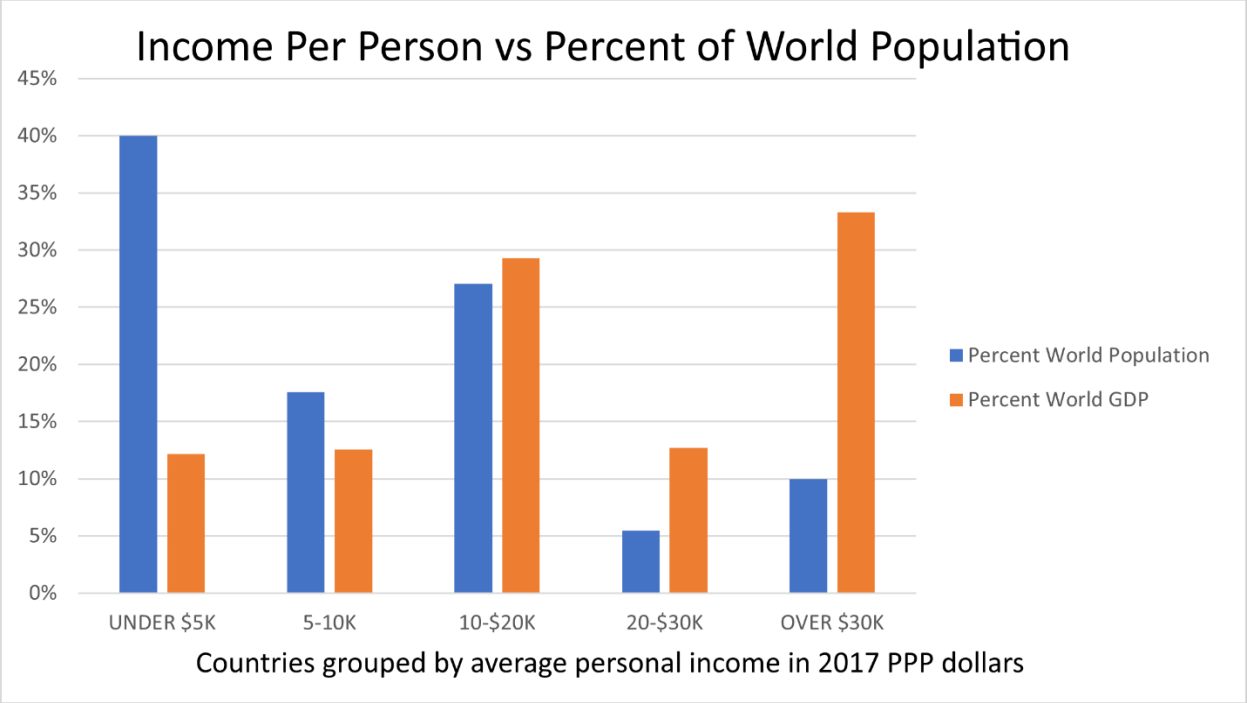


Figure 47: This chart shows population grouped by average annual personal income (calculated as 67% of per capita GDP) for groups of countries, along with the percentage of global GDP for these countries. Sources: World Bank indicator data on GDP per capita in 2017 PPP dollars and country populations in 2019. WW121

Most of the world's population falls into poor countries ($5K is less than $14/day per person in 2017 US purchasing power) and middle-income countries of which China is the largest. As can be seen, the rich countries have nearly 35% of the world's income and output, with 10% of the world's population. The actual median 2019 per capita income worldwide estimated by the World Bank is $7.50/day ($2,738 annual). Currently there are 65 countries with a total population of 3 billion people that don't have a sufficient GDP to provide even that level of income, even if their net national income was completely evenly distributed![198]

Income Distribution Within Countries

In addition to differences in productivity between countries, income distribution varies greatly within countries as we saw for the United States. In the case of the US, we saw that the income distribution was pretty highly skewed toward the upper end, and the US is fairly typical as the chart below shows.

[198] Based on allocating 67% of GDP to personal income. Source: World Bank Indicator Data - GDP per capita, PPP (constant 2017 international $)

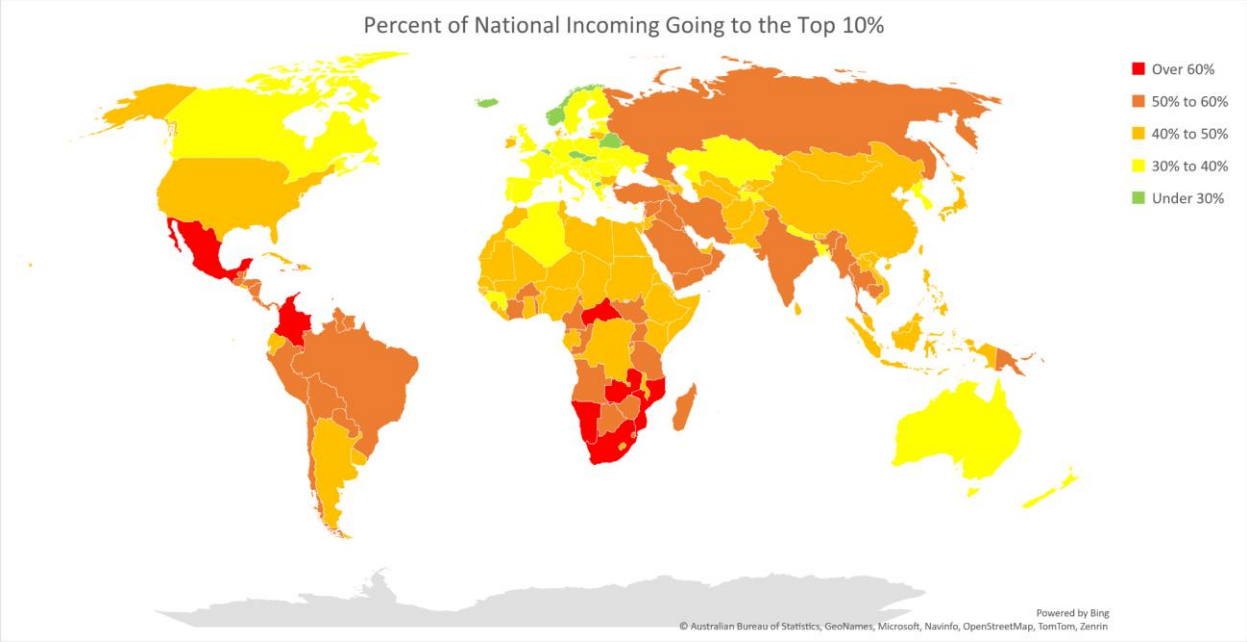


Figure 48: Percent of Income Going to the Top 10% Source: World Inequality Database[199]. WW104

World-wide, some estimates indicate that the top 10% get about half of the world's income[200].

Overall Income Distribution

The combination of differences in GDP per capita between countries, and the skewed distribution of income within countries, determines world income distribution. The World Bank provides an online tool where one can see what portion of the world's population lives below an arbitrary poverty line[201]. The Bank currently uses $2.15/day per person in 2017 PPP dollars as the benchmark for extreme poverty, and by that benchmark, the number of extremely poor people has declined from 2 billion in 1990 to 659 million in 2019. However, if you push the poverty line up to $20/day per person in PPP spending power, the number of people below that line has *increased* considerably, going from 4.4 billion in 1990 to 6 billion today. This is consistent with increases in agricultural productivity and workers moving from agriculture into other relatively labor-intensive lower productivity work while world population continued to grow, a scenario we discussed in the section on productivity convergence[202].

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[199] https://wid.world. Much the same picture emerges from the GINI coefficient, see https://ourworldindata.org/economic-inequality#all-charts.

[200] Based on World Inequality Data as reported in a UN paper that also discusses the various sources for income inequality data and what is included in each. "The Inequality Gap: The Bottom 40 May Be Further Away Than We Thought." n.d. UNDP. Accessed July 29, 2023. While these are pre-tax and subsidies, the main (and substantial) difference between PovCalNet and WID is again due, like the US estimates, to the former being based on surveys and the latter administrative sources. In both the US and World cases, surveys seem to significantly understate the top 10% (and higher) income. https://www.undp.org/library/dfs-inequality-gap-bottom-40-may-be-further-away-we-thought.

[201] https://pip.worldbank.org/home . This is based on actual income levels, not GDP per country.

[202] World population has grown from 5.3 billion in 1990 to about 8 billion today.

The map below shows the median per capita income in PPP dollars by country which puts together the effects of both income distribution between and within countries.

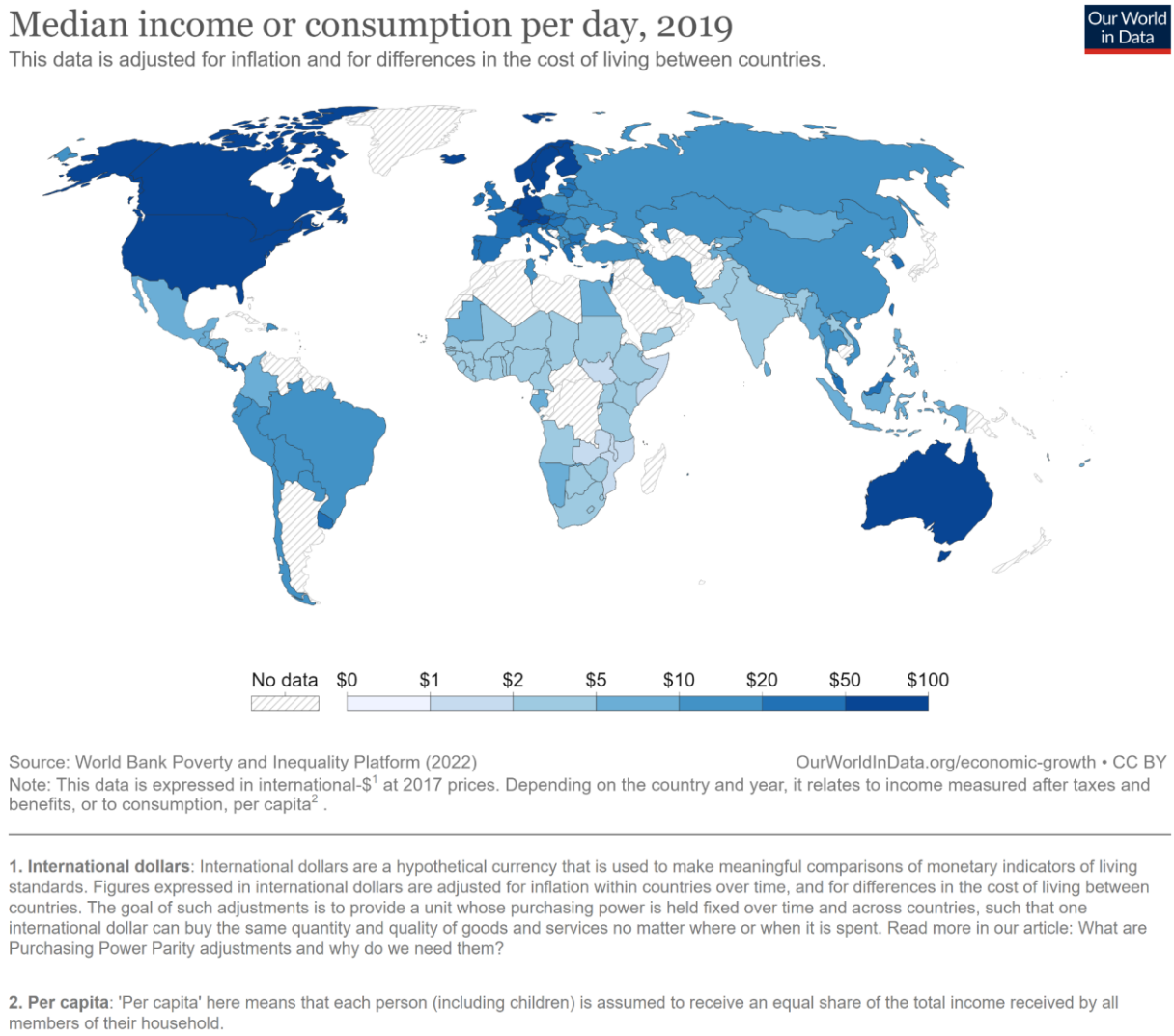

Figure 49: Median income by country in 2017 PPP dollars. Source: Our World in Data visualization of World Bank data https://ourworldindata.org/grapher/daily-median-income?tab=map

This chart, like many of the referenced ones, lets you hover over a country on the web to see its median per capita income, and adjust the year to see changes over time. The skewed legend, which breaks down the $10 increment into 4 categories and the remaining $90 into 3, reflects the skewed distribution of income around the world. By advanced-economy standards, the vast majority of people worldwide are poor.

How has income distribution, both within and between countries changed over time? For a really long look back, the World Inequality Lab has scrunched the numbers since 1820! Here's a chart from their World Inequality Report 2022[203]:

Figure 50: Within Country and Between Country Inequality. Graphic: see footnote 203

Within-country inequality, as measured by the ratio of income between the top 10% and the bottom 50% is back to levels last seen in the early 1900's. The average income of the top 10% is almost 16 times the average income of the bottom 50%. As we have seen in the US, the top 10% income is itself highly skewed. On the other hand, the average income ratio between the top 10% of countries and the bottom 50% reached a peak in 1980 and has since declined. As the author's note, "China ceased to be part of the bottom 50% of the world in 2010, so the continuation of the decline after 2010 is due to the high-growth performance of countries like India, Indonesia, Vietnam, and some (but not all) Sub-Saharan African countries relative to growth rates in rich countries. We should also stress that despite this decline, Between-country inequality remains very high in absolute terms: in 2020, it is roughly at the same level as it was in 1900."

[203] "The World Inequality Report 2022." October 20, 2021. https://wir2022.wid.world/chapter-2/.

Wealth Distribution

Income can be entirely consumed or part of it can be saved. If one saves over a period of time, one accumulates wealth. Economists like to say that income is a flow, and wealth is a stock, by which they mean an accumulation. As individuals we build wealth by saving and investing those savings. Countries also accumulate wealth by investing in, for example, highways or education. Companies too, can accumulate wealth, even though that wealth ultimately belongs to their shareholders.

In addition to the usual types of wealth such as stocks and bonds and mansions, there are other forms of wealth that are quite important and should be kept in mind. Wealth can include[204]:

- Financial Wealth: This is the most common and easily measurable form of wealth. It includes money, stocks, savings accounts, and other financial assets.

- Physical Wealth: Physical wealth comprises tangible assets such as real estate, land, buildings, vehicles, and valuable possessions like art, jewelry, and collectibles.

- Human Capital: Human capital represents the knowledge, skills, education, and expertise possessed by individuals. It can be a significant source of wealth, as people with higher levels of education and skills tend to have better earning potential and career opportunities.

- Social Capital: Personal social capital relates to the value derived from social networks, relationships, and connections. It can provide opportunities, support, and access to resources that contribute to an individual's or organization's wealth. At the national level social capital can include factors such as trust, social cohesion, and the effectiveness of social and political institutions.

- Intellectual Property: Intellectual property, such as patents, copyrights, and trademarks, can be a valuable source of wealth. These assets grant exclusive rights to ideas, inventions, or creative works, allowing their owners to monetize them.

- Natural Resources: In some cases, wealth is tied to the possession of natural resources like oil, minerals, forests, and agricultural land. The exploitation and management of these resources can generate substantial wealth for individuals and nations.

- Health and Well-being: Good health and well-being are often considered a form of wealth. They enable individuals to enjoy a higher quality of life and pursue opportunities for personal and financial growth.

- Time: Time can be seen as a form of wealth. Having control over one's time, such as through flexible work arrangements or retirement, can be highly valuable.

[204] I wish to thank ChatGPT for this list which is only lightly edited.

With the exception of personal social capital and time, all these types of wealth pertain to both individuals and countries as a whole. Estimates of household and country wealth usually only include the net market value of financial and tangible assets, and intellectual property. It is also important to remember that a country's wealth includes public investment or "common wealth", in such things as infrastructure and an educated workforce which are key drivers of productivity and hence income increases.

Current Wealth Distribution

As with income, there are large differences in mean and median wealth between countries as well as a highly skewed wealth distribution within countries and indeed the world as a whole.

Between Countries

As with income, there are large differences in total wealth per person between countries, but the distribution of wealth within countries and regions is pretty similar around the world as shown by the table and chart below.

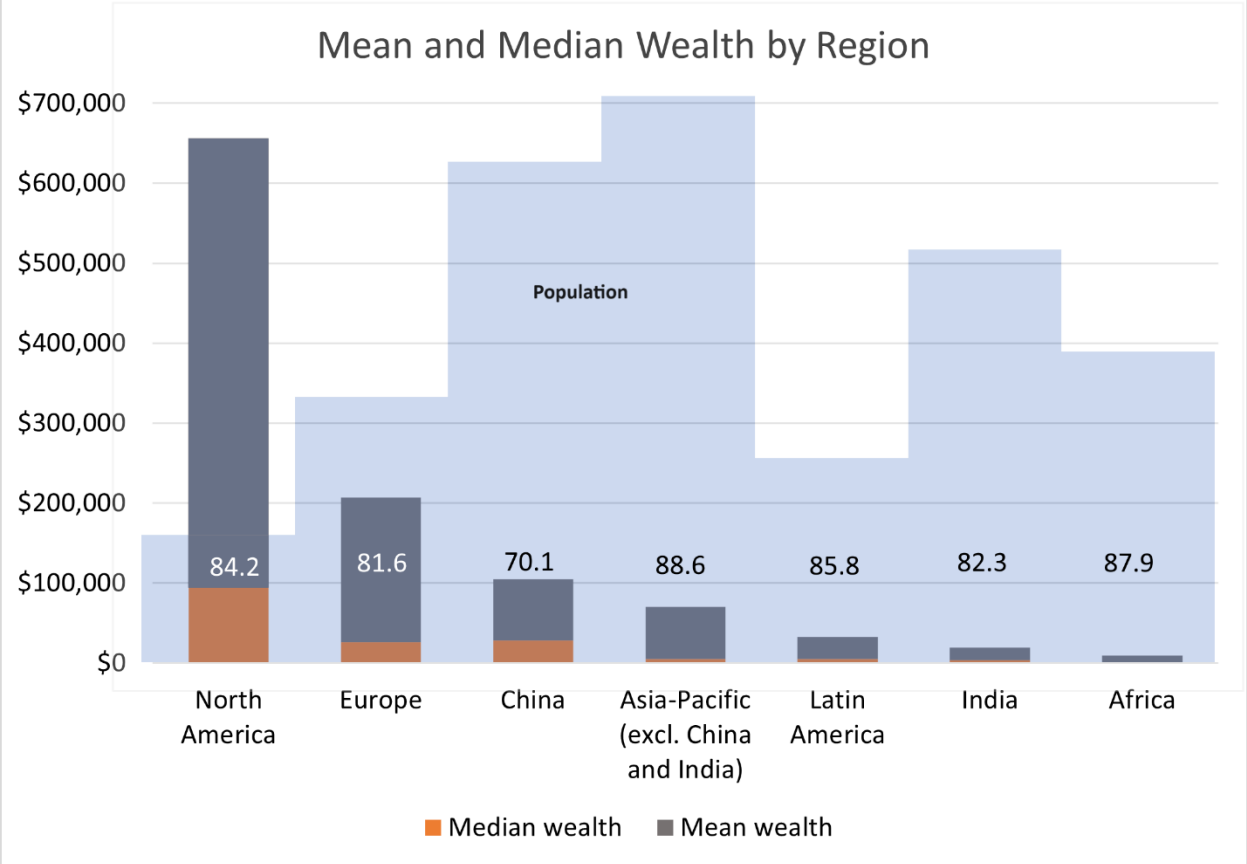

Figure 51: Mean and Median household wealth by region in 2021 US dollars. The Gini coefficient (row of numbers over bars) indicates a level of inequality: 100% is totally concentrated, 0% is totally equal. The blue area shows the relative population of each region. Date Source: "Credit Suisse Global Wealth Databook 2022", table 3-1, as aggregated in the Wikipedia article https://en.wikipedia.org/wiki/List_of_countries_by_wealth_per_adult#cite_note-CS2022-1-1r.WW127

The chart shows the huge differences in mean (i.e. average) wealth between regions. The faded blue background shows the population of each region. In each bar the difference between the median and mean wealth indicates the highly skewed nature of the wealth distribution within the population of that region. Mean wealth (aka average wealth) is total wealth divided by the number of households: it is the wealth every household would have if wealth were evenly distributed. Median wealth shows the midpoint of actual wealth distribution: half of all households have more than this level of wealth and half have less. If the household wealth of China were evenly distributed, the average Chinese household would have as much wealth as the median US household.

The Gini coefficient (row of numbers over the bars) indicates the level of inequality within each region: 100% means one household has all the wealth, 0% is totally equal.

The main purpose of this chart was to show that there are vast differences in average and median household wealth between countries, but even here we see the skewed distribution of wealth within regions and countries.

Between Households

Household wealth distribution for the world as a whole is even more skewed than income distribution.

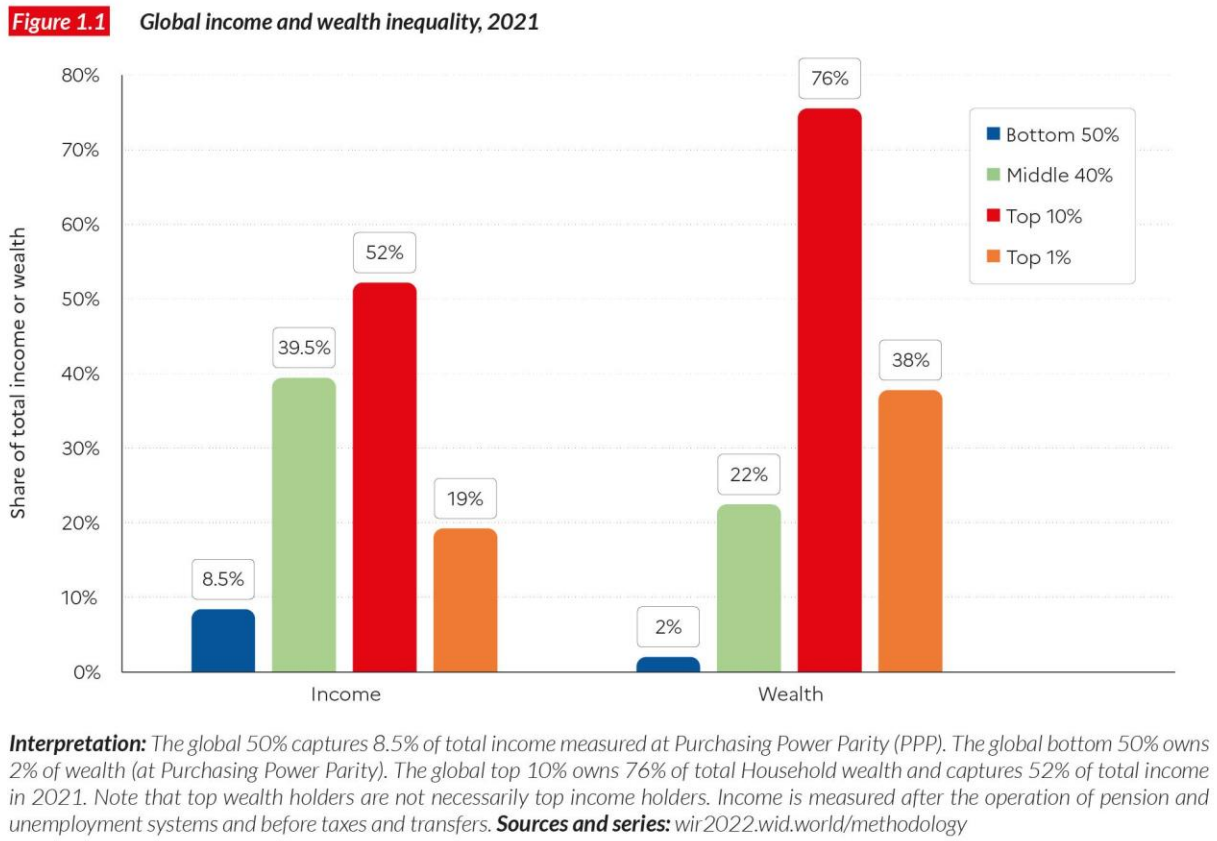

Figure 52: Global Income and Wealth Inequality. Source: "The World Inequality Report 2022." October 20, 2021. https://wir2022.wid.world/chapter-2/. While economists differ in what should be precisely included in wealth, the data sources largely agree in terms of distribution.

This chart shows the global share of income and wealth distribution among households. The top 10% (which includes the top 1%) has 52% of income globally but owns 76% of the world's wealth. Meanwhile the bottom 50% has 2% of global wealth and the middle, between 50% and 90%, has 22%.

As of 2019 the US ratios for wealth were almost exactly the same[205]:

- The Top 10% owns 76% of wealth (12.9 million families)
- The Middle 40% owns 22% (51.4 million families)
- The Bottom 50% owns 1% (64.3 million families of which 13.4million had negative net worth)

[205] St Louis FED reporting on results from the Survey of Consumer Finances. Hernandez, Ana, and Lowell R. Ricketts. 2020. "Has Wealth Inequality in America Changed over Time? Here Are Key Statistics." Federal Reserve Bank of St. Louis. December 2, 2020. https://www.stlouisfed.org/open-vault/2020/december/has-wealth-inequality-changed-over-time-key-statistics.

This distribution of wealth between households is pretty similar across world regions as shown in the chart below. Europe has a slightly bigger percentage of wealth held by middle wealth households, Latin America and MENA (Middle East and North Africa) somewhat less.

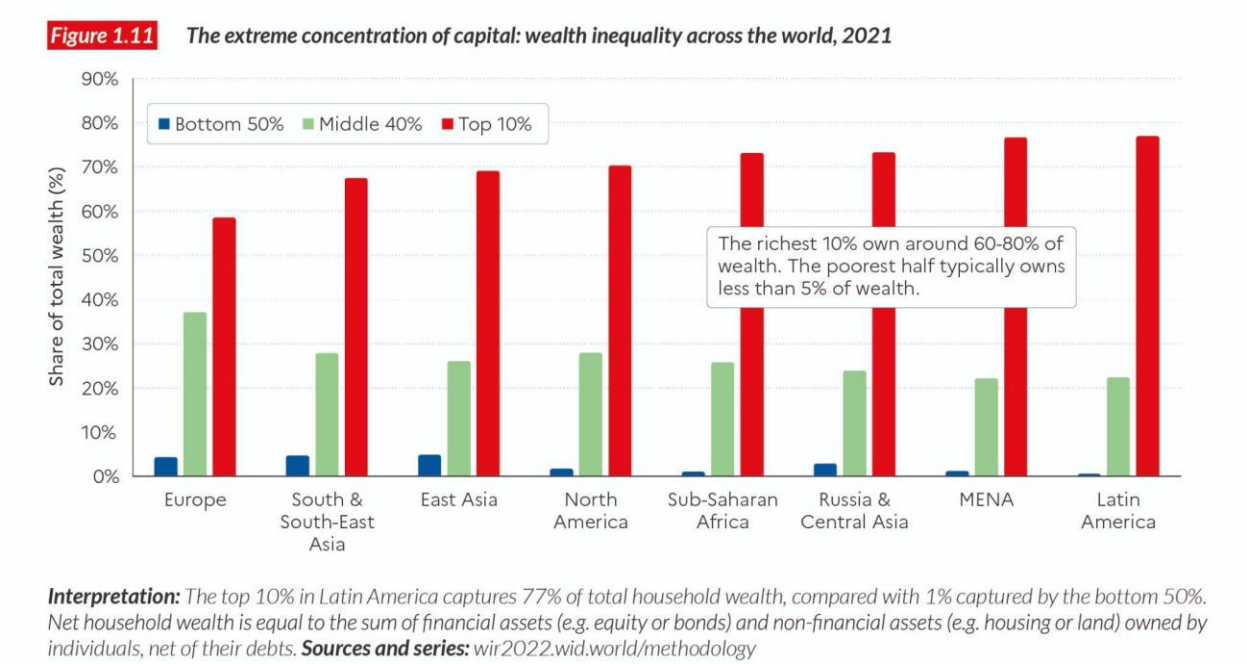

Figure 53: Source: "The World Inequality Report 2022." October 20, 2021. https://wir2022.wid.world/chapter-2/.

Given this uniform concentration of wealth at the top 10% level across countries and regions, one is tempted to wonder if this kind of ratio has persisted over time in relatively free market economies.

Wealth Distribution Over Time

The answer to the last question we asked is yes. Wealth inequality is more the norm than the exception and has persisted over history. Historians Walter Schiedel and Steven Friesen in their article "The Size of the Economy and the Distribution of Income in the Roman Empire" estimate that the top 1% in Rome controlled 16 percent of the wealth[206], although that is admittedly less than half of what America's top 1 percent control now.

More recently Piketty, Saez, and Zucman and others have undertaken the enormous effort of collecting such historical information on income and wealth as can be found and making it as consistent over time as possible, as well as reconciling the data with national accounts. Here is a chart of the top 10% share of wealth from the World Inequality Database.

[206] Scheidel, W., & Friesen, S. (2010). The Size of the Economy and the Distribution of Income in the Roman Empire Journal of Roman Studies, 99 as reported in https://persquaremile.com/2011/12/16/income-inequality-in-the-roman-empire/.

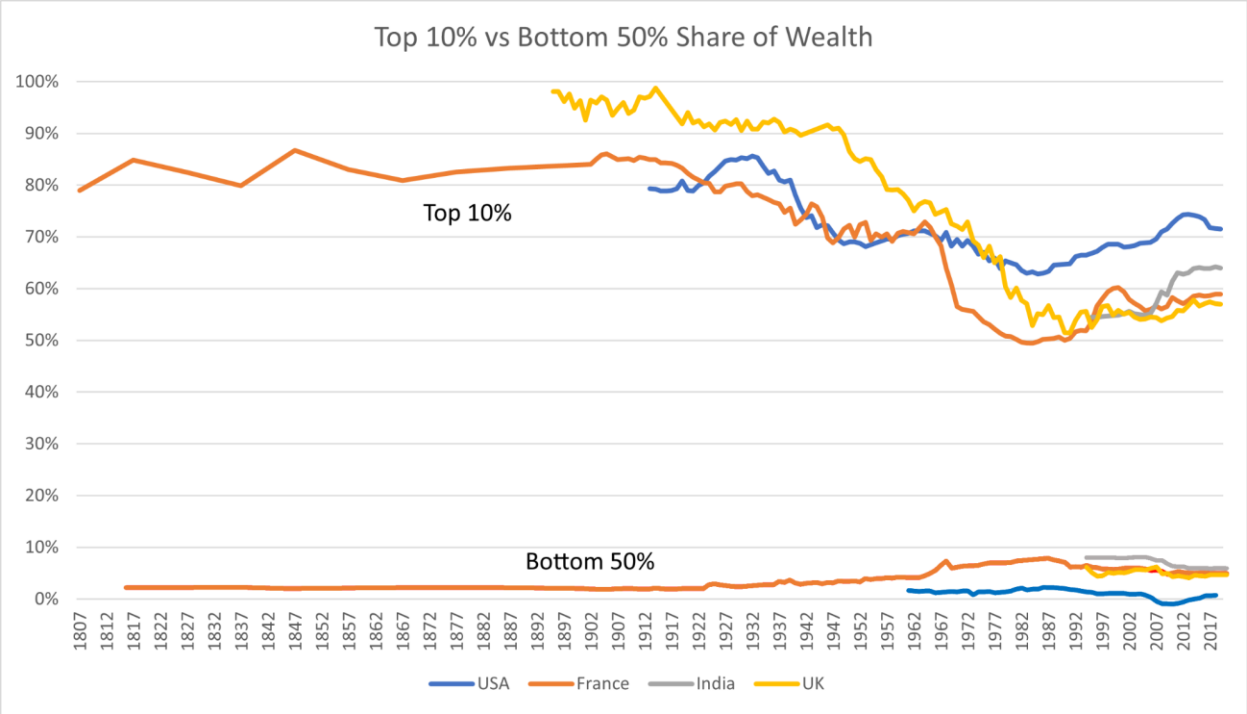

Figure 54: Top 10% and Bottom 50% Share of Wealth, Selected Countries. Data Source: World Inequality Database https://wid.world/

France has been collecting usable wealth data since the early 1800's and the top 10% consistently owned over 80% of it. Consistent with the earlier chart, the bottom 50% has a tiny fraction of the wealth, with the "middle" from fifty percent to ninety percent owning the remaining roughly one quarter, mostly in the form of houses.

Thomas Piketty in his amazing, entertaining, and highly readable book "Capital in the 21st Century", notes that 90% of French national wealth was inherited in 1910 falling to a low of 45% in 1970 but was back up to 72% when he published his book in 2014. Wealth was even more concentrated in Britain at the end of the 1800's with large fortunes kept intact through "primogeniture", or inheritance by the first male heir, and social norms. In the US, too, wealth was highly concentrated. In all three countries, as well as others, the concentration of wealth declined after the first World War and then more rapidly after the second World War, but has started to increase again since the 1980's. There are a number reasons for the declines in wealth concentration before the 1980's, they include the increased economic growth rate after the wars which tends to dilute existing fortunes and public sentiment which turned against concentrated wealth and resulted in legislation and tax structures that sought to reduce predatory practices (think antitrust in the US) and reduce the size of fortunes over time (think high marginal tax rates). More recently productivity growth rates have fallen, as we've seen, and at least in the US, effective marginal tax rates have fallen, especially on capital income. Both factors would tend to increase wealth concentration, as would the already noted unequal growth of incomes. The last few decades have also seen notable increases in the value of housing and equities.

The concentration of wealth in the upper 10% is not all a story of truly huge fortunes. While the top 1% own 38% of wealth, another 38% is owned by the richest 90-99 percent with a net worth that goes up with age, as is to be expected. The median net worth of the top 10% of US families was $2.6 million in 2019 according to the FED's survey of consumer finances, but that includes the top 1%.

The top fortunes in the world are a mix of "new" and "old" money. It is easy to think of new money fortunes, in the Forbes Real-Time Billionaires[207] list the top entries in order include Elon Musk (self-made), Bernard Arnault and Family (French, started with a modest fortune and turned it into $223 billion, so sort of old and new money), Jeff Bezos (self-made), Larry Elison (self-made), Bill Gates (self-made), Warren Buffet (self-made per Forbes). In fact, if you go down the list and click on each name Forbes will tell you the source of these billionaires' wealth and in most cases follow that by "self-made". The billionaires list is international including, for example, Zhong Shanshan, worth $64.6B who dropped out of elementary school in China and worked as a construction worker, newspaper reporter, and beverage sales agent before starting his own bottled water company.

Forbes also publishes the American top 400 list, all billionaires, which includes a "self-made score" which runs from 1 to 10 with scores 1-5 being "inherited" and 6-10 being "self-made". In 2020 they ranked the 400 like this:

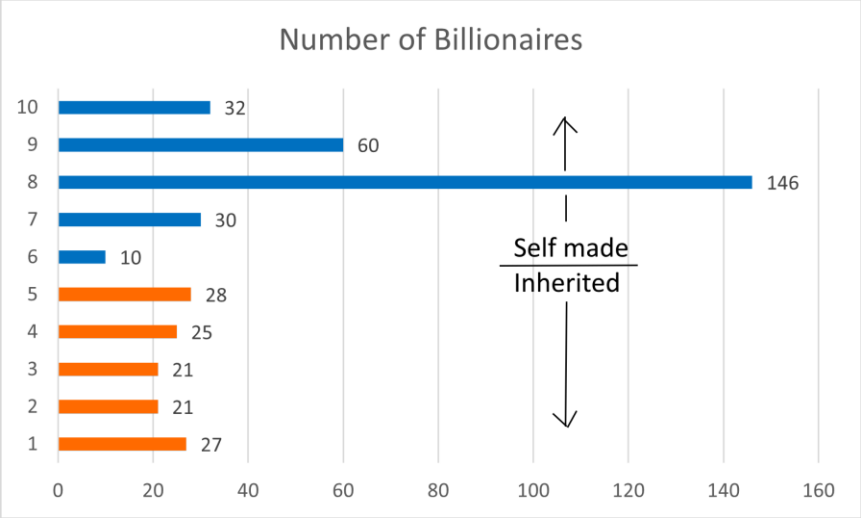

Figure 55: Forbes 400 Richest Americans by "Self-Made" Score: 1-5 being "inherited" and 6-10 being "self-made". Data Source: https://www.forbes.com/sites/jonathanponciano/2020/09/08/self-made-score/?sh=3af1105f41e4

The run-away top ranking is 8, which Forbes describes as "Self-made who came from a middle-class or upper-middle-class background: Mark Zuckerberg & Jeff Bezos". Scores 9 and 10 are

[207] https://www.forbes.com/real-time-billionaires/#73b3b3aa3d78

for people who rose from nothing such as Carl Icahn, Patrick Soon-Shiong, George Soros and Oprah Winfrey.

Altogether in 2020, there were 122 on the 400 list who mostly inherited versus 278 who were mostly self-made. Forbes notes:

"When we first created the self-made score, we went back and assigned scores for the members of the 1984 list. Less than half of them were self-made. By 2014, 69% of the list was deemed self-made. Fast forward to the present list, and that figure has inched up to 69.5%. All but one of the 18 newcomers this year [2020] are self-made."

Some of the inheritors on the list include members of the Mars and Cargill families, a couple of the privately held companies we mentioned earlier in discussing income distribution. It is clear from this Forbes list that "new money" outweighs "old money" in these top fortunes.

While the top of the wealth ladder is heavily populated by people who rose from more or less humble beginnings, overall, there is a strong correlation between your parent's wealth and your wealth later in life. This is hardly surprising, most wealth is passed on, especially since, in most countries including the US, inheritance taxes are now pretty minimal. Estimates of inherited wealth as a fraction of total national wealth range from 20% to 40%, which of course implies that 60% to 80% of national wealth is "new" wealth but that doesn't mean that this new wealth didn't grow from old wealth, indeed much of it did. If you inherit a business worth $20 million (in current dollars) at age 30 and build it to a $400 million business by age 60, you have accumulated $380 million in "new" wealth. Even if you just sold the business and invested the money at a net 8% interest, you would have accumulated $180 million in "new" wealth.

The increasing concentration of wealth observed has many worried that we're seeing the accumulation of new "dynastic" wealth heavily concentrated in a limited number of families. What does the data say?

To answer this question, one really needs to look at families over time, and such longitudinal datasets which follow the same people over the years are very few in number.

A 2022 Bank of America study of 1,052 people in a representative sample of household with investable assets of more than $3 million, found that 28% of them came from affluence with an inheritance, 46% came from the middle class with some inheritance (or from affluence, but hadn't yet inherited wealth), and 27% were from middle class or poor families[208]. Net worth of $3 million is close to the average for the upper 10%.

A number of economists have based studies of the source and evolution of higher levels of wealth on a Norwegian administrative dataset that has collected wealth and income information

[208] "2022 Bank of America Private Bank Study of Wealthy Americans." n.d. https://ustrustaem.fs.ml.com/content/dam/ust/articles/pdf/2022-BofaA-Private-Bank-Study-of-Wealthy-Americans.pdf.

since 1994. This data makes it possible to follow single individuals over their working lifetimes from their twenties into their fifties. Some of the conclusions, at least for Norway[209]:

- Labor income is the most important determinant of wealth up to the 99% level.
- Above the 0.1% level, most wealth (and income) is from equity, in particular privately owned businesses.
- Again, there is a significant mix of “new money” and “old money” among people who in their 50’s are in the top 0.1% of wealth for their age bracket. Of the 0.1%, about one fifth were below the 75% level of wealth in their late 20’s and can be called “new money” while 29.2% were already rich in their late 20’s, almost entirely from family money. Someone who was in the 0.1% when young had 292 times the chance of being in the 0.1% when in their 50’s as the average person[210].
- Few people, five percent, who were in the 0.1% when young fell to the 75% level or below in their 50’s.
- Not surprisingly, those who were wealthy when young saved more and earned higher rates of return on their investments than the less fortunate.

This still doesn’t tell us if we’re building “dynastic” wealth, because we’re not looking across multiple generations, but it’s clear that a significant portion of the wealthy at the 0.1% level come from modest backgrounds, but also that the rich tend to stay that way.

Piketty and others have argued that the recent growth in wealth concentration stems from the rich getting a higher rate of return on their investments than the general growth rate of the economy. Again, in terms of a pie, if the capital slice of the pie grows at a certain rate, the rest of the pie has to grow as fast for the slice to remain proportional. But it looks like much of the recent growth in wealth at the top has come from “new money” rather than returns on “old money”. And the increasing inequality of labor income further contributes to concentration of wealth at the 10% level.

It is only possible to answer the question of what happens to family wealth over time by looking at data, and even then, the answer will be specific to that time period and country. One such study uses the estate data records of families with rare surnames in England between 1858 and 2012. The authors show that there is a high persistence of wealth across generations, but that over long periods of time large fortunes become relatively smaller fortunes.

[209] Mostly from Elin Halvorsen, Joachim Hubmer, Serdar Ozkan, and Sergio Salgado. 2023. “Why Are the Wealthiest So Wealthy? A Longitudinal Empirical Investigation.” FEDERAL RESERVE BANK OF ST. LOUIS. https://research.stlouisfed.org/wp/more/2023-004.

[210] Interestingly, inheritances did not contribute much to “lifetime resources” as recorded in the data. Using other data and inference, the authors concluded that in fact family wealth was being passed to young people at an early age and called this “unobserved intergenerational transfers”.

The average estate of the rich group went from 55 times the average of all estates in the mid 1800's to 4.6 times the average in 2012[211] . The authors conclude that while the rich are still wealthy 5 generations later:

... there is nothing in English history 1858-2012 to suggest that wealth inheritance itself explains most of current wealth. In all periods wealth creation de novo accounts for most wealth.

They also conclude that the reversion of family lineage wealth to the mean is slow in England because the rich go to good schools, live in rich neighborhoods, and become doctors and lawyers[212]. In short, they have more opportunity to earn and save and build wealth because they have a lot of social capital, which is still quite important in Britain, and probably worldwide.

While this is just one study of a particular population, it jibes well with the Norwegian findings. The picture we get is that it certainly helps to be born into a rich family, that wealth in family lineages dissipates slowly over time on average (yes, many rich get richer), but that there is always substantial new wealth being created in the modern world. Given the rate of technological change, growth rates in the developing world, and the ability of new fortunes to be rapidly built, these conclusions do not appear surprising.

Economic Mobility

Current Mobility

For almost all people around the world, income comes mostly from labor, and their "wealth" is built from saving and investing from a labor income. "The American Dream", is an amorphous concept but in economic terms it usually refers to "the belief that anyone, regardless of where they were born or what class they were born into, can attain their own version of success in a society in which upward mobility is possible for everyone."[213] But, as we all know, the playing field isn't level. While it is true, as we've seen, that people with extraordinary abilities can rise to great wealth from almost any country and background, in the aggregate children of poor people tend to have lower incomes and wealth than children of better off parents. That said, the extent to which children's earnings reflect their parents varies between countries and over time. What can we say about current economic mobility and its determinants?

First of all, it is important to differentiate between absolute and relative incomes. As the economy grows, one would expect children to earn more in real terms than their parents even if

[211] The research is documented in Clark, Gregory, and Neil Cummins. 2015. "INTERGENERATIONAL WEALTH MOBILITY IN ENGLAND, 1858–2012: SURNAMES AND SOCIAL MOBILITY." *The Economic Journal* (582): 61–85. These quotes are from an unpublished paper based on that research.
[212] As quoted in Doward, Jamie. 2015. "Inheritance: How Britain's Wealthy Still Keep It in the Family." *The Guardian*, January 31, 2015. https://www.theguardian.com/society/2015/jan/31/inheritance-britain-wealthy-study-surnames-social-mobility.
[213] This elegant formulation is from Investopedia https://www.investopedia.com/terms/a/american-dream.asp.

they are in the same position on the earnings scale relative to their peers. In other words, if I'm in the 5th percentile of earnings now, I will still make more than my parents who were also in the 5th percentile at the same time in their lives, at least if GDP per capita has gone up in the meantime and inequality hasn't changed. That is called "absolute" income mobility. By contrast, "relative" income mobility relates to how closely a child's earnings are tied to their parents. If my parents were in the 5th decile of earnings, how likely is it that I'll be in the top 10 percent?

We've looked at absolute income mobility in our discussion of GDP per capita growth and its distribution over the working population. In the US, for example, we've seen that GDP per capita has increased but so has income inequality, so that absolute intergenerational income has increased more for the top of the income distribution than it has lower down in the distribution.

What do studies say about relative intergenerational income mobility?

Income mobility is often measured by looking at the correlation of parent and child income. Let's say Bob's father made twice as much as Ted's (100% more). Then if Bob now makes twice as much as Ted, the correlation is perfect, a correlation of 1. If Bob only makes 50% more than Ted, then the correlation is .5, if he makes 20% more the correlation is .2. Of course, this statistic is estimated by using income data on a lot of fathers and sons. Looking at how this statistic is measured reveals some obvious problems. For example, why fathers and sons rather than family incomes? Also, it is clear that long term income data is needed for both the parents and children since income varies over a lifetime. It is hard to get such data, especially in comparable form.

Economists are well aware of these issues and do their best to account for them. Given the caveats, here is a chart that shows income persistence, the correlation we just discussed, plotted against income inequality as measured by the Gini index. It's often called "The Great Gatsby Curve". In the chart, inequality goes up towards the right, and "income persistence" or the lack of mobility goes up toward the top. Norway, Denmark, and Finland are at the low end of inequality and have the most intergenerational income mobility, the United States is towards the middle and several South American countries are at the high end, with high inequality and low income mobility.

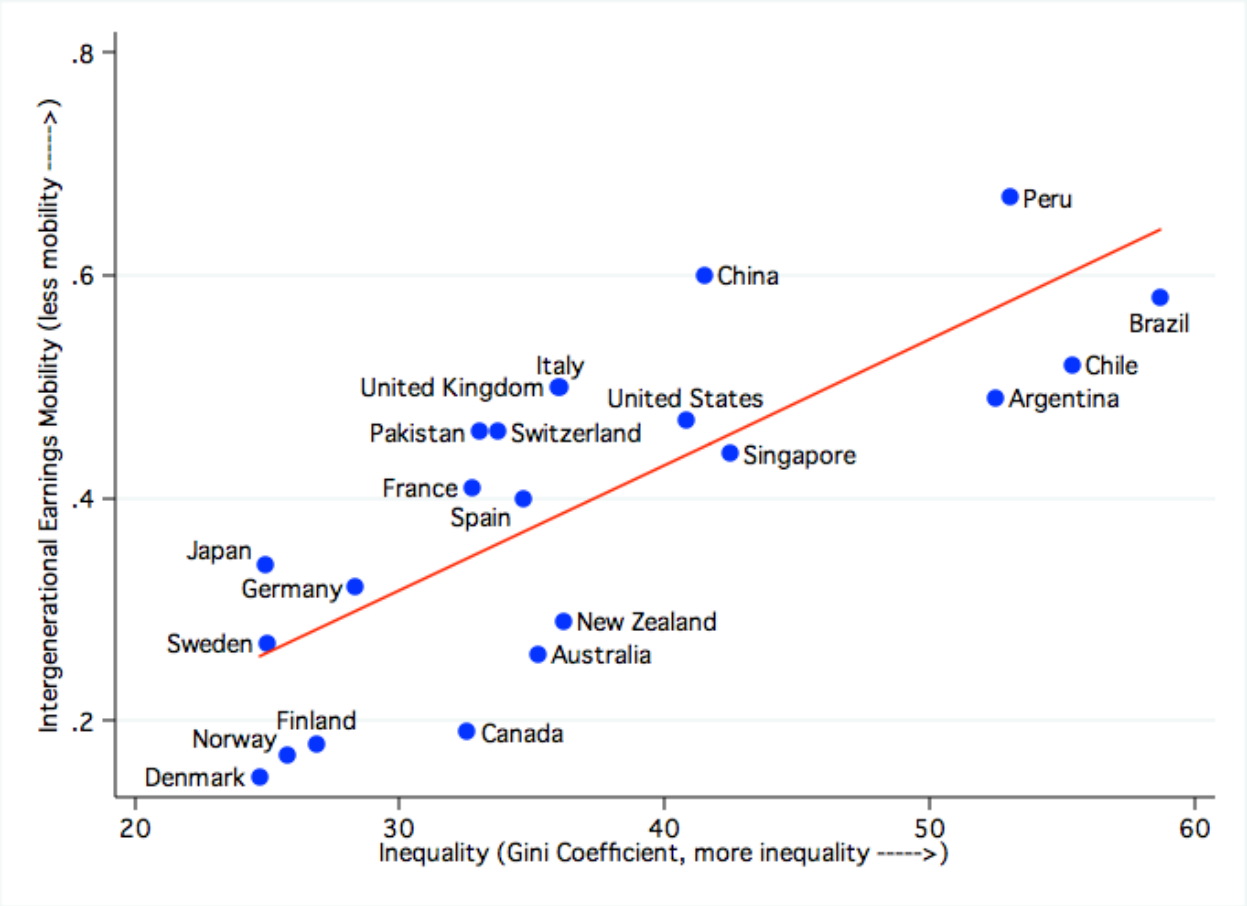

Figure 56: The "Great Gatsby Curve" - Intergenerational income persistence (more persistence means less mobility) plotted against income distribution inequality. Source: Miles Corak blog post and paper[214]

It is not surprising that high income mobility and lower income inequality go hand in hand: if everyone earned nearly the same income, the small differences remaining would be unlikely to correlate with parents' income. At the other end of the spectrum, high income inequality often indicates that at least part of the population isn't able to climb the economic ladder easily. Peru, which sits high on the income inequality scale and low on the mobility scale is oddly a country that has made great strides in reducing poverty: absolute mobility is high because people's incomes have grown, but relative mobility is low since the same groups tend to stay in the same place on the economic ladder. In Peru, as in many countries, some rural areas are economically depressed, and children that stay close to home have limited opportunity to grow their incomes. Also in many countries, there are groups that are at a disadvantage because they aren't fully

[214] Corak, Miles. 2016. "Inequality from Generation to Generation: The United States in Comparison." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2786013. Also Here is the source for the "Great Gatsby Curve" in the Alan Krueger speech at the Center for American Progress on Jan 12, 2012. A similar chart is in the World Bank "Fair Progress?" report on page 141.

integrated into the economy for one reason or another. In Peru, native speakers have significantly less mobility than Spanish speakers[215].

Worldwide, it is very difficult to get income data on parents and their children over generations, so major studies of income mobility tend to look instead at factors that correlate with it. The World Bank's 2018, 300-page, study of economic mobility relies heavily on educational mobility which correlates strongly with income mobility in countries for which both measures are available[216]. Educational mobility data is far more widely available than income data. We should note that correlation does not equal causation: it is not necessarily true that increasingly widespread education results in more widespread earnings opportunity, but they do go hand in hand. The study finds that, in the aggregate, there is good news and bad news worldwide. To quote a few results: *Sons and daughters are on average better educated than their parents almost everywhere. However, the developing world today is roughly where the high-income world was 40 years ago*. *Gender gaps in educational mobility are closing fast. Mobility from the bottom half of the education ladder to the top quartile has fallen over time in developing economies, whereas persistence at the bottom has increased.* The study also finds that average relative mobility for economies in South Asia and Africa is significantly lower than that for the other developing regions, and that in in several developing economies, mostly in Africa, the Middle East, North Africa, and Latin America, income mobility trails behind educational mobility which suggests that jobs making use of the extra education aren't available.

Another large study of worldwide mobility by the World Economic Forum avoids the statistical correlation route entirely and looks instead at factors that can be reasonably assumed to increase or decrease social mobility[217]. These include such indicators as health access, adolescent birth rate, education and its quality, technology access, work opportunities, fair pay, and measures of political corruption and stability. By assigning scores to each area, say "percent of rural population with electricity", the report comes up with a ranking for countries by social mobility which correlates well with the income mobility we see in The Great Gatsby Curve, but spans many more countries. This report, like others, shows the Nordic countries and parts of Europe outperforming the rest of the world in mobility. Further down the list, of the 82 countries ranked, Canada ranks 14, the US 27th, China ranks 45th, and South Africa ranks 77th. The report estimates that *if countries included in this report were to increase their social mobility index score by 10 points, this would result in an additional GDP growth of 4.41% by 2030 in addition to vast social cohesion benefits.* The rankings also show that: *countries that*

[215] Economic Mobility and Fairness in a Developing Country: Evidence from Peru IZA DP No. 16465 available at https://docs.iza.org/dp16465.pdf. This deals with wealth mobility but income and wealth mobility are correlated.
[216] World Bank Group. 2018. "Fair Progress? Economic Mobility across Generations Around the World." World Bank Group. https://www.worldbank.org/en/topic/poverty/publication/fair-progress-economic-mobility-across-generations-around-the-world.
[217] "Global Social Mobility Index 2020." 2020. World Economic Forum. January 19, 2020. https://www.weforum.org/publications/global-social-mobility-index-2020-why-economies-benefit-from-fixing-inequality/.

adhere to the "stakeholder capitalism" model tend to perform better than countries with a focus on "shareholder value maximization" or "state capitalism"[218]*.*

There are many interrelated factors that underlie economic mobility, as The World Economic Forum report indicates, and these will differ between countries. However, it is generally agreed that one consistent factor "explaining" intergenerational income mobility is simply a country's wealth. In general, economic mobility is higher in richer countries than in poorer ones, so economic development benefits both absolute economic mobility (higher pay in successive generations) and relative mobility (chance to do better than your parents on the income scale) of people in developing countries[219]. But even among countries at the productivity frontier there are clear differences in mobility which do not correlate neatly with how rich the country is, as is apparent from The Great Gatsby Curve and the results we've discussed above. For example, Canada has considerably more intergenerational income mobility than the US[220].

Why Are Income Mobility and Lower Income Inequality Linked?

Since income inequality and mobility are so closely correlated, one might think that anything that decreases income inequality would also tend to increase mobility. But the causal relationship could go the other way: increasing income mobility could drive down inequality. Actually, both are almost certainly true as a couple of thought experiments show.

Let's suppose we could somehow make income inequality go away. If every family had the same income, kids would pursue education and earn incomes based on their interests, talents, and preferences rather than being constrained by economics relative to other families. Since their parents all had the same incomes, the children's relative incomes would tend to be randomly higher or lower, and not by much, which would essentially allow for complete income mobility as we've defined it. Other things being.

On the other hand, if we could wave a wand and remove all impediments to children pursuing any career or business as freely as children in different economic circumstances, in short remove the link between parent's incomes and children's potential incomes, then income inequality would also tend to decrease. Why? Because there would be a greater supply of, say, dentists thus driving down dentists' incomes (I beg the forgiveness of dentists). Other things being equal.

[218] Global Social Mobility Index 2020 page 5. See the discussion later in this chapter on the Nordic Countries.
[219] See page 2 in World Bank Group. 2018. "Fair Progress? Economic Mobility across Generations Around the World." World Bank Group. https://www.worldbank.org/en/topic/poverty/publication/fair-progress-economic-mobility-across-generations-around-the-world.
[220] For a discussion of possible reasons, see Corak, Miles. 2016. "Inequality from Generation to Generation: The United States in Comparison." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2786013.

It should be clear that the two thought experiments amount to much the same thing. Policies that increase mobility or decrease inequality both tend to drive countries down The Great Gatsby Curve.

Now in both cases I mentioned "other things being equal". What "other things" than parents income inequality drive kids' income inequality in the aggregate? In addition to the many indicators used in the World Economic Forum study, kids will have different talents and interests and preferences, but we assume that applies to all kids equally. Some authors point out that there could be cultural differences among groups that influence their choices of, and aptitude for, certain professions. My personal feelings are that people adapt pretty quickly to opportunity. A more important "other thing" is capital income. By focusing on labor income, we've implicitly left out capital income, which is quite substantial. We'll include that shortly. A third "other thing" is the distribution of opportunity geographically. As we mentioned in the case of Peru, there are depressed sections of the country, and this will tend to increase income inequality and reduce calculated overall mobility. And a final "other thing" we have to mention is the treatment of groups within an economy. People with certain accents or features or other differences may not be fully integrated into an economy as we mentioned is the case for Peru's indigenous language speakers.

In looking at income mobility in rich countries, many studies have focused on the high mobility and low-income inequality of the Nordic countries, often in contrast to the US. Denmark is one of these countries.

One of the main reasons why intergenerational mobility is higher in Denmark is precisely because inequality of incomes is lower. Below is a sample of occupations taken from the list we saw earlier in this section. For each occupation, the ratio of full-time wages in that occupation to the lowest paid occupation is shown for the US and Denmark.

Table 16: ratio of wages compared to lowest wage occupation in the US and Denmark. Source: US Bureau of Labor Statistics, The Mobile Statbank - Earnings by occupation, sector, salary, salary earners, components, sex and time[221]

Occupation	US Relative Pay	Denmark Relative Pay
Family Medicine Physicians	9.17	2.81
General Internal Medicine Physicians	8.66	2.81
Chief Executives	8.34	3.86
Dentists	7.87	2.38
Registered Nurses	3.33	1.57

[221] The Danish wage information is from 2013, but while wages go up year to year, the ratios don't change much.

Loan Officers	3.28	1.83
Buyers and Purchasing Agents	3.00	1.75
Firefighters	2.35	1.47
Sheet Metal Workers	2.34	1.33
Carpenters	2.27	1.38
Postal Service Mail Carriers	2.24	1.25
Mental Health and Substance Abuse Social Workers	2.22	1.52
Childcare Workers	1.10	1.11
Cashiers	1.05	1.00
Cooks, Fast Food	1.00	1.20

Scandinavian earnings were not always so compressed. What is now called the Nordic model was quite consciously developed over time starting in the 1930s. There is a high level of unionization in these countries now and wages are negotiated by representatives of labor, employers, and the government. Trade union "density" is 67% in Denmark and 12% in the US. Other aspects of the Nordic model include a strong social safety net which actually makes it easier for companies to hire and let go workers as needed in response to business opportunity. While unemployment benefits are generous, they are not unlimited, everyone is expected to work if they can. High levels of taxation support benefits that are available to everyone and not tied to income. These benefits include high quality education and healthcare, housing allowance and elder care. As almost any economics piece on the Nordic model will tell you, surveys of happiness put these countries at the top of the list. These are all capitalist countries with private ownership of business[222]. US GDP per capita was $70,248 in 2021, while Norway's was $89,154, so the Nordic model certainly doesn't have a negative effect on productivity.

We began this section by defining the American Dream as a society where anyone can get ahead by hard work. Let us conclude the section by looking in detail at a study of how economic opportunity is distributed in the US in comparison with the Nordic countries and the United Kingdom[223]. This study looked at how often sons and daughters of parents from one income quintile (for example the bottom 20%) move into another income quintile (for example, the 60% to 80% income quintile). The income persistence numbers we've been looking at are single numbers and don't tell us if opportunity is distributed differently at different levels of income, but looking at how often sons and daughters move out of the quintile in which they were born does tell us that. Only earnings were included, not transfers. To make sense of the results, remember

[222] Brief introductory information on the Nordic model can be found on Investopedia and Wikipedia as well as the Danish government web site, https://denmark.dk/society-and-business/the-danish-welfare-state

[223] Jantti, Markus, Bernt Bratsberg, Knut Røed, Oddbjørn Raaum, Robin A. Naylor, Eva Osterbacka, Anders Bjorklund, and Tor Eriksson. 2006. "American Exceptionalism in a New Light: A Comparison of Intergenerational Earnings Mobility in the Nordic Countries, the United Kingdom and the United States." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.878675.

that if opportunities were equally distributed one would expect children from every economic background to be equally likely to end up in any of the quintiles. In other words, 20% of kids of parents in any quintile would end up in each quintile. Diving right in, here is a summary of the results. Like other studies, this one shows that overall mobility is lower in the US than the UK which in turn has lower mobility than the Nordic countries. In all the countries persistence is high at the top quintile of the income distribution, in other words kids of the well off are likely to end up earning like their parents. Perhaps surprisingly, mobility is quite similar between the US, UK, and Nordic countries in the middle of the income distribution. What really sets the US apart is that mobility out of the lowest income quintile group is much lower in the US than in the other countries. This applies to men in particular. While the results for women suffered from a lack of data, the study concludes that *daughters born into poor families in the U.S. have a much higher probability of climbing up the income distribution than their brothers have. The out-of-poverty mobility for women is almost at the same level as for the other five countries, i.e. around 75 per cent*.

In other words, intergenerational mobility was about as good for the US middle class as it was in the Nordic countries using data from the time period in question. Since wages, even before taxes and benefits, are much less equal in the US than the Nordic countries the differences between quintiles in dollars is also much larger here, which could well explain why us middle class Americans feel like the American Dream is alive and well. Our kids can grow up to be surgeons and earn big bucks. However, that is far less likely if you're born to poor parents in the US compared to the Nordic countries.

Finally, none of this relates specifically to starting and growing a business.

"When the World Bank ranks countries on ease of doing business, based on criteria such as starting a company, dealing with construction permits, getting credit, trading across borders, enforcing contracts, or paying taxes, the Nordic countries consistently rank among the most business-friendly nations in the world. In fact, on those criteria, American entrepreneurs would be better off in Denmark, which scored higher than the US in the 2015 ranking."[224]

Overall if by the American Dream we mean opportunity for all, the US is no longer exceptional or even a particularly good example.

There is one group for whom both the US, the Nordic countries, or indeed any rich country, provides an extreme and immediate huge boost in income mobility for both parents and children, and that is migrants. When migrants leave a poor country for a rich one, they immediately boost their incomes and their kids' opportunities. We'll look at this in the next chapter.

[224] Finnish journalist Anu Partanen in her book, "The Nordic Theory of Everything - In Search of a Better Life" as quoted in Forbes in 2016 https://www.forbes.com/sites/eshachhabra/2016/07/24/why-the-nordics-are-the-best-place-to-run-a-business-and-live/?sh=2ac988891ed9

Migration

Introduction

People, as they have always done, move from country to country, or internally within a country, leaving one location to settle or work in another[225]. Overall, in 2020, about 3.6 percent of the world's population lived in a country other than the one they were born in, up somewhat from the 2.8% in 1995[226]. While not a large percentage globally, that still amounts to 281 million people in 2020, roughly the population of Indonesia, the 4th most populous country in the world. This number includes emigrants, who are people that have moved permanently to another country (80 million in 2019), overseas workers, who work for a period of time in another country and then return home (169 million)[227], and refugees who flee wars and natural disasters (32 million).

With the exception of refugees, most migrants live and work outside their native country for economic reasons and greater opportunities. Not surprisingly, two thirds of migrants settle in high income countries, with over 60% of migrant workers located in western Europe, North America, and the oil rich Arab States.

The United States hosts the largest number of migrants in the world, about 46.6 million in 2015, or about 14.5% of the population, but a number of wealthy countries, such as Canada, Australia, and Germany host more migrants as a percentage of their populations. Much of what applies to the economics of migration in the United States applies to immigration to wealthy countries in general, for that reason we will look at US immigration in detail before taking a more general look at world migration.

A note on terminology. An *immigrant* is a person who has moved permanently to another country from their country of birth. They are *emigrants* from their country of birth. The term *overseas worker* is used when referring to migrants from sending countries, while we will use the term *guest worker* when speaking about these same migrants from the point of view of the receiving country. International *migrants* include anyone who currently resides outside the country of their birth, which includes immigrants, overseas workers, and refugees. In the US, there are far more immigrants than guest workers, but that is not true everywhere: the oil rich Arab countries allow only guest workers, for example.

[225] In the US each year about 14% of the population moves which is about equal to the entire accumulated immigrant population. We will not be looking at internal migrations, although it is an interesting subject and lends insight to the benefits of migration between countries.
[226] https://worldmigrationreport.iom.int/wmr-2022-interactive/ accessed Mar 3, 2023
[227] Many of these "overseas workers" may become permanent residents in countries that allow for such as status.

US In-Migration

The Numbers

Given all the noise about immigration in the US, one might think there has been major change over the last few decades. There hasn't been. Here are the numbers of authorized permanent residents allowed into the US by year since 1900 as a percent of the population:

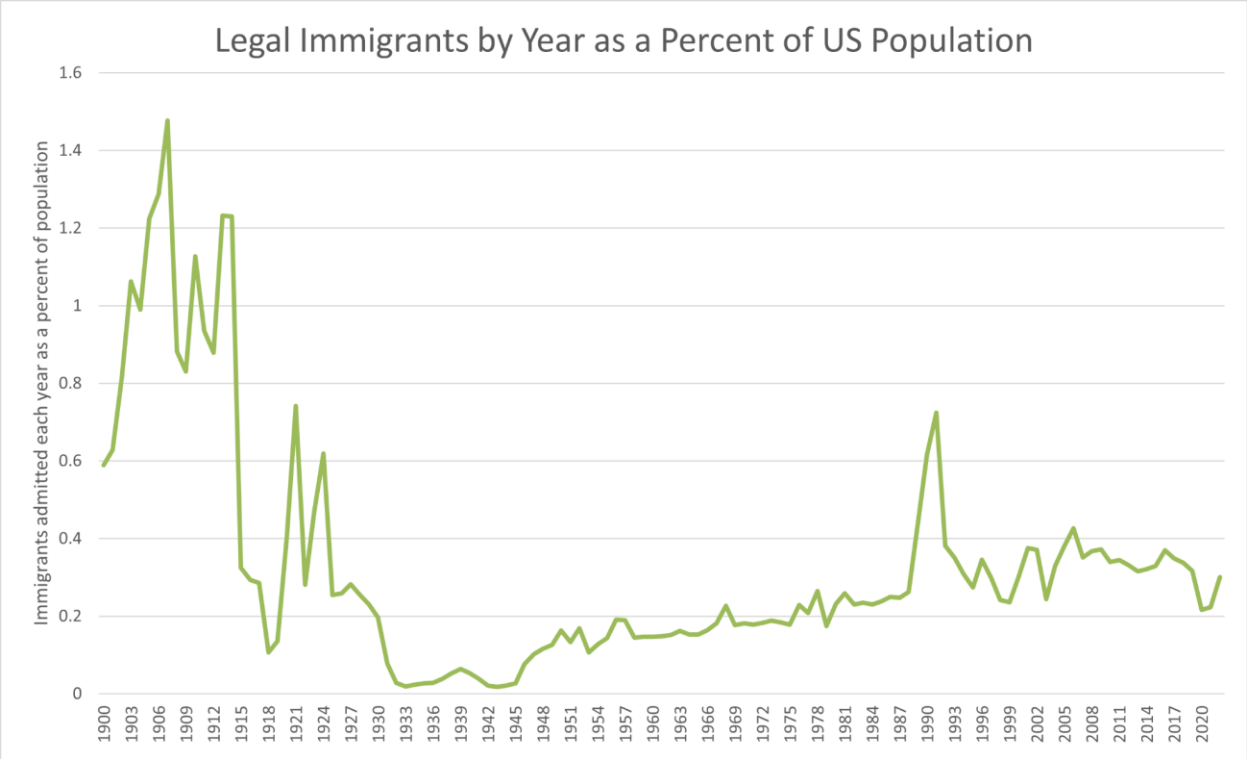

Figure 57: Legal Permanent Residents Accepted by Year as Percent of Population 1900-2022. Source: Migration Policy Institute Data Hub tabulation of Department of Homeland Security data. WW105

From the time of European settlement until after the civil war, there was no restriction on the number of immigrants to the US, in fact the country sought to encourage European immigration. In the 1880's the US passed legislation excluding the Chinese, who had been actively sought as workers on the transcontinental railroad a couple of decades earlier. The 1880's also allowed for the exclusion of immigrants "likely to become a public charge". In the early 1900's, as the chart shows, there was a large influx of immigrants, many from southern Italy. In the 1920's, after World War I, a quota system was implemented which severely restricted the number of immigrants and favored immigrants from certain countries, mostly Northern and Western European ones, and limited immigration from Southern and Eastern Europe, Asia, and Africa. Given the unemployment of the Great Depression, anti-immigrant sentiment ran high.

In 1965 Congress passed the Immigration and Nationality Act (aka the Hart-Celler Act) which scrapped the former country-based quotas. The bill was passed with bipartisan support from

Republicans and Northern Democrats and opposed by Southern Democrats who at that time represented the racist South.

The Hart-Celler Act set the main principles for immigration regulation still enforced today. It applied a system of preferences for family reunification (75 percent), employment (20 percent), and refugees (5 percent) and for the first time capped immigration from within the Americas[228]. This act was tweaked twice by Congress, first in 1986, under Reagan, to increase enforcement including fines for employers who hired illegal immigrants as well as providing amnesty for unauthorized immigrants (hence the spike on the chart above shortly after), and in 1990, under HW Bush, to increase the total number of immigrants allowed, and increase the number of visas for professionals. It is important to understand that immigration numbers are, and have been, determined by law through these Acts of Congress. If an immigrant meets the requirements set in these acts, they have to be admitted. Simply put, it's the law and only Congress can amend it.

As the chart above shows, currently authorized immigration into the US is about 0.4% the size of the US population, or roughly one million people a year. The chart below shows the breakdown since 2012:

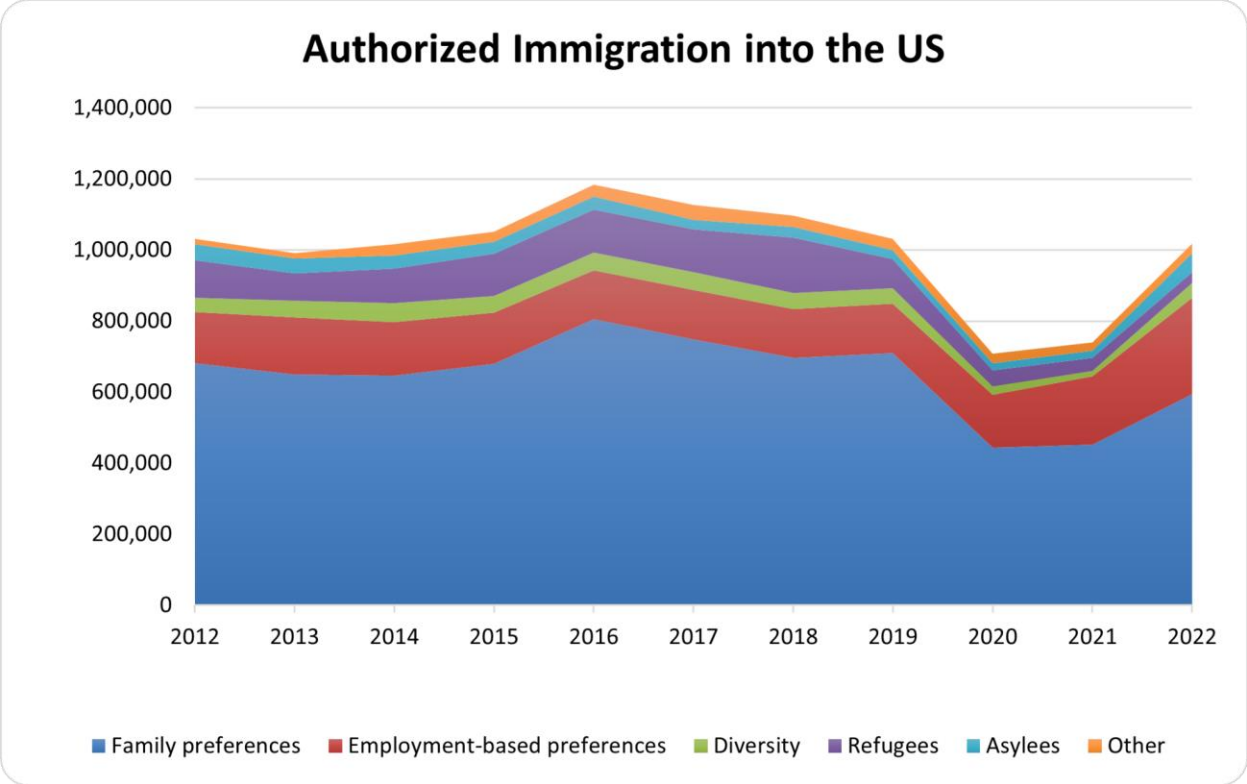

Figure 58: New Permanent Residents by Class of Admission. Source: Department of Homeland Security Office of Immigration Statistics. WW106

[228] See "Timeline." 2018. Immigration History. The University of Texas at Austin Department of History. February 27, 2018. https://immigrationhistory.org/timeline/. Also https://en.wikipedia.org/wiki/Immigration_and_Nationality_Act_of_1965

Several things are clear from this chart. Family and employment preferences account for the vast majority of permanent residents admitted while refugees (who apply from outside the US) and asylum seekers (who apply from inside the US) are a small fraction of those admitted. It is also evident from both the long term and short-term charts that immigration is hardly affected by which political party holds sway. The chart also helps explain why immigrants fall disproportionately into high skilled and low skilled groups. The roughly 140,000 immigrants admitted annually under employment preferences, many of them graduates of US universities, are by definition highly skilled. Immigrants accepted under family preferences often fall at the lower end of the "skills" continuum, at least as measured by years of education.

To recap, the US accepts about a million authorized immigrants a year in accordance with rules enacted by Congress in 1965 and amended in 1986 and 1990. These immigrants are accepted under family and employment-based preferences, a small percentage of immigrants are refugees and asylum seekers.

In addition to Lawful Permanent Residents admitted, there is a much larger flow in and out of non-immigrants which includes tourists and business travelers (70,056,257 admissions in 2017), students (1,845,739 admissions in 2017), and temporary workers (3,969,276 in 2017)[229]. It should be noted that these are total admissions, and, in many cases, the same individual will cross the border several times in one year[230]. The tourists and business travelers are a major boost to the US economy, in fact our trade surplus in services is partly due to foreign tourists spending more here than US tourists spend abroad. There are also unauthorized immigrants, both those that manage to cross undetected at the southern border and a larger group that overstays visas. While it is difficult, for obvious reasons, to get exact numbers for the flow of these unauthorized immigrants, the Department of Homeland Security estimates that the illegal immigrant population increased by 470,000 per year from 2000 to 2007, but only by 70,000 per year from 2010 to 2015. Currently, there are about 11 million unauthorized immigrants in the US, the majority of them here for over 10 years[231]. The total immigrant population currently stands at around 46 million, which is around 14% of the total population, having risen from 11.1% in 2000 and a low of 4.7% in 1970. This is near a historic high as shown in the chart below. The US has the highest number of immigrants of any country in the world, although not the highest percentage at 14%. Other countries with high immigrant percentages include Saudi Arabia (39%), Australia (30%), Canada (21%), Sweden (20%), Germany (19%), and Ireland (18%)[232].

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[229] Source: U.S. Department of Homeland Security Yearbook 2017 https://www.dhs.gov/immigration-statistics/yearbook/2017 see Table 25

[230] For an estimate of the number of individuals and other details see Teke, John, and Waleed Navarro. n.d. "Nonimmigrant Admissions and Estimated Nonimmigrant Individuals: 2016." Accessed January 29, 2023. https://www.dhs.gov/sites/default/files/publications/Nonimmigrant%20Admissions%20and%20Estimated%20Nonimmigrant%20Individuals%20Fact%20Sheet%202016_0.pdf.

[231] https://www.factcheck.org/2018/06/illegal-immigration-statistics/

[232] This includes all the foreign born who have lived in the country for a year or more. Note that by this definition, the US has an immigrant population of 15%. Data is from https://www.un.org/development/desa/pd/content/international-migrant-stock via Our World in Data.

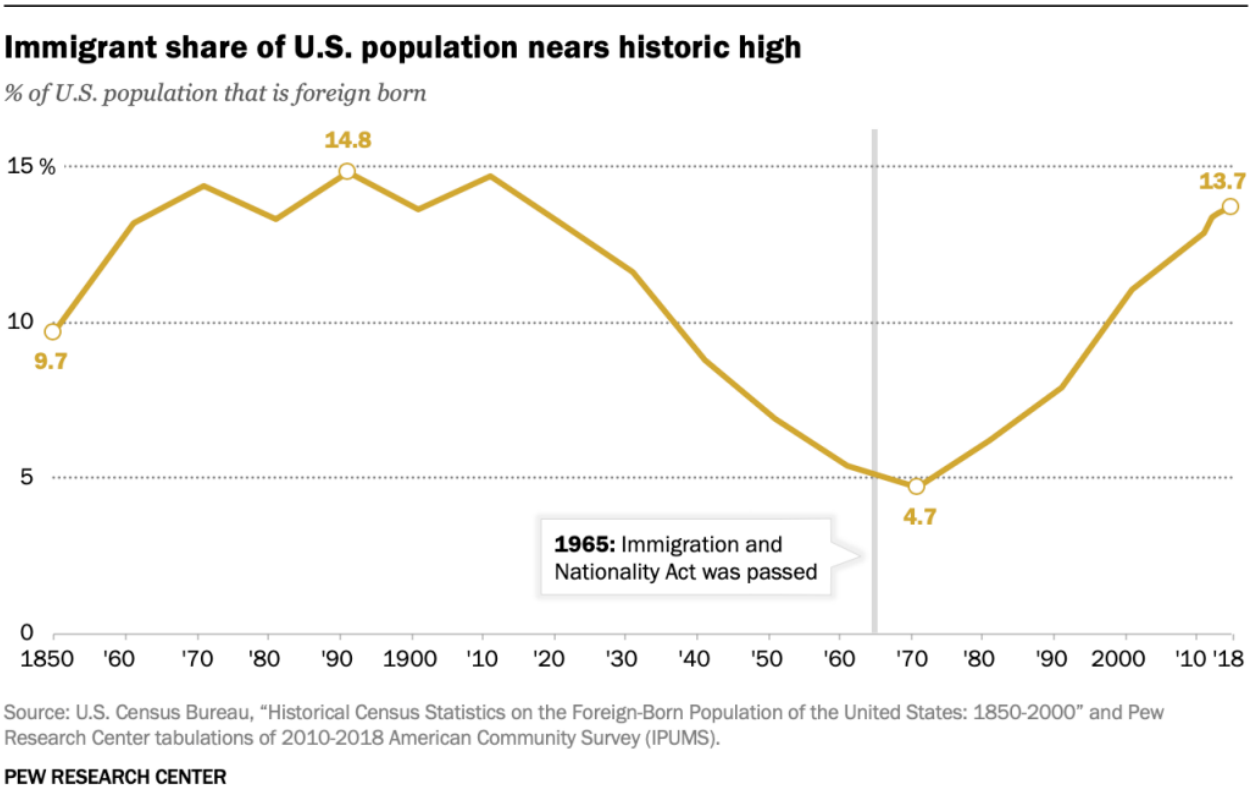

Figure 59: Immigrant Share of US Population. Graphic: PEW Research Center

Authorized (and as shown below, unauthorized) permanent residents, as well as guest workers, are considered essential by US business and farm interests. To quote from the US Chamber of Commerce recently:

American employers of all sizes and across a host of industries are facing chronic workforce shortages that significantly limit the ability of their businesses to grow. The vast shortcomings of our legal immigration system are a key contributing factor as to why companies are struggling to hire and retain the talent they need to succeed in an increasingly competitive global marketplace. As demand for workers has increased in recent years, the outdated and arbitrarily low visa quotas, onerous compliance burdens, decades-long backlogs, and obsolete eligibility requirements that pervade employment-based visa programs leave many companies out in the cold when it comes to adequately meeting their workforce needs[233]*.*

The American Farm Bureau Federation also calls for immigration reform, to increase the number of farm workers, noting:

[233] https://www.uschamber.com/immigration/calling-on-congress-fix-americas-broken-immigration-system accessed 1/29/2023.

The impacts of an enforcement only approach to immigration would be detrimental to the agricultural industry. If agriculture were to lose access to all undocumented workers, agricultural output would fall by $30 to $60 billion....

Many migrants who begin their careers as farm laborers move onto other sectors of the economy or less demanding positions after several years. This progression leads to farmers often being the first to bear the negative economic impacts of decreased border crossings and migrant labor shortages[234].

These quotes are a clue to the confused politics of immigration in the US. Business and large-scale farming have traditionally been associated with the Republican party and they call for more foreign workers to be let in, both as immigrants and temporary workers. On the other hand, the more recent populist wing of the Republican party is generally associated with anti-immigration sentiment. The Democratic party is also somewhat conflicted. Traditionally, the Democratic party represents labor, and labor unions have often favored limiting immigration to protect domestic workers. Progressive Democrats are concerned with humane treatment of immigrants and pathways to citizenship for long term unauthorized immigrants and their children.

In short, US immigration quotas are set by law, and building a wall on the southern border won't do much when the large majority of immigrants and temporary workers are authorized (i.e. "legal"), and most of the unauthorized immigrants are overstaying valid visas. There have been several attempts in Congress to overhaul immigration policies, but these have gone nowhere, which is not surprising given the business interest in, and agricultural need for, foreign workers.

As mentioned, a small percent of immigrants is let in as refugees or asylum seekers, but even a low chance of entry is worth the risk for many who are desperate to escape real persecution and crime, or who in fact come as economic migrants. This has resulted in much publicized issues at the southern border. However, in accordance with US laws and quotas, few of these migrants are actually admitted as permanent residents[235].

[234] "Agriculture Labor Reform." n.d. American Farm Bureau Federation. Accessed January 29, 2023. https://www.fb.org/issue/labor/agriculture-labor-reform.

[235] It is widely believed that the refugee system worldwide, as laid out in United Nations documents following World War II, is broken. See Katz, Matt. 2020. "The World's Refugee System Is Broken." The Atlantic, February 29, 2020. https://www.theatlantic.com/international/archive/2020/02/japan-refugees-asylum-broken/607003/.

The US Migrant Surge of 2022-2023

The number of legal permanent residents accepted into the US has hardly changed over the last 30 years. 1,090,172 new permanent residents were accepted in 1989 and 1,018,349 were admitted in 2022, with the average being almost exactly one million per year, including during the Trump administration (see Figure 58). Recently there has been a much-reported surge in migrants seeking entry into the US. Please refer to the footnotes for a number of good "explainers" which detail the who and why of this surge and how it is being handled. What follows is a very brief overview of this complicated subject.

The section of US law that deals with immigration is Title 8. During COVID a provision of the Public Health Service Act of 1944, Title 42, was used to summarily deny entry to immigrants during the "health emergency", including migrants applying for asylum[236]. The COVID "health emergency" was declared over in May of 2023 and Title 42 could no longer be used to circumvent the provisions of Title 8. The surge started in 2021, two years before the end of Title 42[237]. What is causing it?

Several factors are "pushing" and "pulling" migrants to attempt entry into the US both at official border crossings (legal attempts at entry), and by illegally crossing between points of entry. The US Customs and Border Protection (CBP) is tasked with intercepting illegal border crossings and refers to such interceptions as "encounters"[238].

Until fiscal year 2021, most illegal crossings were by migrants from Mexico, El Salvador, Guatemala, and Honduras, but in the last couple of years these migrants have been joined by large numbers from Venezuela, Nicaragua, and Cuba. Migrants are "pushed" by conditions in their home countries. All these countries except Mexico are very poor. The Central American countries of El Salvador, Guatemala, and Honduras, have, in addition to poverty and hunger, extremely high murder rates fueled by gang violence, political corruption and instability. Back-to-back major hurricanes in 2020 fueled food insecurity, and climate change is expected to add further to economic declines in future[239].

The "pull" factors to the migrant surge include the booming job market in the US after the end of COVID. A second pull factor is a 2022-2023 "parole" program that accepts up to 30,000 Venezuelans, Nicaraguans, Cubans, and Haitians a month into the US for up to two years provided they have a sponsor here. People accepted into this program can fly directly to the US avoiding the pile up at the border[240]. Why these countries? Like the Central American countries these are economic basket cases, but the US has embargoes against all of these countries, except Haiti, which has made conditions worse, and naturally has made these countries less likely to accept back refugees. These embargoes are a political holdover from the cold war, all three were "leftist" even if they are just dictatorships now. Removing the embargoes would help ease conditions and allow more repatriation of refugees. The murder rate per 100,000 in Cuba is 4.2 compared to 7.4 in Florida, and 17.3 in Guatemala. The reimposition of sanctions against Cuba in 2017 is a direct driver of the flow of what are basically economic migrants from that country now[241].

It should be noted that neither parole nor applications for refugee status and asylum have led to a significant increase in migrants accepted for legal permanent residence, but none-the-less such migrants have to be treated according to the laws of the country. The surge has caused overloading of the systems in place to deal with migrants. The laws regarding

migrants were put in place by Presidents and Congresses of both parties and need to be updated in a bi-partisan manner.

One final note is that the US is far from the only country with a surge in migrants. Seven million Venezuelans have left their country since 2015, mostly settling in nearby countries much poorer than the US. Canada has also experienced a surge in migrants, and Mexico has to deal with the huge wave of migrants not accepted into the US. European countries also have to deal with large waves of migrants from the Middle East, Africa, and Ukraine. The best way to reduce migration is to reduce the wars and economic collapses that foment it.

Economic Effects in the US

Immigration, like trade, can hurt certain groups of domestic workers as we saw in the primer. One example is provided by the meat packing industry in the US. More than a century ago, Sinclair Lewis wrote "The Jungle" about the Chicago meat packing industry, which at that time was dangerous and dirty and largely conducted by immigrants. Over time, the meat packers unionized and, as noted by Eric Shloser in an article in the Atlantic, "by the early 1970s, a job at a meatpacking plant offered stable employment, high wages, good benefits, and the promise of a middle-class life."[242] Eric goes on the describe what happened next:

As I described in my book Fast Food Nation, published in 2001, the largest companies in the beef industry had recruited immigrants in Mexico, brought them to the meatpacking communities of the American West and Midwest, and used them during the Ronald Reagan era to break unions. Wages were soon cut by as much as 50 percent. Line speeds were increased, government oversight was reduced, and injured workers were once again forced to remain on the job or get fired.

The same thing happened in poultry processing. In December 2001, the New York Times reported that:

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[236] https://www.adl.org/resources/tools-and-strategies/what-title-42-and-what-does-it-have-do-asylum?gad_source=1&gclid=Cj0KCQiA1rSsBhDHARIsANB4EJa9gmeXdYGztMG-RIeNpu8xt1XtpLtVHzMB-ohIf8fNRN_AEolGZF0aAgJaEALw_wcB&gclsrc=aw.ds

[237] https://www.nytimes.com/interactive/2023/10/29/us/illegal-border-crossings-data.html

[238] There were over 2 million "encounters" in fiscal years 2022 and 2023 when Title 42 was still largely in effect. Title 42 does not penalize recurrent illegal border crossings, but Title 8 does, so many of the Title 42 encounters were repeated attempts.

[239] Council on Foreign Relations https://www.cfr.org/backgrounder/central-americas-turbulent-northern-triangle

[240] https://immigrationforum.org/article/the-reasons-behind-the-increased-migration-from-venezuela-cuba-and-nicaragua/

[241] https://immigrationforum.org/article/the-reasons-behind-the-increased-migration-from-venezuela-cuba-and-nicaragua/

[242] Schlosser, Eric. 2019. "Why It's Immigrants Who Pack Your Meat." The Atlantic, August 16, 2019. https://www.theatlantic.com/ideas/archive/2019/08/trumps-invasion-was-a-corporate-recruitment-drive/596230/.

The government charged the company (Tyson Foods Inc.) and six of its employees with conspiring to transport illegal immigrants across the Mexican border and help them get counterfeit work papers for jobs at more than a dozen Tyson poultry plants. The indictment said that, to meet production and profit goals, Tyson officials would contact local smugglers near its plants to get more workers[243].

Clearly the domestic workers in the unionized meat packing industry were hurt by this exploitation of immigrants.

As in trade, however, one also has to look at the flip side: meat prices were almost certainly lowered for consumers, who could as a result afford more beef and chicken. In the case of trade, we wanted to see if trade increased the average productivity of workers as predicted by comparative advantage. With immigration we can ask the same thing. If average productivity increases as a result of immigration, then on average we are better off because we produce more stuff per person than we would if immigration had not occurred, and vice versa. Unfortunately, it is very difficult to isolate the productivity contribution of "immigrants" which are a diverse group which changes over time and includes both workers with little education, and high skilled workers here under different immigration preferences. To quote the National Academies of Sciences 2017 book "The Economic and Fiscal Consequences of Immigration" which is an excellent review of the literature:

The effects of immigration have to be isolated from innumerable, simultaneously occurring influences that shape local and national economies. Beyond this measurement challenge, the relation between immigration labor inflows and market outcomes is not a constant; it varies across places and immigration episodes, reflecting the skill set of incoming immigrants and natives in destination locales, a given market's mix of industries, the spatial and temporal mobility of capital and other inputs, and the overall state of the economy[244].

While some economists argue on theoretical grounds that "low skilled" immigrants will hurt overall productivity, much depends on whether new immigrants take jobs that complement or compete with jobs held by people already in the country, be they earlier foreign-born immigrants themselves (as we or our forebears all were at some point) or native born. It is also important to remember that over time immigrant families, especially the children, become "just like everyone else" economically and the economy simply expands, so any productivity and wage effects of immigration are limited to the continuing flow of new immigrants.

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[243] Barboza, David. 2001. "Meatpackers' Profits Hinge on Pool of Immigrant Labor." The New York Times, December 21, 2001. https://www.nytimes.com/2001/12/21/us/meatpackers-profits-hinge-on-pool-of-immigrant-labor.html.

[244] National Academies of Sciences, Engineering, and Medicine, Division of Behavioral and Social Sciences and Education, Committee on National Statistics, and Panel on the Economic and Fiscal Consequences of Immigration. 2017. The Economic and Fiscal Consequences of Immigration. National Academies Press. Page 25

Despite the difficulties, economists have conducted statistical studies to try to quantify the effect of immigration, diverse as it is, on productivity, wages, employment, growth, and government spending.

Sorting the results from those with the most consensus to those with the least:

Immigration has not negatively affected overall employment levels[245]. Now, in early 2023, there is in fact a worker shortage in the US. As we have seen, business and farm interests are begging for more workers. The country is having a hard time finding workers for specific low pay occupations such as health aides and farm workers.

Immigration has caused overall GDP growth. No surprise here, more workers result in more output, as well as more consumption. In fact, without continued immigration, the US population would start falling, and GDP might very well stagnate or shrink. As explained later, this is because the native birth rate in the US, at 1.7 children per woman, is below the replacement rate of 2.1 children per woman, as indeed it is in most advanced economy countries. While overall GDP grows with immigration, that doesn't tell us anything about per-capita GDP which determines average income, it just says total output is higher. One estimate is that immigrants increased GDP by $2.3 trillion in 2017[246].

Immigration has had little effect on wages for most "native born" workers, but probably has a negative ongoing impact on specific groups of native-born and prior immigrants with less education. Most of the studies of the effect of immigration on wages have looked at what are referred to as "low skilled"[247] workers. Since there is no way to know what wages would have been in the absence of immigration for various groups of workers, economists use a variety of techniques to try to identify any immigration related wage effects. All of these techniques have their difficulties as the National Academies of Sciences review points out in considerable detail, and results vary considerably from study to study[248]. We will quote from that book's conclusion:

When measured over a period of more than 10 years, the impact of immigration on the wages of natives overall is very small. However, estimates for subgroups span a comparatively wider range, indicating a revised and somewhat more detailed understanding of the wage impact of immigration since the 1990s. To the extent that negative wage effects are found, prior immigrants—who are often the closest substitutes for new immigrants—are most likely to experience them, followed by native-born high school dropouts, who share job qualifications

[245] National Academies of Science, 2017, Page 5
[246] Borjas, George J. 2019. "Immigration and Economic Growth." Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w25836. Table 2.
[247] Many studies use years of education to assign a skill level, we will use "years of school" to identify "skill level" when that is the case. Other studies assign skill level by occupation. For example, carpenters and construction workers are classified as skilled, while metalworkers and textile workers are classified as unskilled.
[248] National Academies of Science, 2017, Chapter 5

similar to the large share of low-skilled [fewer years of school] workers among immigrants to the United States [249]

Regarding the less studied effects of high-skilled [more years of school] immigration (recall that immigrants tend to fall disproportionately into low and high skilled extremes) the book concludes:

Several studies have found a positive impact of skilled [more years of school] immigration on the wages and employment of both college-educated and non-college-educated natives. Such findings are consistent with the view that skilled immigrants are often complementary to native-born workers, especially those who are skilled; that spillovers of wage-enhancing knowledge and skills occur as a result of interactions among workers; and that skilled immigrants innovate sufficiently to raise overall productivity. However, other studies examining the earnings or productivity prevailing in narrowly defined fields find that high-skilled immigration can have adverse effects on the wages or productivity of natives working in those fields.[250]

In short, workers, both native born and earlier immigrants, in occupations where new immigrants are competitive, can see wages suppressed somewhat. The wage suppression that econometric studies have calculated range from a reduction of 1.4% to a wage increase of .3% for each additional 1% inflow of immigrants. These studies, and the wage impacts they calculate, are almost all limited to the effect on native high school dropouts or specific skills, and often just men[251]. Estimates of the wage effects of immigrants with high levels of education are few and far between and the literature usually focuses on the benefits to the larger economy of such immigrants.

Table 17: Percent of the US workforce that were immigrants in 2012. shows the percent of immigrant workers in major occupations. It is clear that some occupations rely pretty heavily on immigrant labor.

Table 17: Percent of the US workforce that were immigrants in 2012.

Occupation	Share foreign born in 2012
Across All Occupations	15.8%
High-level professionals	19.4%

[249] National Academies of Science, 2017, Page 5
[250] National Academies of Science, 2017, Page 6
[251] National Academies of Science, 2017, Page 242, Table 5-2

Professionals	11.8%
Managers	10.5%
Sale workers	11.6%
Service workers	26.9%
Farmers and farm laborers	32.6%
Skilled workers	22.7%
Unskilled workers	29.0%

Table Notes: Overall, 15.8% of workers are foreign born, so immigrants tend to cluster in occupations with percentages higher than that. In this listing “skilled workers” are classified by occupation rather than years of schooling. For example, carpenters and construction workers are classified as skilled, textile machine and metal workers as unskilled.
Source: National Academies of Science, 2017, Page 97, Table 3-2

It is clear from this table why the American Farm Bureau values immigrants.

Effects of Immigrants on Government Spending

In addition to the effect of immigrants on wages, economists have also debated whether immigrants are a net positive or negative in terms of government spending. Again, the answer is difficult because it requires aggregating across a varied group of immigrants. Highly educated immigrants bring a large financial benefit since they hold jobs that pay well and contribute much more to taxes than they consume in benefits. Even a 21-year-old immigrant with a high school diploma brings a net 6 figure fiscal benefit to the country over their lifetime[252]. However, many immigrants are older, less educated, and poorer. To quote from the National Academies of Science study:

An immigrant and a native-born person with similar characteristics will likely have about the same fiscal impact. Persons with higher levels of education contribute more positively to government finances regardless of their generational status. Furthermore, within age and education categories, immigrants generally have a more salutary effect on budgets because they are disqualified from some benefit programs and because their children tend to have higher

[252] This estimate was for the 1990’s. See National Academies of Science, 2017, page 327.

levels of education, earnings, and tax paying than the children of similar third-plus generation adults[253].

Looking in detail at the years 2011-2013, the study finds that, for that two-year sample period:

the net cost to state and local budgets of first generation adults (including those generated by their dependent children) is, on average, about $1,600 each. In contrast, second and third-plus generation adults (again, with the costs of their dependents rolled in) create a net positive of about $1,700 and $1,300 each, respectively, to state and local budgets. These estimates imply that the total annual fiscal impact of first-generation adults and their dependents, averaged across 2011-2013, is a cost of $57.4 billion, while second and third-plus generation adults create a benefit of $30.5 billion and $223.8 billion, respectively. By the second generation, descendants of immigrants are a net positive for the states as a whole, in large part because they have fewer children on average than do first generation adults and contribute more in tax revenues than they cost in terms of program expenditures.[254]

Finally, looking at all levels of government, the study concludes:

Viewed over a long time horizon (75 years in our estimates), the fiscal impacts of immigrants are generally positive at the federal level and negative at the state and local levels. State and local governments bear the burden of providing education benefits to young immigrants and to the children of immigrants, but their methods of taxation recoup relatively little of the later contributions from the resulting educated taxpayers. Federal benefits, in contrast, are largely provided to the elderly, so the relative youthfulness of arriving immigrants means that they tend to be beneficial to federal finances in the short term. In addition, federal taxes are more strongly progressive, drawing more contributions from the most highly educated. [255]

To summarize, on average, first generation immigrants are more costly to governments, mainly at the state and local levels, than are the native-born generations[256].

The Productivity Impact of Immigrants

There has been a lot of research into the productivity impacts of highly educated immigrants, however quantifying the impact is not as easy as pointing out that it is likely to be positive. For example, the foreign-born account for 50 percent of those with doctoral degrees working in mathematics and computer science occupations, and other research has estimated that scientists and engineers are responsible for a large fraction of the productivity gains in recent years[257].

[253] NASC 2017, page 11
[254] NASC 2017, page 12
[255] NASC 2017, page 11
[256] Conclusion from the National Academies of Science, 2017 summary, page 7
[257] One study concluded that “patenting activity by foreign-born college graduates is estimated to have increased U.S. GDP by 1.4-2.4 percent over the decade of the 1990s” NASC 2017, page 71.

There have not been many attempts to directly quantify the overall productivity impact of immigrants, and these have had mixed results. A lot depends on whether such immigrants' skills are complementary or competitive with the mix of skills already in the country, and there is conflicting research on that score. However, if you ask a farmer who needs to get his crop picked whether immigrants improve his productivity, the answer would probably be yes.

It is interesting to look at the states that have the most immigrants both in absolute terms and as a percent of their populations.

The states with the top immigrant populations, including California, Texas, Florida, New York, and New Jersey, are hardly economic basket cases. In fact, a simple static correlation between the percent of immigrants in the state's population and the wealth of the state in Gross State Product (GSP) per worker[258] is significantly positive as shown in this scatter graph.

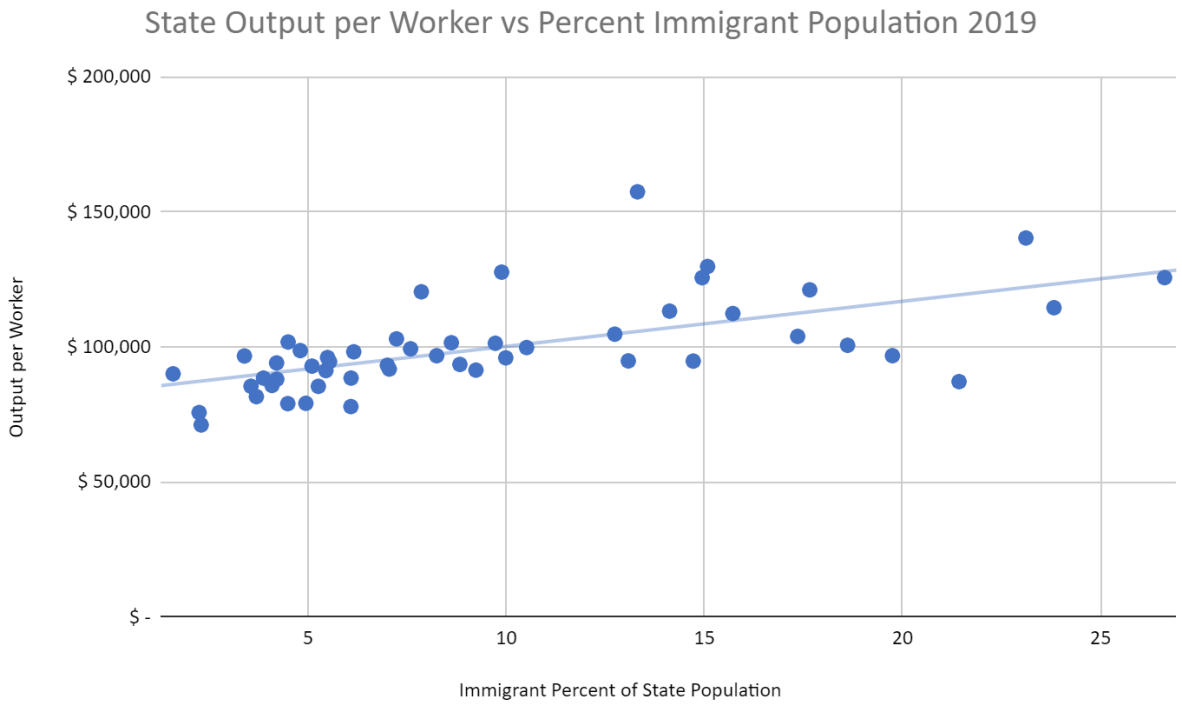

Figure 60: Output Per Worker vs Immigrant Percent. The 50 states and District of Columbia (dots) graphed by percentage of immigrants in their population and output per worker (employees and proprietors). The trend line is positive, meaning higher immigrant states have higher output per worker with a high degree of probability this association is not due to chance. California is furthest right; the highest dot is the District of Columbia. Sources: BEA and Census Bureau.

[258] GSP is like GDP, but for the state.

Of course, one can't infer causality from this relationship since immigrants tend to settle where job opportunities are good, and the economy is booming. Economists have tried to determine if immigration (in the US, with our particular set of immigrants, over a specific interval of time) "causes" economic growth. They do this by trying to account for all the other factors that might cause growth and then see if there is a remaining correlation between growth of the immigrant population and growth in gross state product per capita. As can be imagined, this is a tall order, and like most econometric models, results vary depending on the explanatory variables chosen and assumptions made. The results are a mixed bag, with some showing a positive impact on productivity and others no significant impact[259].

California, the state with most immigrants, has about ten million or 26% of the population of the state, and almost a quarter of all the immigrants in the US[260]. In addition, there are another seven million younger native-born citizens in California who have one or both immigrant parents.

In California, 87% of the graders and sorters of agricultural products, 76% of the first-line supervisors of farming, fishing, and forestry workers, and 79% of other agricultural workers are immigrants. Eighty three percent of manicurists and pedicurists are immigrants, as are 81% of the sewing machine operators. These are all low paid jobs, and so statistically they reduce output per worker, but someone has to pick and sort the crops. This type of work tends to be complementary to the work done by the native born and earlier immigrants, which allows more of the latter to pursue better paid, and more economically productive work. At the other end of the spectrum, immigrants in California fill 39% of science, technology, engineering, and math jobs, and are well represented among Silicon Valley entrepreneurs[261]. In short, the overall impact on productivity change from immigration is unclear but economists' best efforts indicate it is either neutral or somewhat positive.

Before we leave the subject of immigration's effects on productivity, we should note that the discussion so far has been strictly from the internal perspective of the United States. From a world perspective, when an immigrant moves from a low productivity country to a high one such as the US, their productivity can increase enormously. When we look at the global picture later, we will see that migration can help speed up productivity gains worldwide. Of course, when an

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[259] Peri, Giovanni. n.d. "Immigration, Labor Markets, and Productivity." Accessed February 16, 2022. https://ciaotest.cc.columbia.edu/journals/cato/v32i1/f_0024452_19953.pdf, finds a positive impact on total factor productivity, employment, and wages when looking at growth in immigrants as a percent of state population versus measures such as the growth of gross state product (GSP) per worker over time. Borjas, George J. 2019 in "Immigration and Economic Growth." Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w25836 finds that growth in GSP correlates with growth in immigrant percent by state, but growth in GDP per capita measured over time is not significantly different from zero (i.e. neither increases nor decreases productivity growth when other factors are included).

[260] At first glance these two roughly 25% numbers are confusing. But it turns out that California's total population in 2019 was 39 million, so roughly a quarter of that is 10 million which is also roughly a quarter of the 44 million authorized and unauthorized migrants in the US.

[261] These California statistics (cross checked by the author) are mostly sourced from the American Immigration Council, which works on behalf of immigrants.
https://map.americanimmigrationcouncil.org/locations/california/

immigrant goes from picking fruit or providing manicures in a poorer country to picking fruit or providing manicures in a richer one, their productivity may actually not increase much, although they may later move up the productivity ladder more easily in the rich country.

Other Economic Impacts of immigration in the US

Immigrants concentrate in what are referred to as gateway cities. Major concentrations of immigrants are found in Miami, New York, and Los Angeles, and lower concentrations in Houston, San Francisco, Boston and Chicago and many smaller cities[262]. The literature has found a positive correlation between immigrant populations and housing costs[263], but it is difficult to quantify this relationship because many gateway cities have thriving economies that would in any case result in high demand and prices. Of course, rising housing prices benefit homeowners and landlords in these cities, which tends to increase inequality.

Increases in the share of low-skilled immigrants in the labor force appear to have reduced, over time, the prices of immigrant-intensive services such as childcare, eating out, house cleaning and repair, landscaping and gardening, taxi rides, and construction[264]. This also has implications for income inequality, but clearly benefits anyone who uses these services.

And, finally, since immigrants fall into the "tails" of the education distribution, and education correlates strongly with income, immigration tends to increase income inequality. However, if we remember that this applies to first generation immigrants, and even among those, earnings increase over time, the effect is not large compared to other causes of growing income inequality. One study found that immigration contributed 5% to the growth of inequality between 1980 and 2000[265].

US Immigrant Demographics

Where do immigrants live in the United States? We've already mentioned that about one quarter of all immigrants live in California, the chart below shows the immigration population and its share of the state's population.

[262] https://www.migrationpolicy.org/programs/data-hub/charts/us-immigrant-population-metropolitan-area. If we remember that most immigrants come under the family reunification preference, it is not surprising that they will settle near each other.
[263] NASC 2017, page 296
[264] NASC 2017, page 280
[265] Card, David. 2009. "Immigration and Inequality." Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w14683.

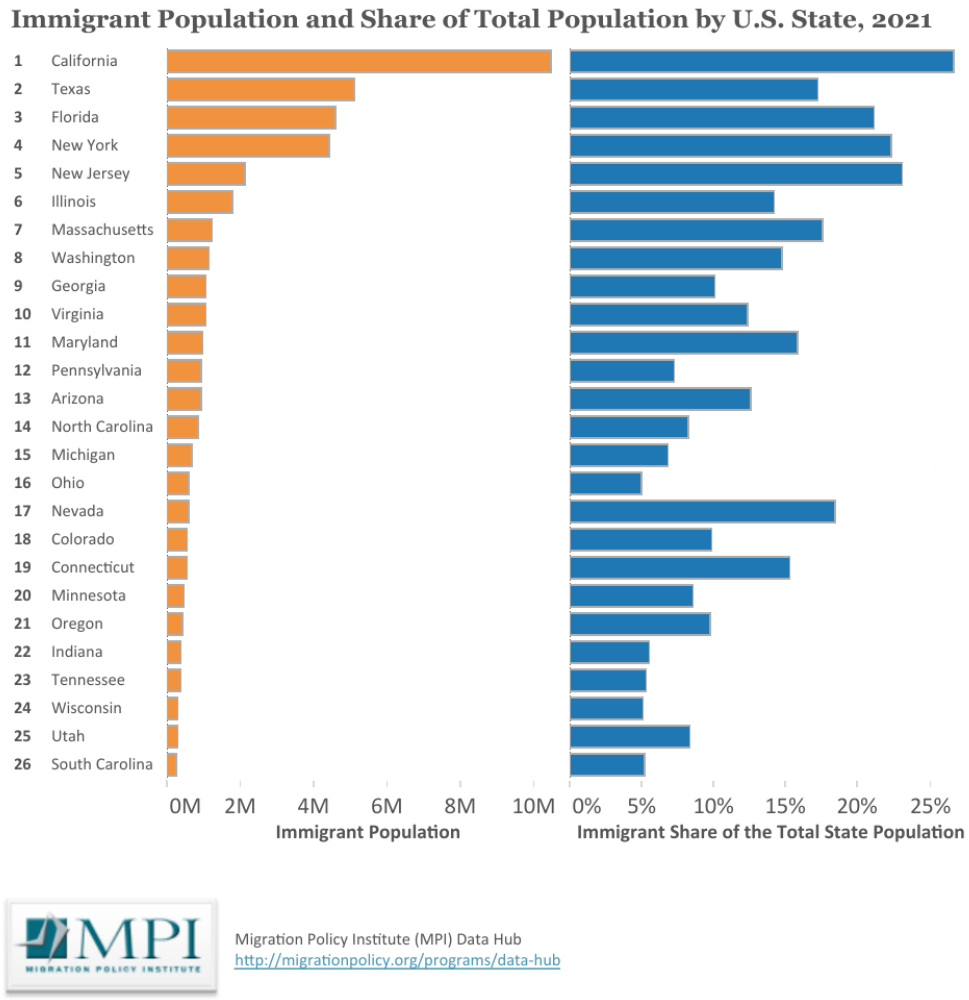

Figure 61: Immigrants by state. Source: Migration Policy Institute

The gateway cities are pretty clear from a mapping of immigrant populations by metropolitan areas.

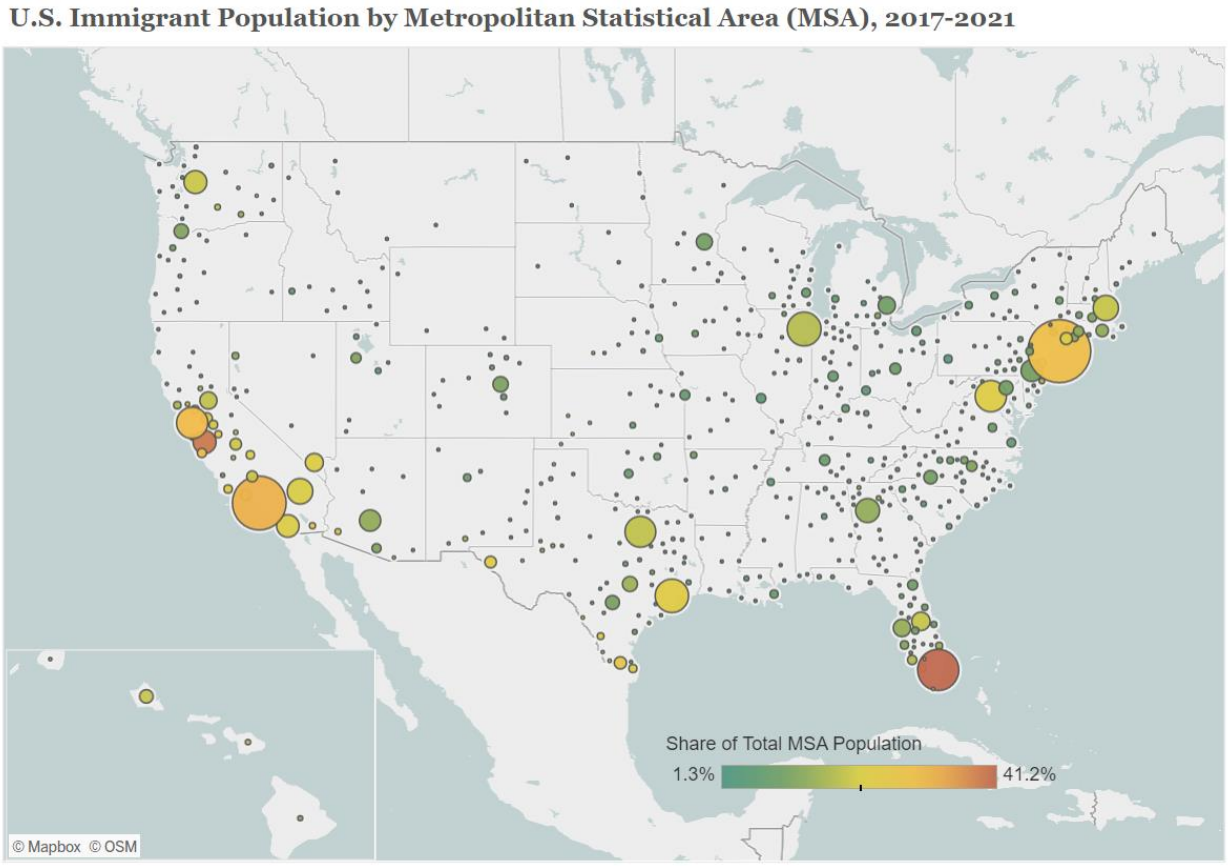

Figure 62: Immigrant Concentrations in the US

Immigrants to the US come from a wide range of countries and regions. At this point in time, most immigrants come from Asia, followed closely by Mexico. Here's where authorized immigrants admitted in 2017 came from.

Table 18: Where US immigrants came from in 2017. Source: Table 2 of Department of Homeland Security, 2017 yearbook.

Europe	89,706
Asia	404,371
America	489,676
Africa	116,667
Australia region	5,986
Not Specified	20,761
Total	1,127,167

As the table below indicates, naturalized US citizens (immigrant citizens) have much the same earnings and a lower household poverty rate than households headed by native born citizens, while immigrants who are not citizens earn less and have higher poverty rates.

Table 19: Some Basic Demographic Data for the US. Source: US Census Bureau, Table 50501 for 2019

			Foreign born		
United States, 2019	**Total**	**Native**	**Foreign born total**	**Naturalized citizen**	**Not a U.S. citizen**
Total population	328,239,523	283,306,622	44,932,901	23,182,917	21,749,984
Median earnings (dollars) for full-time, year-round workers					
Male	$52,989	$55,483	$46,591	$56,813	$38,612
Female	$43,215	$44,584	$39,159	$45,974	$30,589
Household mean earnings					
Household mean earnings	$93,563	$93,077	$95,965	$108,240	$79,812
Family Statistics					
Average family size	3.23	3.12	3.72	3.61	3.89
Families in poverty	13.80%	13.10%	16.30%	10.00%	22.90%

Recent work on prospects of immigrants and their children shows that first generation immigrants close the income gap with natives somewhat over the course of their lives, but their 2nd and 3rd generation children do quite well. One possible explanation is that immigrants are both more likely to settle in growing areas, and more likely than natives to move to such areas, and these are precisely the places (California, Texas) where opportunities for advancement are best.

Immigration and the Aging Workforce in the US

We've noted that immigration grows the size of the economy (GDP) but probably doesn't have much effect on average productivity (GDP per worker). We've also noted that certain occupations and industries rely heavily on immigrants. But immigration also has an important effect on population growth and in particular the size of the working age population. The US population is aging, with the ratio of working people to retirees declining. Without immigrants who come here during their working years, this ratio would be declining faster. The United States, like other advanced economies, has a birth rate that is considerably below the replacement rate. The birth rate needed to keep the population from falling is 2.1 births per woman but for some time now in the US it's been around 1.7 births per woman. That means that fewer and fewer working age people will need to support a growing population of retirees over age 65. This ratio, called the "old age dependency ratio" has been growing even while the US has been admitting a million authorized immigrants a year. Without immigration, the ratio would be growing faster, and in fact the Census Bureau says the US population as a whole would start dropping[266]. A few charts tell the story.

[266] https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1146.pdf

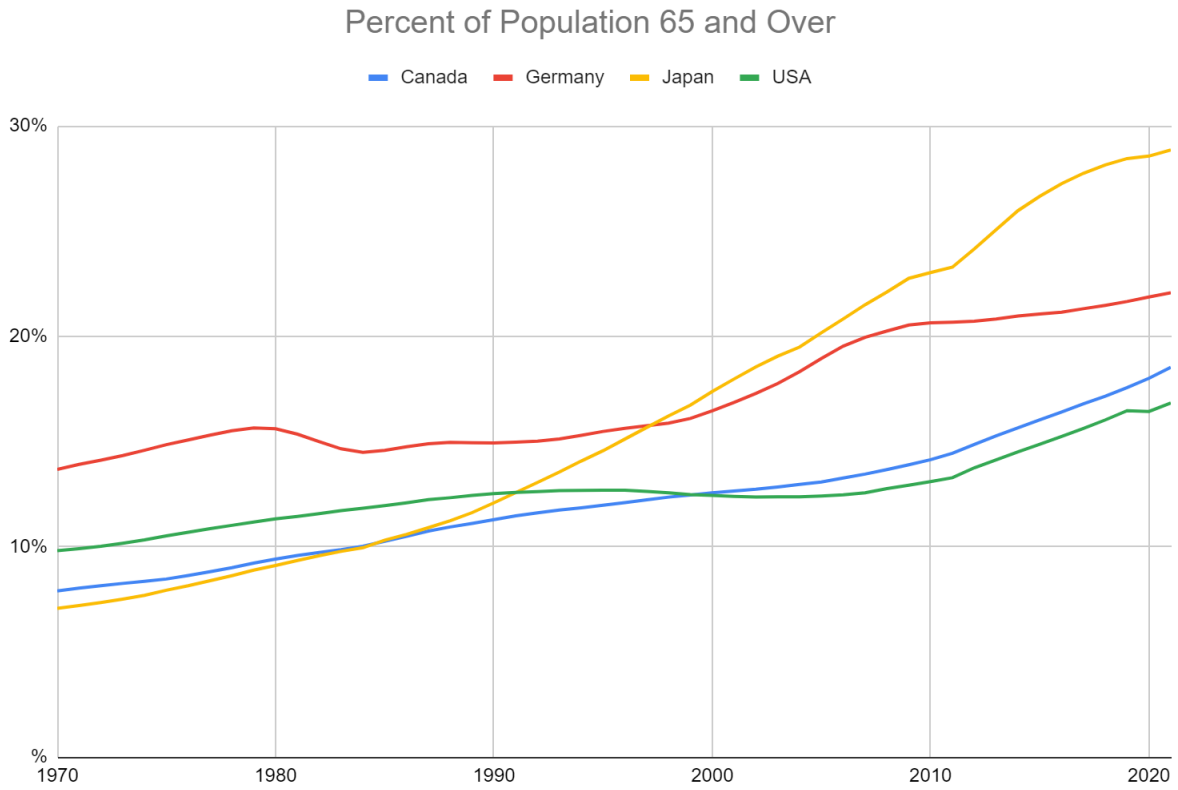

Figure 63: Percent of population 65 or over, selected countries. Source: OECD https://data.oecd.org/pop/elderly-population.htm#indicator-chart

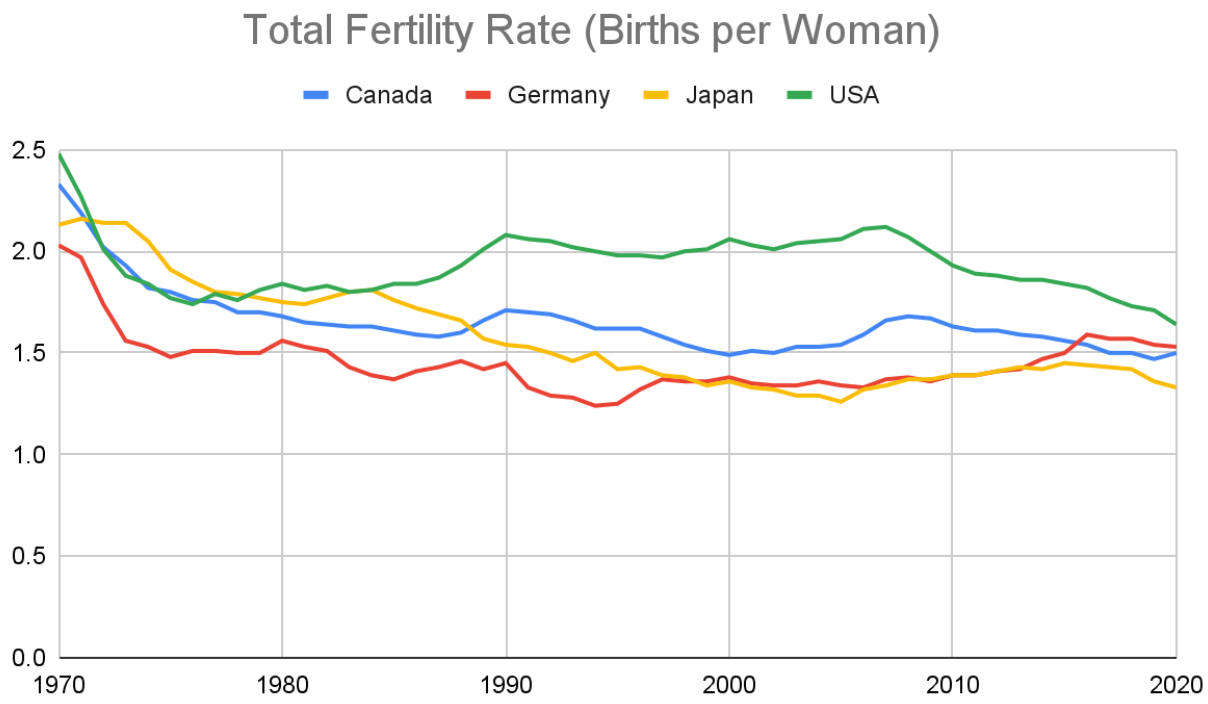

Figure 64: Average births per woman over her lifetime. A total fertility rate of less than 2.1 means the population will fall. Source: OECD https://data.oecd.org/pop/fertility-rates.htm#indicator-chart

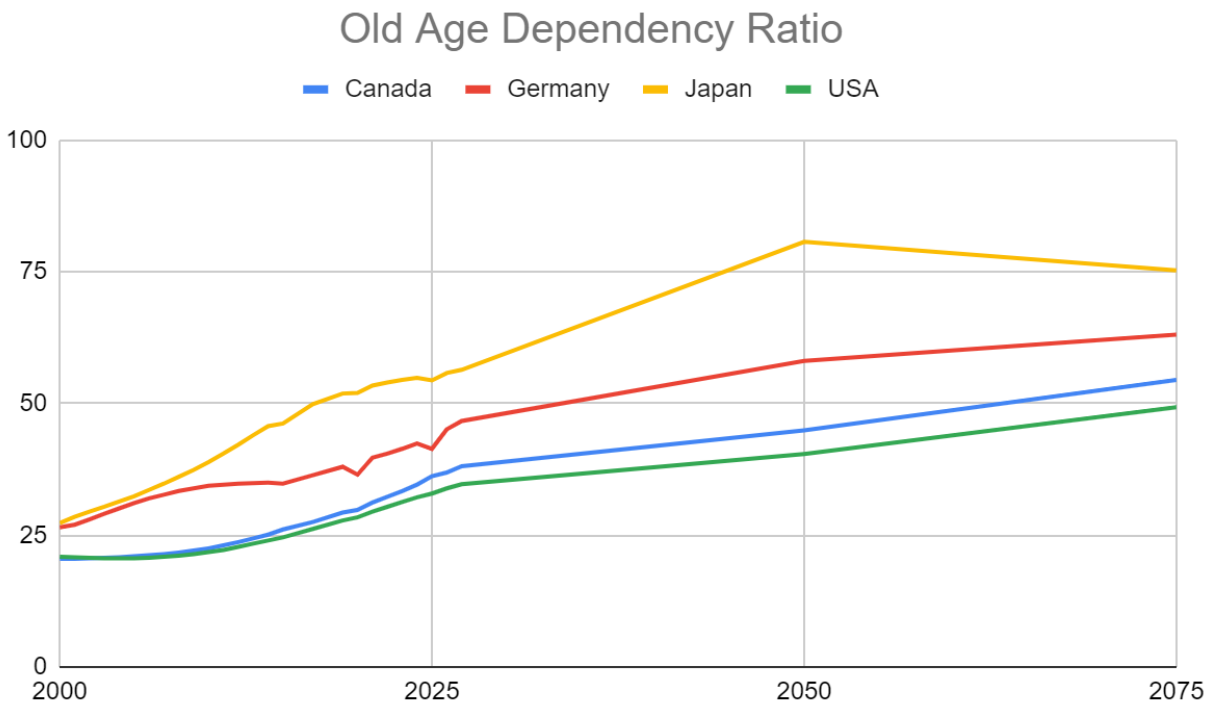

Figure 65: The Old Age Dependency Ratio Projected out to 2075. The ratio is defined as the number of individuals aged 65 and over per 100 people of working age, defined as those at ages 20 to 64. The predicted old-age to

working-age ratios depend on mortality rates, total fertility rates and migration predictions. Expected immigration based on historical trends is included. With lower immigration the ratio climbs faster. Source: OECD https://data.oecd.org/pop/old-age-dependency-ratio.htm#indicator-chart

Total fertility rates worldwide are falling, and as mentioned, are well below the replacement rate in advanced economies. Immigrants arrive in their prime working years, the average age of an immigrant in 2019 was 30. Of course, immigrants age too, and their total fertility rate, while slightly higher than the native born, is still below the replacement rate. Considering this strictly from a dynamic perspective, maintaining a constant population, never mind a growing one, would require a continuing influx of younger immigrants to make up for the low birth rate in the US (both native born and immigrant). The influx of young immigrants required to exactly balance the otherwise declining population is pretty modest to judge from US Census Bureau calculations[267]. But there is also the issue of maintaining the working age population as baby boomers retire and the old age dependency ratio creeps up. As the chart above shows, in the US there already are fewer than 4 prime working age people for each person 65 and older. Given the way social security and other retirement programs are financed[268], an increasing old age dependency ratio will place a growing burden on the working population or require curtailing benefits and/or reducing costs. Because not everyone works or pays payroll taxes, in 2019 only 3.1 workers supported one beneficiary, a number that is expected to decline to 2.4 workers by 2030[269]. The primary Medicare trust fund is on track to be exhausted by 2030, after which benefits would have to be reduced somewhat to equal revenue from the payroll tax and other sources[270]. Clearly more working age people would help us get over this demographic hump. One estimate of the number of immigrants required to keep the old age dependency ratio from rising further is around 370,000 above the current roughly 1 million per year[271]. Of course, as we live longer and stay healthier, more of us can continue to work after age 65. Also, there is evidence that programs such as providing universal preschool, child tax credits, and childcare subsidies have a modest positive effect on fertility rates[272]. Eventually, as we will discuss later, the paradigm of endless growth will not only have to come to an end but will do so naturally as the global birth rate declines.

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[267] The Census projected population growth from 2016 to 2060 under various immigration policies. Under a "low immigration" policy, the population would grow by 53 million or 16% over the period, under a "zero immigration policy" the population would decline by 3.4 million (minus 1.1%). https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1146.pdf

[268] Social Security and part of Medicare are financed by payroll taxes, so the current working population pays in, and the retiring working population collects. During the baby boomers prime working years, a large surplus was built up in the Social Security Trust Fund. That

[269] *https://www.taxpolicycenter.org/briefing-book/what-medicare-trust-fund-and-how-it-financed*

[270] Kaiser Family Foundation has a good overview at https://www.kff.org/medicare/issue-brief/faqs-on-medicare-financing-and-trust-fund-solvency/.

[271] "Room to Grow: Setting Immigration Levels in a Changing America." 2021. National Immigration Forum. February 3, 2021. https://immigrationforum.org/article/room-to-grow-setting-immigration-levels-in-a-changing-america/.

[272] Miller, Claire Cain. 2021. "Would Americans Have More Babies If the Government Paid Them?" *The New York Times*, February 17, 2021. https://www.nytimes.com/2021/02/17/upshot/americans-fertility-babies.html. Fertility rates drop with development, and then tick up a bit as countries get richer.

The Big Picture on US Immigration

It is easy to get bogged down in details and lose sight of the big picture, so let's review.

Because of declining birth rates, the United States and other advanced economies are heavily dependent on immigrants and temporary workers to keep their economies going and growing. In the US, under the immigration law passed by Congress in 1965 and updated in 1986 and 1990, over a million immigrants a year are legally accepted into the US, of which around 10% are refugees, and a much smaller number are asylum seekers. There is also a pool of over 3 million non-migrant temporary guest workers.

Economists agree that immigrants increase the size of the economy through growing GDP, and either have little, or a somewhat positive effect, on overall productivity. Most of the increase in GDP accrues to the immigrants themselves.

Recent immigrants can depress the wages of less educated native-born workers, and also earlier recent immigrants. While highly educated immigrants are thought to increase overall productivity, they also may depress the earnings of some native-born workers in specific fields. Neither of these effects is dramatic. Immigrants who have been in the country for ten years or more are thought to have little effect on wages.

From a fiscal perspective, low skilled immigrants are a net positive over time for the Federal Government because of the taxes they pay, but a net negative for state and local governments. Overall, the "expected value" of a young immigrant is significantly positive.

Because of the aging of the baby boom generation, increased life expectancy, and declining birth rates, a smaller working population is being called on to support a growing older population. Immigrants arrive early in their prime work years which helps slow this increase in the old-age dependency ratio.

The US has the largest immigrant population in the world at over 45 million, or roughly 14% of the total population. While this is near a historic high, other countries, such as Canada, have a higher immigrant percentage.

In the United States, business and agricultural interests strongly back continued immigration at current or increased levels. Immigrant labor is particularly important in harvesting crops.

Immigration is thought to have a small ongoing effect on inequality in the US, however most of the growing inequality in incomes is attributable to other factors.

World Migration

Worldwide, migrants fall into 3 broad categories: refugees, emigrants, and overseas workers. To repeat the numbers, in 2020 there were about 281 million migrants, meaning people living in a country other than the one they were born in, which represented about 3.6% of the world's population. Of these about 80 million had emigrated, 169 were overseas workers, and 32 million were international refugees. We will look at refugees first.

Refugees

While refugees receive a lot of news coverage given the direness of their plight, "only" about 12% of migrants, or around 32.5 million people in 2022, were refugees forced from their native countries by disasters and wars. Another 53.2 million people are currently displaced within their country of birth[273]. Most refugees, internal or external, flee their homes because of wars and civil conflicts. More than 8 million Ukrainian refugees have flooded into Europe since the invasion by Russia, with another 5 million displaced within the country[274]. The Syrian civil war has sent 6.6 million refugees over the border with another 6.6 million displaced internally. There are also millions of refugees from wars in South Sudan (2.4 million) and Afghanistan (2.8 million) and from economic disaster in Venezuela (5.6 million). And of course, there are refugees from floods, droughts, earthquakes, and other natural disasters.

Turkey, which borders Syria, currently has the largest share of refugees in the world, with 3.6 million Syrians spread among many, mostly urban, host communities and some refugee camps[275]. Other countries hosting large refugee populations include Colombia with 2.5 million, Germany with 2.2 million, Pakistan with 1.5 million and Uganda with 1.5 million. The US currently has a total of 0.3 million refugees accepted over recent decades[276].

When one thinks of refugees or internally displaced people, the first thing that comes to mind is a refugee camp with rows of tents or chanties. But 92% of internal displaced people live with host families[277] and only about 22% of international refugees live in camps[278]. The large majority of refugees live in urban areas and in many ways resemble economic migrants except that they are more apt to settle closer to home whereas economic migrants, while also looking to minimize distance, mostly settle in high income countries. Sixty nine percent of refugees are hosted in neighboring countries, three quarters in low- and middle-income ones[279], in contrast to economic migrants, most of whom (66%) settle in high income countries.

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[273] https://www.unhcr.org/refugee-statistics/ accessed March 3, 2023
[274] https://www.unhcr.org/ukraine-emergency.html accessed March 3, 2023
[275] The earthquakes of early 2023 didn't help the situation.
[276] UNHCR - Refugee Statistics accessed Mar 30, 2023
[277] https://data.unhcr.org/en/news/11128
[278] Refugee Camps | Definition, facts and statistics (unrefugees.org)
[279] UNHCR - Refugee Statistics accessed Mar 30, 2023

Given this distribution, the economic impact of refugees on the receiving country is similar to that of economic migrants.

Economic Migrants

The large bulk of international migrants are considered to have moved for economic reasons. Most such economic migrants go to nearby countries or regions as this chart from a McKinsey Report shows.

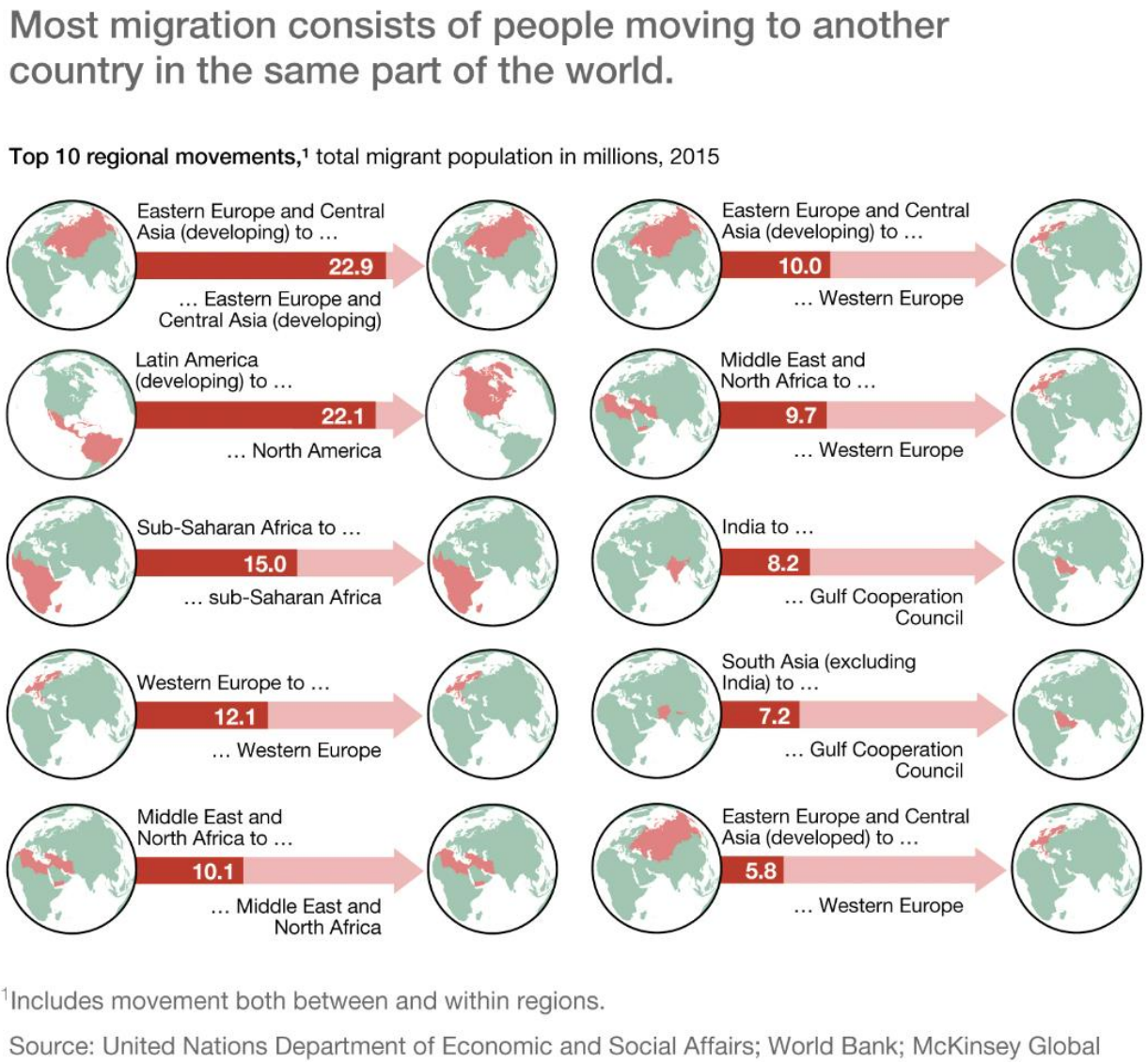

Figure 66: World Migration Patterns. Illustration from McKinsey Report, "Global Migration's Impact and Opportunity."[280] WW107

[280] Woetzel, Jonathan, Anu Madgavkar, Khaled Rifai, Frank Mattern, Jacques Bughin, James Manyika, Tarek Elmasry, Amadeo di Lodovico, and Ashwin Hasyagar. 2016. "Global Migration's Impact and

That said, most economic migrants not surprisingly move from poorer countries to richer ones. The table below shows the countries with the highest number of migrants and their percentage of the population.

Opportunity." McKinsey & Company. https://www.mckinsey.com/featured-insights/employment-and-growth/global-migrations-impact-and-opportunity#/.

Table 20: Top 11 Countries by In-Migrants

Country Name	2015 Migrant Count	2015 % of Population
United States	46,627,102	14.5%
Germany	12,005,690	14.9%
Russian Federation	11,643,276	8.1%
Saudi Arabia	10,185,945	32.3%
United Arab Emirates	8,095,126	88.4%
Canada	7,835,502	21.8%
France	7,784,418	12.1%
Australia	6,763,663	28.2%
Spain	5,852,953	12.7%
Italy	5,788,875	9.6%
India	5,240,960	.4%
High income	157,500,496	13.3%
Low & middle income	84,287,737	1.4%
World	243,192,681	3.3%

Source: United Nations Population Division via World Bank Indicators Interface. Migrants in this context include all people born in a country other than the one in which they reside, so both permanent immigrants and migrant labor.

About 2/3 of international migrants settle in high income countries. Indians work in the oil rich Arab countries while Germany hosts many Eastern Europeans and more recently a flood of Syrians and Afghans. Australia's largest group of immigrants is from England, followed by India, China, and New Zealand, while in the US the largest groups of migrants are from Latin America and Asia. India hosts a lot of migrants, but they are a tiny percent of the population, and far more Indians (17.5 million) are out-migrants. The huge population of India can lead to some confusing statistics, the 17.5 million Indians living outside the country, while the largest national group of migrants, represent a migration rate of only 1% of the Indian population.

The chances of a migrant becoming a permanent resident vary greatly between countries. In the oil rich economies of the middle east, migrants are contract workers employed directly by businesses. In the United Arab Emirates, over 90% of the workforce are migrants, in large part from India. While many migrants have been abused, there is a long-standing historical connection between the two countries and some Indian families have lived there for generations

under work visas and flourished. But the UAE and Saudi Arabia limit citizenship to Arabs with specific lineages and no migrants can gain citizenship[281]. As a result, all of the migrants in Saudi Arabia and the UAE are temporary guest workers. In the US, as we have seen, anyone accepted as a permanent resident can apply for citizenship after 5 years. In Germany visa holders can apply after 8 years. The primary bar to citizenship in the US and Germany for older permanent residents is undoubtedly the language requirement. There will be somewhat different economic effects between a guest worker and an immigrant population. Immigrants become part of the country's human capital in a way that guest workers don't.

Economics of In-Migration

From the point of view of the receiving country, immigrants and guest workers are "in-migrants". We saw in the case of the United States that permanent immigrants form the large bulk of in-migration accumulated over time. The US also has a guest worker program that allows for foreigners to work under temporary visas.

Much of what applies to immigration in the US also applies to other "advanced" economies. Worldwide, fertility rates are falling, and are below replacement levels in many richer countries. Below is the population growth - or shrinkage - in Germany with and without migration.

[281] Early in 2023 Saudi Arabia announced plans to allow children of mixed marriages to apply for citizenship.

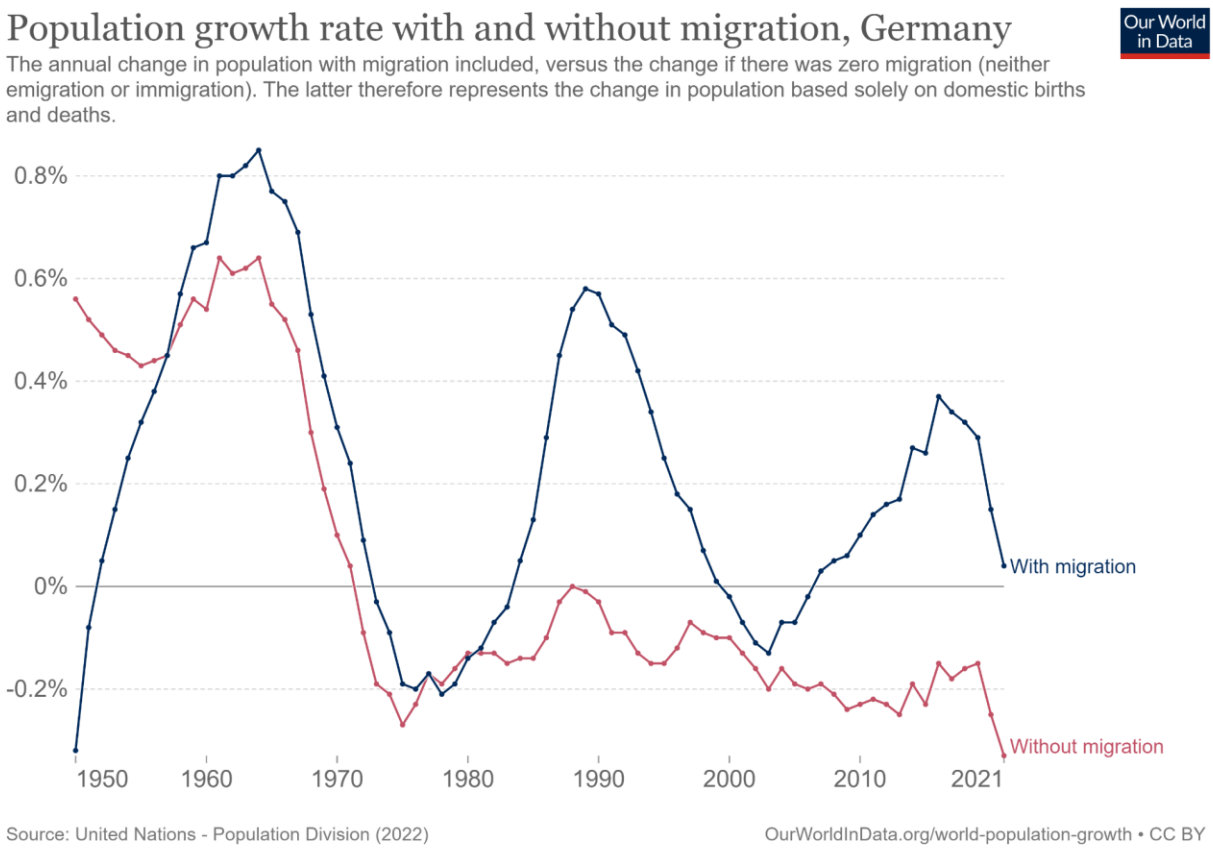

Figure 67: Germany hosts many refugees but has had difficulties with attracting the highly skilled workers its economy badly needs. Source: Our World in Data[282]. WW108

In the chart below, the immigration percentage of is plotted against GDP per capita growth for some countries with complex advanced economies.

[282] Hockenos, Paul. 2023. "Skilled Migrants Aren't Interested in Germany." March 22, 2023. https://foreignpolicy.com/2023/03/22/skilled-migrants-arent-interested-in-germany/?utm_source=PostUp&utm_medium=email&utm_campaign=Editors%20Picks%20OC&utm_term=75904&tpcc=Editors%20Picks%20OC.

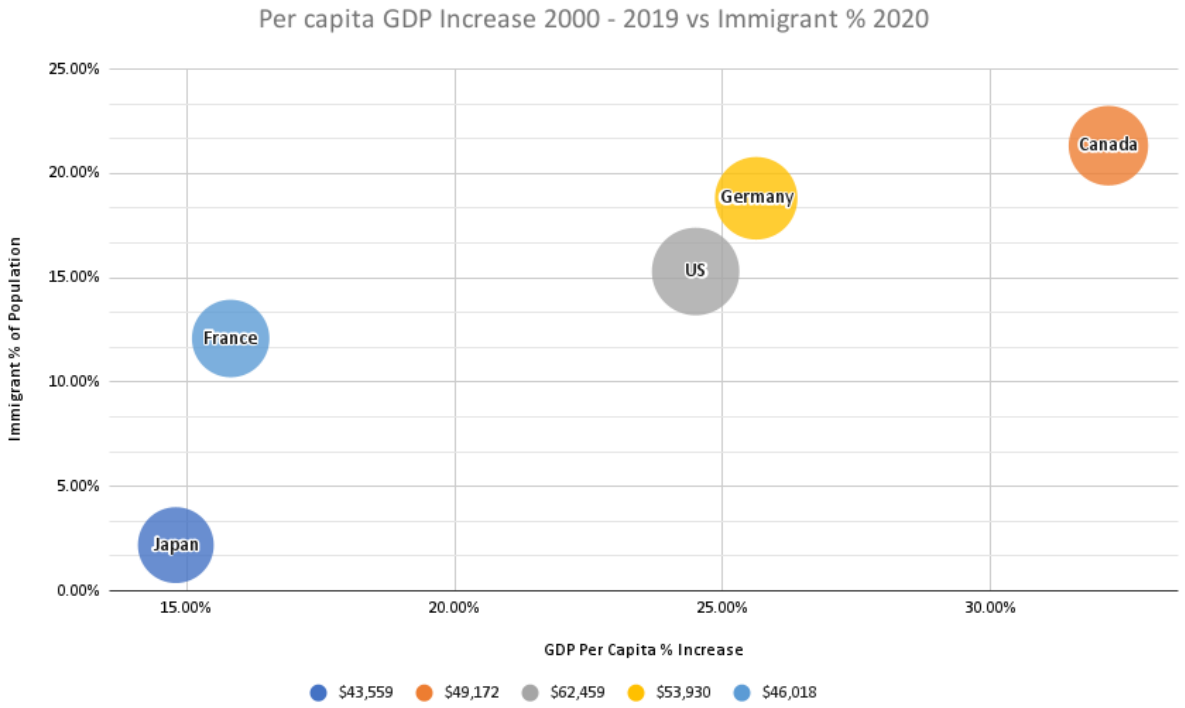

Figure 68: Immigrant percent of the population vs real growth in per capita GDP from 2000 to 2019. The size of each bubble indicates the per capita GDP of the country. This chart does not show growth in immigrant population, rather the percentage of immigrants in 2019. Data Source: World Bank Indicator Data WW109

As in the case of US states, the clear correlation between immigrants as a percent of the population and per capita GDP increase doesn't tell us the direction of causality, if any (they might both be correlated with some other factor or factors). An econometric study of the effects of immigration flow on growth in 22 Organization for Economic Co-operation and Development (OECD) countries found that "first there exists a positive impact of migrants' human capital on GDP per capita, and second, a permanent increase in migration flows has a positive effect on productivity growth. However, the growth impact of immigration is small even in countries that have highly selective migration policies."[283] In other words, even in countries that predominantly admit highly skilled immigrants, such as Canada and Australia, immigrants don't slow down growth, but they don't accelerate it much either as far as statisticians can tell. Of course, overall growth in GDP (a country's total output), rather than GDP per capita, rises or falls with population growth, or decline. Japan is a country with very few immigrants and recently a falling population. Its aging demographics is considered to be one of the factors in its very slow rate of growth in both GDP and GDP per capita in recent decades.

Guest workers allow for more targeted matching between labor needs and migrant labor.

[283] Boubtane, Ekrame, Jean-Christophe Dumont, and Christophe Rault. 2015. "Immigration and Economic Growth in the OECD Countries 1986-2006." https://doi.org/10.2139/ssrn.2622005.

Economics of Out-Migration (Emigration and Overseas Work)

So far, we have looked at how immigration and guest workers affect the receiving country, but in-migration is only half the story. Every migrant comes from another country, what is the effect on those sending countries of out-migration?

Economic migrants mostly leave poorer countries to work, study, or permanently live in richer ones. In some countries, such as the oil rich UAE and Saudi Arabia, permanent residency and citizenship aren't options, migrants usually go to these countries to work, save, and send home remittances. In advanced economy countries such as the United States there are both "guest workers" and permanent immigrants admitted, and both groups send home remittances. Worldwide remittances totaled $657 billion in 2019 which dwarfs official development assistance of $168 billion[284]. Of course, this flood of remittances helps boost economies in the migrants' home countries, and since it flows directly is not subject to the corruption that often plagues official assistance.

So, are emigration and overseas work on balance good for the migrant's home country? Does migration speed economic development? How does it affect wages and employment? As usual, different studies provide a range of results, partly because they study migrant populations from different countries or regions. Keeping that in mind, here are some of the findings.

Economic migration doesn't have much effect on the overall employment rate in the sending country. Most migrants have jobs before they leave, and these jobs do not go empty after they leave, even in countries with relatively low unemployment such as the Philippines. If overseas workers are included, overall employment increases. However, a lot depends on the "replaceability" of the skill the migrant takes with them, the famous "brain drain", discussed more below[285].

Employment may not change much in the sending country, but studies have found a positive effect on wages[286]. While it might seem that higher wages would drive down labor demand and thus lead to higher unemployment, we have to remember that repatriated wages are also driving up demand in the migrant-sending country. The rise in wages and increased demand encourages further capital investment[287].

While most migrants are not extensively educated, a sizable portion are. "Brain drain" happens when highly educated people migrate and take with them their native country's investment in their education. It's not just about money, many talented students from less developed countries go to school in advanced countries and end up staying there, depriving their native country of their human capital. However, there can also be positive effects from highly educated people emigrating for better wages. In addition to their substantial repatriations, the very promise of

[284] Our World in data https://ourworldindata.org/migration
[285] Asch, Beth J., and Courtland Reichmann. 1994. *Emigration and Its Effects on the Sending Country*. Rand. pages 31-32
[286] IBID pages 32-33
[287] IBID page 33, study of Pakistani construction workers

higher pay overseas can encourage students to seek higher education in their own country, and if enough of them stay, this can have a positive effect. In the Philippines, as doctors and nurses left for the US in the 1960's and 1970's, the number of medical and nursing schools ballooned. While many graduates emigrated (and sent home a substantial regular flow of money), enough stayed to increase the supply of doctors and nurses at home[288]. It is also true that emigres sometimes return, bringing their accumulated education and experience back with them, usually when there are increased opportunities in their native country. To quote one source:
"[Brain drain] can be a boon or a curse for developing countries, depending on the country's characteristics and policy objectives. ... effective brain drain exceeds the income maximizing level in the vast majority of developing countries, especially in sub-Saharan Africa, Central America, and small countries."[289] In other words "brain drain" hurts most developing countries, especially the smaller ones.

The overall picture on the effect of emigration and overseas work on development varies from country to country. On the one hand, repatriated wages help spur demand and growth in the sending country, and substantially increase the income of the migrant families back home, but on the other hand the migration of highly skilled and educated workers can negatively impact development. Some countries have pursued successful development programs with hardly any overseas migration and vice versa. It is in fact development that tends to determine the extent of migration rather than the other way around, and there is no substitute for the conditions that lead to growth. As we saw in the section on Global Productivity & Convergence these include stable government, a suitable legal and regulatory environment, an educated workforce, less corruption, as well as natural factors such as country size and resource base.

Migration Summary

Despite the fact that physical migration is easier than ever because of improved lower cost transportation and communications, the fraction of people who migrate worldwide hasn't increased much in recent decades and currently stands at 3.3 percent of world population, or 281 million of which 32 million are refugees and the rest are economic migrants and overseas workers. Economic migrants predominantly move to, or work in, high income countries: the US has the most migrants of any country in the world with 46 million residents who were born elsewhere. Other high-income countries with large migrant populations include the countries of Western Europe and the oil rich Arab states. In the Arab states, up to 90% of workers are temporary migrants working under direct employment contracts. In Europe and the US by contrast, most migrants are permanent residents or citizens.

Given that birth rates are below the replacement rate of 2.1 children per woman in most high-income countries, immigrants are often the difference between a shrinking population and one

[288] IBID p 73
[289] Docquier, Frédéric, and IRES (UCLouvain), Belgium. 2014. "The Brain Drain from Developing Countries." *IZA World of Labor: Evidence-Based Policy Making*. https://doi.org/10.15185/izawol.31.

that is stable or slow growing. Japan, a high-income country with a low birth rate, has failed to attract immigrants, has a declining population, a declining GDP, and declining GDP per person. The baby boom and extended life expectancy are aggravating the problem of low birth rates by increasing the number of retirees that must be supported by each worker. Immigrants, who arrive early in their work lives help keep this ratio from increasing in wealthy countries.

Economic studies show that immigrants in high income countries contribute directly to GDP growth, probably do not have much impact on overall productivity and wages, but continuing in-migration can negatively impact the wages of natives and prior migrants in occupations that extensively employ migrant workers. Immigrants can increase economic inequality, but this effect is small, perhaps explaining 5% of the increase in inequality in the US over the last 3 decades.

Looking at the flip side of migration, there is a large flow of money from economic migrants and overseas workers back to their families in their native countries, $657 billion in 2019, which is about four times official development aid from rich countries to poorer ones, and about one third as large as world foreign direct investment. This flow doubles the income of families with overseas workers in many countries, which in turn increases local demand and grows the sending countries' GDP. On the other hand, the emigration of skilled workers and highly educated professionals and scientists from poorer countries to richer ones, "brain drain", can significantly reduce poorer countries human capital. The effects of wages sent home, and the countervailing brain drain on a country, depend on the conditions and policies in place in that country. Absent a stable government, a suitable legal and regulatory environment, and lower levels of corruption, wages sent back from overseas are not sufficient in themselves to further development.

Sustainability

If you're running a business, sustainability means a business model that will work over an indefinite period of time. If your business is chronically losing money then you have to have a plan to get to profitability, or the business is not sustainable. In this case it is easy to see that there is a scarce resource, money, that the business will eventually exhaust. If the business can increase revenue relative to costs, it can become profitable and sustainable.

Sustainability is always about using up a scarce resource rather than achieving a viable balance where the resource is renewed in some way as quickly as it is consumed. A couple more examples:

In fishing, a wild population of fish is caught and consumed. If the fish population cannot reproduce at a sufficient rate, fish stocks will decline and so will yields. Restrictions on catches attempt to balance the rate at which fish are caught with their ability to reproduce and grow to maturity, thus making the business sustainable. Of course, each individual fisherman would like to catch as many fish as possible, so catch limitations have to be implemented and enforced at an aggregate level. In the US, "fisheries management involves scientists, researchers, managers, fishermen, and local communities working together to ensure the future of fisheries resources, marine habitat, fishing businesses, and coastal communities" according to a trade group[290]. In short, fishermen understand the need for, and support, sustainable fisheries management even if at times there are differences of opinion about numbers.

Sustainability often involves externalities. In a classic example of externalities, a factory making widgets dumps toxic chemicals in a river which is used as a water supply downstream, causing people using that water to suffer. The factory doesn't pay for those damages in a pure laissez faire free market, and so has no incentive to reduce the toxic discharges. As we pointed out in the primer, because the full costs of the widgets are not built into their price, the price for widgets will be too low and too many sold. There are a number of ways to fix that issue: ban dumping the toxic chemical, make the factory pay for the damages, or apply a tax to recover society's costs. In the case of a toxic chemical, outlawing the discharge will probably be the choice, but in other situations economic solutions may work better, as we'll see.

The above makes it clear that ensuring sustainability generally involves scientific research, economics, and of course politics. Politics itself is inextricably linked to economics, from the local to the global, as even a casual observer knows.

The American Economic Association says that "Economics can be defined in a few different ways. It's the study of scarcity, the study of how people use resources and respond to incentives, or the study of decision-making. It often involves topics like wealth and finance, but

[290] Seafood Harvesters of America https://www.seafoodharvesters.org/fisheries-explained#newsroom-press-release-title-color1.

it's not all about money. Economics is a broad discipline that helps us understand historical trends, interpret today's headlines, and make predictions about the coming years."[291]

In short, economics is an essential tool if we're going to achieve sustainability in the face of population and consumption growth in a world with limited resources.

Population and Consumption Growth in a Finite World

Population Growth and "Peak Human"

The chart below shows how the earth's human population has taken off on a logarithmic climb since about 1900, not much more than 100 years ago. The industrial and agricultural revolutions along with advances in medicine allowed cities to grow and absorb an ever-larger population. As discussed earlier, 80% of the population of most countries was engaged in agriculture in the 1700's, which meant that populations were constrained by the amount of farmable land. The mechanization of agriculture and improvements in crop yields along with the availability of highly productive industrial jobs set the stage for this rapid growth which occurred at different rates around the world, and in fact is still continuing.

[291] https://www.aeaweb.org/resources/students/what-is-economics

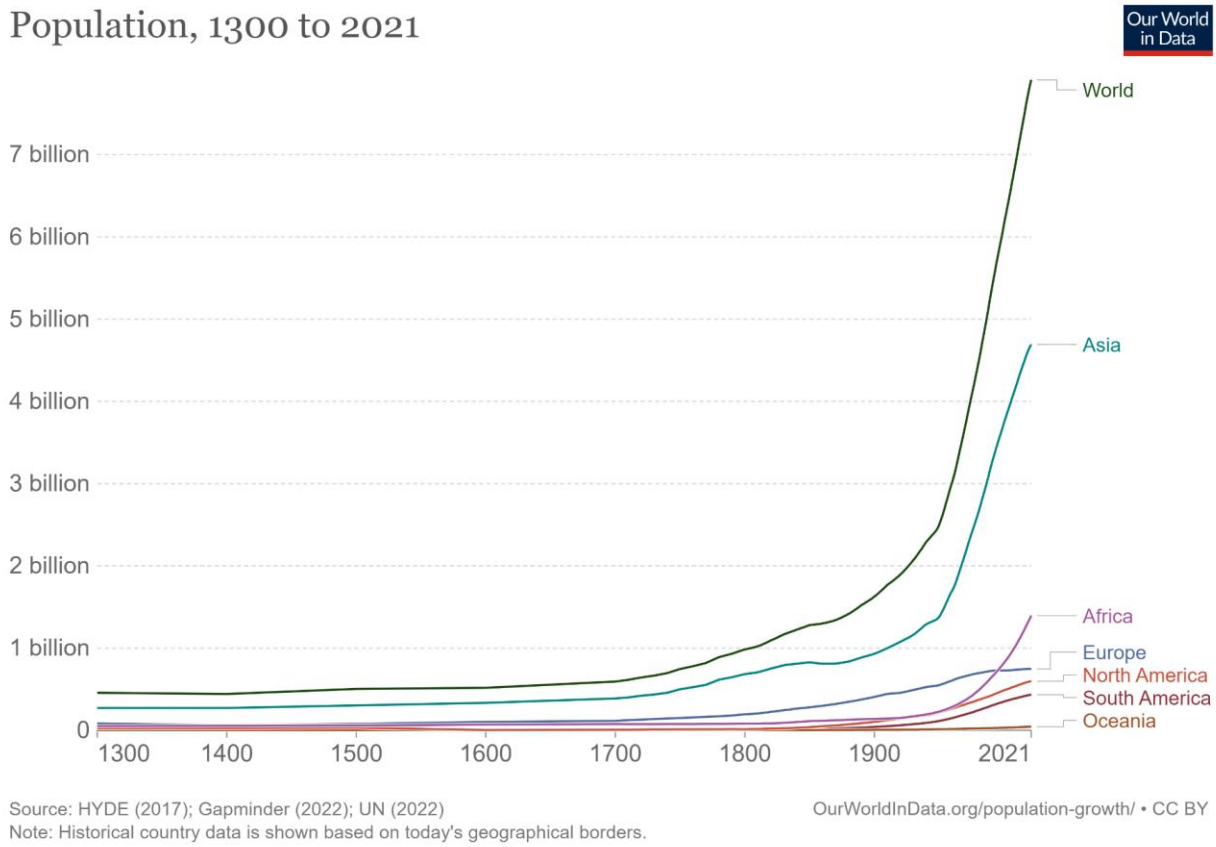

Figure 69: World and Regional Population Growth. Graphic Source: Our World in Data

The explosion in world population has been accompanied by huge increases in consumption per person, although this varies widely between countries and regions depending on GDP. The combination of an enormous human population and increasing personal consumption is unsustainable in its current form as we have reached or exceeded the capacity of the earth to supply some of our demands and dispose of our waste.

There is some good news on the population front. As noted earlier, fertility rates, or the number of children born per woman on average, have been falling for years[292].

[292] See the section on “Immigration and the Aging Workforce in the US” in the section on migration.

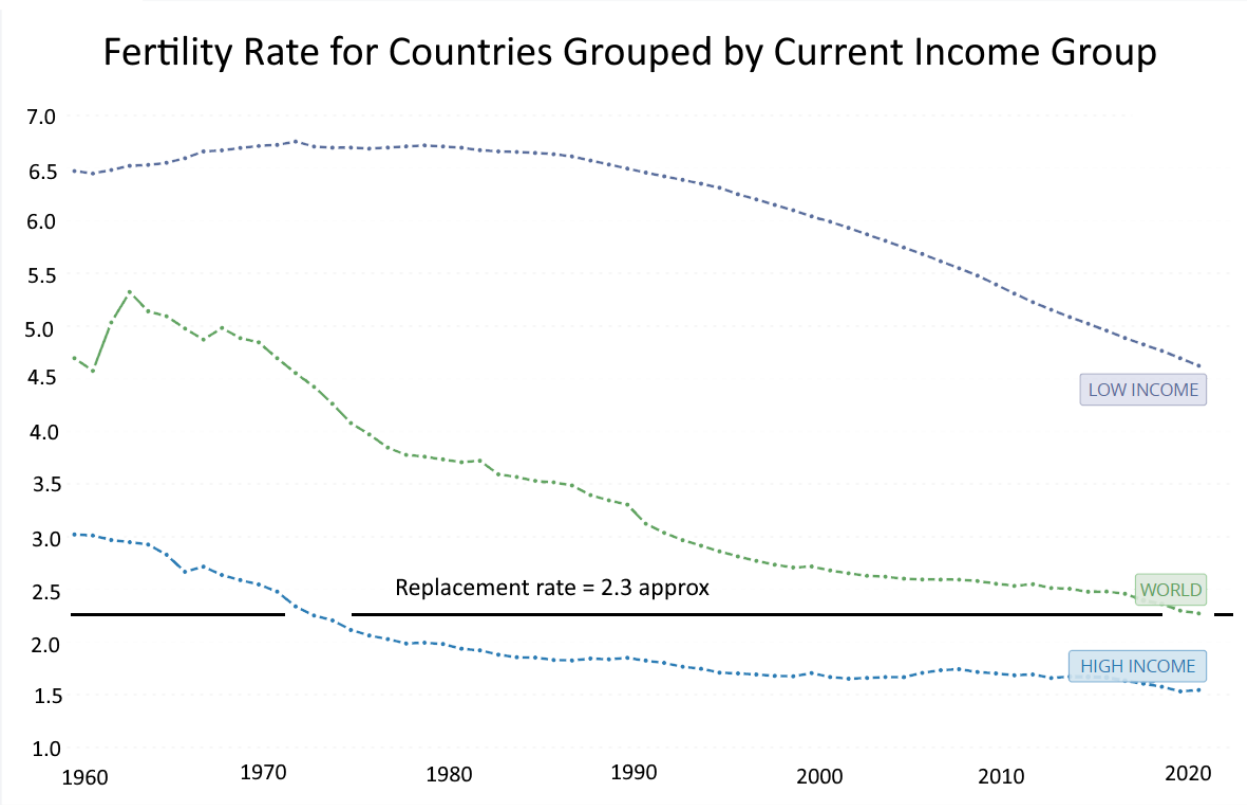

Figure 70: Fertility rates by income group. The approximate world-wide replacement rate is 2.3 children per woman. In advanced economies, the replacement rate is about 2.1 births per woman because of lower mortality rates. Data Source: World Bank CC By

As countries get richer and more urbanized and infant mortality rates fall, the fertility rate goes down. Worldwide, we're close to the rate that just replaces the current population once the age profile has stabilized. There is a lag between fertility rate decline and that decline being reflected in population numbers because, to put it simply, young people have kids and older people don't and it takes a while for the young to grow old, and the old to die.

Given predictions about birth rates in the future - which largely depend on rates of economic development and urbanization - along with the dynamics of an aging population, it is possible to estimate the future of the earth's human population.

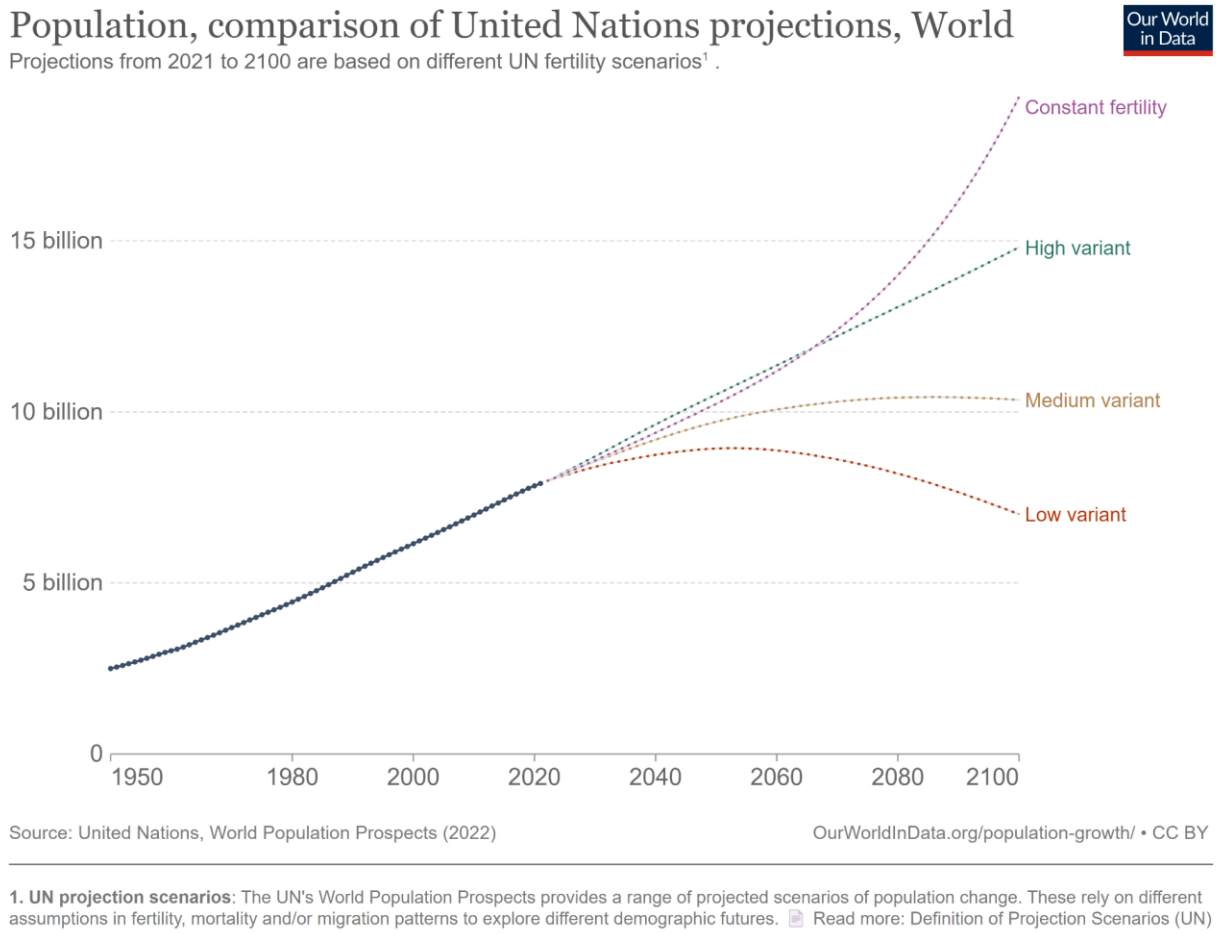

Figure 71: UN Human population projections. Source: Our World in Data chart of UN Data CC-BY WW114

Under the medium assumptions, “peak human” population will stabilize at around 10 billion people in 2050, up from the current 8 billion[293]. While the end of population growth is welcome, 10.2 billion is still an increase of 2.2 billion people in 30 years, or about 28% more people than the earth holds now. In other words, we’ll need 28% more food, and other basic necessities at a minimum, not accounting for per capita consumption growth.

Consumption Growth

With some luck, the human population of the world will only grow by another 28% or so before reaching “peak human” and then perhaps slowly declining. However, as people earn more, they consume more, and that will increase demand for already strained resources. We’ll get into what those strained resources are in more detail later, but what can we say about increases in demand?

[293] The assumptions are detailed at https://population.un.org/wpp/DefinitionOfProjectionScenarios/#:~:text=The%20five%20fertility%20scenarios%20are,and%20instant%2Dreplacement%2Dfertility.

As people's incomes increase, they want to eat "better" which usually means consuming more meat and fish and less grain. They improve their housing and buy consumer goods and household appliances. They switch from bicycles to motor scooters to cars. They buy air conditioners and heat their houses. There is also an increase in demand for services such as better education and healthcare, entertainment, and restaurant meals which don't require a lot in the way of natural resources.

One way of gauging the potential impact of consumption growth is by estimating what it would take in natural resources if the current 8 billion people on earth consumed as much as those in rich countries. For example, in many better off countries there are 6 or more cars for every 10 people[294]. That level of car ownership would require about 5 billion cars worldwide. Currently there are 1.5 billion, so there is potentially demand for at least another 3.5 billion cars. Is that possible? The answer is yes, and no. There is plenty of iron ore for making steel (70% of steel is recycled, but that many cars would require a lot of new steel), and over time the world could pretty easily add the capacity to manufacture that many cars. The limiting factor is actually producing and consuming energy sustainably, both in manufacturing the cars and in running them. Steel manufacture uses a lot of fossil fuels, and running cars, even electric ones, requires a lot of energy. We cannot sustainably manufacture and drive cars without addressing the greenhouse gas problem.

As this example of cars indicates, meeting future world demands without exceeding the sustainable capacity of the earth involves mostly a few fundamental resources. Chief among these is the problem of producing the energy and food we want sustainably, meaning, as defined above, without exceeding the ability of the world to supply our demands or absorb our waste on an ongoing basis.

Climate Change

The burning of fossil fuels releases CO2 as a waste product into the atmosphere. Since the start of the industrial age, we humans have added over a trillion tons of CO2 to the atmosphere at a steeply accelerating rate, increasing its concentration by 50%. In the history of the earth, CO2 has played an essential warming story: two little of it and earth freezes over, as it has nearly done several times. Increasing its level warms things up, and that's what our emissions have been doing. Unfortunately warming the atmosphere up too quickly too much has major unpleasant consequences and risks. The good news is that we can control our CO2, and other greenhouse gas emissions at very reasonable costs as we will see in this chapter, in fact saving money by doing so.

The Science - in Very Brief

The biggest sustainability problem we have is not "climate change", it's the cause of that change which is the emission of greenhouse gases that are warming the planet at a rate exceeding

[294] https://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita

prediction. Releasing greenhouse gases into the atmosphere is a clear case of externalities, like the example we gave above of a factory dumping toxic chemicals into a river.

It is entirely understandable that we didn't realize there was a cost to releasing greenhouse gases. Any kid looking up at the sky sees a vastness that extends seemingly forever. On a clear cold winter night though, that same kid might begin to understand how thin that insulating layer above us really is. The atmosphere is made up almost entirely of nitrogen, oxygen, and argon (yes argon at about 1%!). These gases constitute 99.5% of the atmosphere and do not contribute to the greenhouse effect. Carbon dioxide at .039% is a powerful greenhouse gas, and the amount of warming it causes is directly proportional to the number of molecules. Since 1850, humanity has added 1 trillion metric tons of carbon dioxide to the atmosphere, 33 billion tons in 2019 alone. The result has been a substantial increase in the number of molecules of CO2 in the atmosphere: 421 ppm as of May 2022 up from 280 ppm before the industrial revolution, an increase of 50% in the number of CO2 molecules heating the planet[295].

There is a natural carbon cycle on earth in which as much carbon dioxide, released by various "sources" into the atmosphere, is absorbed back from the atmosphere by various "sinks" such as rocks and sediment, the oceans and plant and animal life. This cycle is "sustainable" since it maintains equilibrium over time[296]. Perturbations to this cycle occur when there are unusual releases of carbon dioxide, as through periods of major volcanic activity. After these increased emissions stop it takes hundreds of years for the atmospheric CO2 levels, and global temperatures, to fall back to their pre-disturbance levels because the rate of absorption of CO2 into long term sinks, such as rocks, is fairly slow[297]. This means that the climate change that has occurred to date will persist for at least the next few hundred years and can only get worse with more human emissions[298]. And CO2 is only one of several human-released greenhouse gases, methane and nitrous oxide have even greater warming power.

Clearly continuing to release greenhouse gases into the atmosphere is not sustainable. Every additional billion tons of greenhouse gases will cause increased warming, and, at some point, it will become prohibitively expensive or impossible to deal with the consequences. There is now a lot of talk about "mitigation" and "adaptation" to deal with the effects of climate change, but the quicker we reduce greenhouse gas emissions, the lower the costs of damages, mitigation and adaptation. As the old saw says, "an ounce of prevention is worth a pound of cure".

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[295] Heat radiating from the ground is absorbed and re-released by CO2 molecules anywhere in the atmosphere. When you stand on a hot asphalt street in summer, CO2 all around you is absorbing heat and then releasing it in all directions. There are many good summaries of the science such as https://gml.noaa.gov/outreach/carbon_toolkit/

[296] It is important to realize that CO2 is constantly absorbed and released by the major short-term sinks such as the biosphere and oceans. So even though any individual CO2 molecule is absorbed by a "sink" within about 4 years, other CO2 molecules are released from that "sink". Extra CO2 is only taken out of circulation when it passes into a long-term sink such as sediment or rock.

[297] https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-reached/

[298] I'm discounting CO2 sequestration post release.

Climate Models

There are many excellent explanations of climate models online (see footnote) from which this is drawn[299]. Climate models are computer simulations of our earth that predict climate changes over time in the atmosphere by dividing the surface into squares of about 100 KM (60 miles) on a side and layers about 1 KM (.6 mile) high extending up into the atmosphere. Detailed historical data about the conditions at each point in this lattice are obtained from observations used for weather forecasts and other purposes. Calculations show how the conditions at each point in the lattice change over time according to physical principles. Models are tuned by running them on historic data to see how well they predict the past. In addition to the initial conditions, the models are given data on items that they can't predict such as the intensity of the sun's output, human greenhouse gas emissions, and aerosols from various sources. Recent models also include ocean circulation, ice sheets, and biological and geologic cycles into "coupled" global models. Over a million lines of code are required for some of these models, and they have to be run on the most advanced supercomputers.

The point of running such models is to get a picture of how the atmosphere, the oceans, the biosphere, and geochemistry co-evolve over time given various levels of the input greenhouse gas emissions and other factors both natural and human. The models can predict how changes in climate will be distributed geographically and show how the various components of climate interact. For example, as the climate warms there may be more clouds that will somewhat cut down on incoming solar energy. You can see the amazing detail of these climate predictions for any location in the US using Future Climate Projections - Graphs & Maps | NOAA Climate.gov

On the global scale, these models arrive at much the same short term temperature predictions as a simple calculation based on the historic relationship between CO2 emissions, CO2 atmospheric concentration, and temperature. Simply put, the relationship between CO2 concentration and temperature increase has been close to linear as shown in the graph below, and CO2 concentration grows linearly with emissions. Using this one can predict future global temperatures from current CO2 concentration and hypothetical future emissions[300].

[299] See UCAR E&O - Randy Russell - Climate Model Resolution ; What Are Climate Models and How Accurate Are They? ; Q&A: How do climate models work? - Carbon Brief

[300] There are roughly 7.82 Gigatons of CO2 per one part per million in the atmosphere. Using the recent historic relationship of .01 degree C of warming for every 1 parts per million increase of CO2, and noting that about 47% of added emissions stay in the atmosphere, one can compute how much warming there would be from various levels of CO2 emission. For example, continuing to emit 37GT of CO2 per year until 2100 results in 611 PPM of CO2 with a short-term temperature rise of about 3 degrees C. Climate models using a medium emissions scenario come up with a CO2 concentration of 670 PPM in 2100 and warming of 3-4 degrees C.

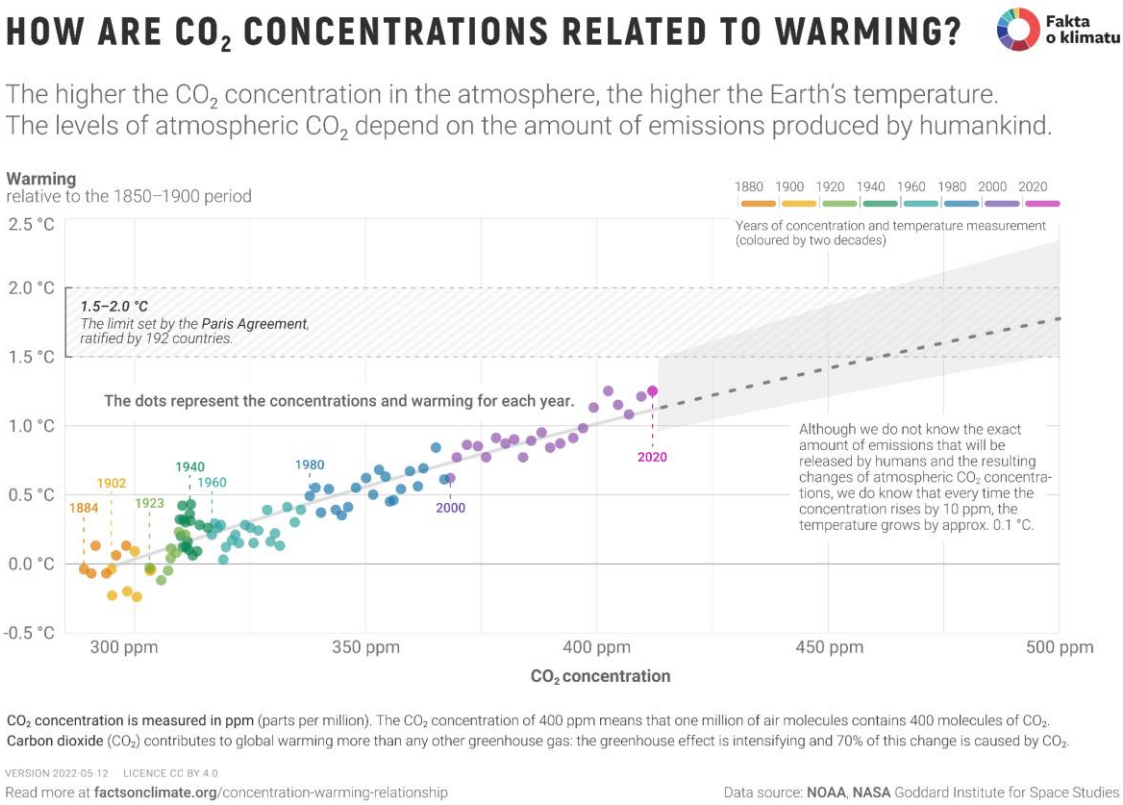

Figure 72: Linear Relationship Between CO2 and Increasing Temperatures

The fact that simple extrapolation of historic experience and the most sophisticated and detailed climate models pretty much agree makes it hard to deny the evidence. We know how much CO2 we are releasing, and how that directly relates to warming, both from physics and past observation. Many possible confounding factors such as level of solar emissions are considered in the models.

The Economics of Greenhouse Gas Reduction

Benefits of GHG Reduction

Economists have weighed in on the costs versus the benefits of greenhouse gas reductions. By reducing the release of greenhouse gases, the world will be spared costs associated with global warming. So, the benefits of reducing greenhouse gas emissions include the cumulative cost of damages avoided.

But if we agree that the damages from continued global warming will eventually become impossible to overcome (e.g. severe loss of the ability to grow food), then the sooner we reduce

greenhouse gas emissions, the greater the payback in avoiding damages from an increasingly hotter planet.

What are some of the damages associated with the world heating up?

- Property damage from rising sea levels, more frequent and severe storms, and increased wildfires.
- Agricultural losses as temperature and precipitation patterns reduce agricultural productivity.
- Health and healthcare costs: recent heat waves have been responsible for tens of thousands of deaths.
- Adaptation and mitigation costs: as seas rise, and rainfall and storm intensity increase, infrastructure has to be built to deal with the new realities, when possible.
- Other damages include increased human displacement (one third of Pakistan was recently flooded) and migration (as agriculture fails), and what is called “biodiversity loss” - another way of saying “mass extinction”, which is happening already because of habitat loss.
- Risk of catastrophic feedback warming: the higher the temperature goes the more the risk of runaway feedback developing. As the earth warms, there is more water vapor in the atmosphere, and water vapor is itself a greenhouse gas. As snow and glaciers melt, darker ground absorbs more heat. As the permafrost melts, methane, a much more powerful greenhouse gas than carbon dioxide, is released.

These damages increase with temperature, which in turn increases with greenhouse gas emissions. Most of the “benefits” of greenhouse gas reductions come from reducing these negative costs. But there are additional positive economic benefits as well from reducing fossil fuel burning.

- Currently fossil fuel consumption causes a massive redistribution of income and wealth. ExxonMobil had a pre-tax profit of $70 billion in 2022, and the Saudi oil company, Aramco, made 303 billion pre-tax[301]. That’s just the profit, total revenue is much higher. Renewables are far more evenly distributed.
- Wind and solar are now actually among the lowest cost way to generate electricity, so every new installation actually *saves* consumers money over a fossil fuel plant[302]. This shift in costs is driving free market investment in these technologies far more than mandates.
- Greenhouse gas reductions will employ millions of workers. The International Labor Organization estimates that implementing the Paris Agreement on Climate Change could create a net gain of 18 million jobs by 2030[303]. Of course, some jobs will be lost but the net is highly positive. As with trade, there must be ways to ease the transition.

[301] https://www.statista.com/statistics/269857/most-profitable-companies-worldwide/
[302] https://ourworldindata.org/grapher/levelized-cost-of-energy?time=2000..latest based on International Renewable Energy Agency (IRENA) data.
[303] https://www.ilo.org/global/topics/green-jobs/lang--en/index.htm

- Oil and gas exploration and production cost $6.55 trillion in 2022 alone[304]. Reducing consumption of these fuels offsets the costs of sustainable energy. $6.55 trillion a year buys a lot of solar panels and windmills, and sun and wind are free.
- Fossil fuels are in addition highly subsidized around the world, with over $1 trillion in explicit subsidies and much more in "implicit" subsidies, such as the costs of health effects of particulate pollution which are not charged to the fuels[305]. Switching from fossil fuels reduces the cost of these subsidies, explicit and implicit.

Given this list of benefits from reducing greenhouse gas emissions, it is not surprising that many cost/benefit analyses find a strong net positive from reducing them to net zero over some time period[306].

Costs of GHG Reductions

Energy

So far, we've looked at the benefit side of greenhouse gas reductions. The cost side is more complicated, since there are a number of major sources of emissions.

[304] https://www.ibisworld.com/global/market-size/global-oil-gas-exploration-production/#:~:text=The%20market%20size%2C%20measured%20by,is%20%245.3tr%20in%202023.
[305] The IMF sized explicit fossil fuel subsidies at $1.3 trillion in 2022 and implicit subsidies at an additional $5.7 trillion. But the latter include environmental damages we've already listed as benefits of greenhouse gas emissions. https://www.imf.org/en/Blogs/Articles/2023/08/24/fossil-fuel-subsidies-surged-to-record-7-trillion
[306] A review of literature can be found at https://eciu.net/analysis/briefings/climate-impacts/climate-economics-costs-and-benefits.

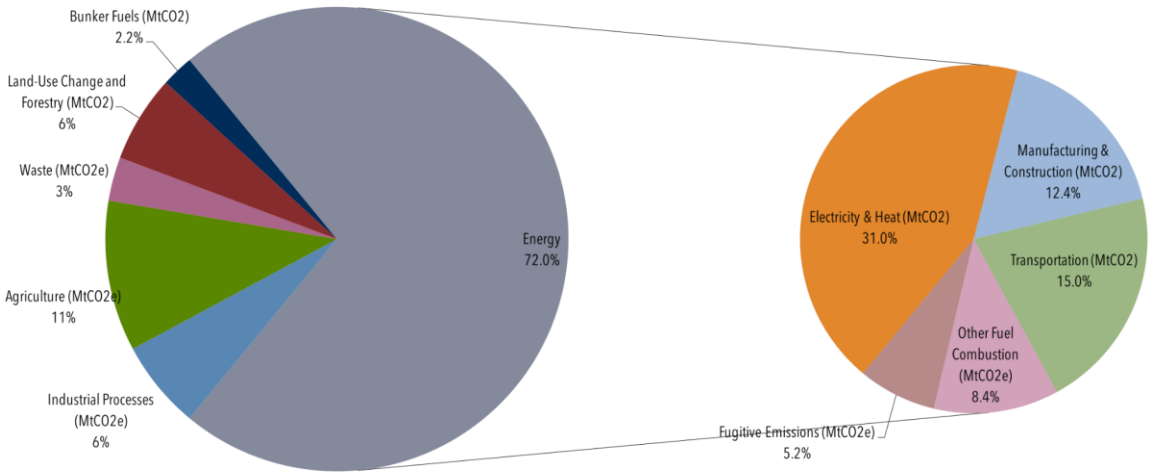

Figure 73: Sources of greenhouse gas emissions, 2017. Some activities release gases such as methane that cause substantially more heat absorption than CO2. Emissions of these other gases are adjusted to the equivalent amount of CO2 (CO2e). Source: Graphic from Climate Watch via Center for Climate and Energy Solutions. CC-BY[307]

In the above graphic, the large pie chart shows that the use of fossil fuels in the energy sector is by far the largest contributor to greenhouse gas emissions. The small chart shows that within the energy sector, the largest emissions come from using fossil fuels to generate electricity and for heating.

Fortunately, the news about generating electricity from renewables is amazingly good.

Renewable energy actually is the cheapest power option in most parts of the world today. Prices for renewable energy technologies are dropping rapidly. The cost of electricity from solar power fell by 85 percent between 2010 and 2020. Costs of onshore and offshore wind energy fell by 56 percent and 48 percent respectively.

Falling prices make renewable energy more attractive all around – including to low- and middle-income countries, where most of the additional demand for new electricity will come from. With falling costs, there is a real opportunity for much of the new power supply over the coming years to be provided by low-carbon sources.

According to the UN, cheap electricity from renewable sources could provide 65 percent of the world's total electricity supply by 2030. It could decarbonize 90 percent of the power sector by 2050, massively cutting carbon emissions and helping to mitigate climate change[308].

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[307] https://www.c2es.org/content/international-emissions/#:~:text=Globally%2C%20the%20primary%20sources%20of,72%20percent%20of%20all%20emissions. Climate Watch has some great graphics and tools.

[308] https://www.un.org/en/climatechange/raising-ambition/renewable-energy#:~:text=Cheap%20electricity%20from%20renewable%20sources,helping%20to%20mitigate%20climate%20change.

Looking again at the small pie chart that shows sources of emissions within the energy sector, we see that transportation and manufacturing also emit large amounts of greenhouse gases, and that heating also contributes. Both transportation and heating can be electrified while also being made more efficient, which explains the push towards electric vehicles and electric heat pumps for both heating and cooling. In manufacturing, fossil fuels are also used for heating and generating electricity. The electricity can be generated from renewables and so can heat. For example, in the production of primary iron, fossil fuels such as coal are used in blast furnaces to process the ore, but electric arc furnaces can also be used. In fact, iron can be produced (and recycled) by burning hydrogen produced by the electrolysis of water. Hydrogen when burned becomes only water again[309]. Much of the use of fossil fuels for energy in manufacturing can similarly be converted to electricity. There was a time not that long ago when a US President-to-be was touting the “all electric future” at the behest of General Electric. Well, that's finally coming true now.

We haven’t quantified the cost of the energy transition yet. Because new renewable energy is cheaper than new fossil fuel generated energy, new power investment is already flowing mostly to solar and wind. The chart below shows the costs of generating electricity when all costs, including construction, cost of capital, and operating costs (including fuel) are considered.

[309] https://energypost.eu/iron-and-steel-how-can-hydrogen-and-direct-electrification-take-over-from-fossil-based-production/#:~:text=The%20Direct%20Reduced%20Iron%E2%80%93Electric,iron%20for%20further%20steel%20production.

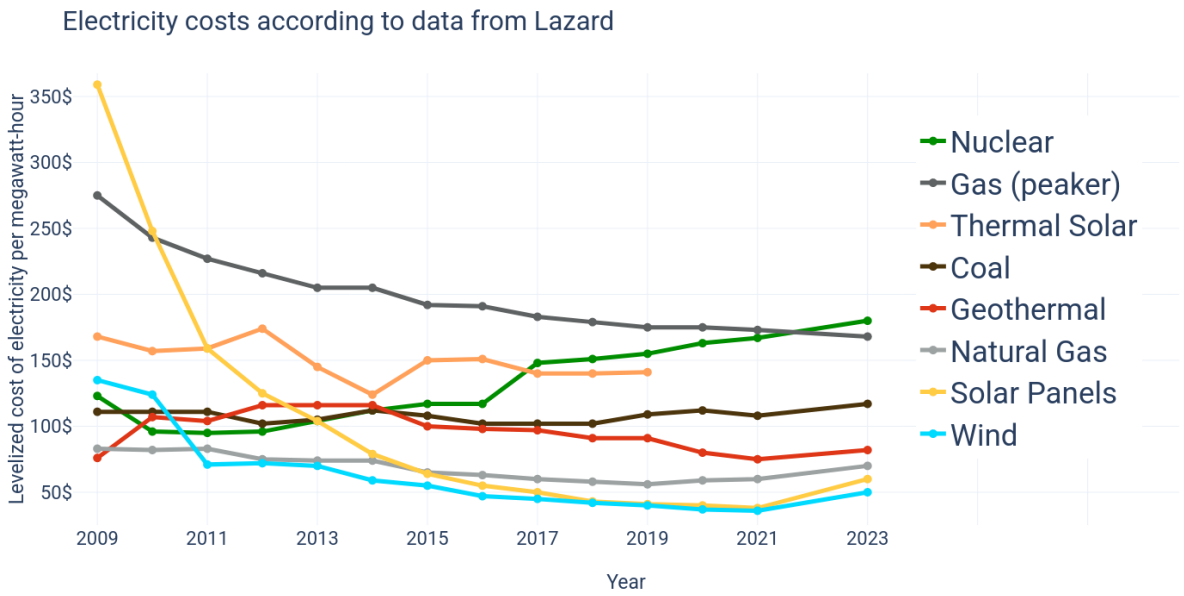

Figure 74: Cost of electricity generated in various ways. Source: Wikipedia illustration[310] using levelized data from Lazard[311]

It's clear that wind and solar are the least expensive way to generate new electricity, and the market has responded. In 2023, roughly $660 billion was spent worldwide on new renewable energy generation versus $108 billion on new fossil fuel fired power plants[312]. Note that the costs do not include the "external" costs associated with global warming or health effects which apply to fossil fuel plants without scrubbers and CO2 sequestration. With those costs internalized, the true costs of coal and gas would be much higher.

Unfortunately, there are large sunk costs in existing power plants and only the operating costs would be saved by replacing them. Amazingly, even with these sunk costs, it would be cheaper in the US to replace 99% of existing coal fired power plants with wind and solar because the operating costs are so high - without even considering climate or health[313]. The International Energy Agency (IEA) has modeled what it would take to reach net zero emissions by 2050, we will look at that report in some detail in the cost/benefit section. The model shows that worldwide investment in renewable energy generation will have to increase to $1.3 trillion by 2030 and decline slowly thereafter. For comparison, the world spending on fossil fuel production reached a high of $1.4 trillion in 2014, so it would be hard to argue this represents an increase in

[310] By Mir-445511 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=137272269

[311] https://www.lazard.com/research-insights/2023-levelized-cost-of-energyplus/. These figures agree with those in the IEA net zero document, https://www.iea.org/reports/net-zero-by-2050, Table B1 which shows the costs for the US, EU, India, etc. in 2020.

[312] https://www.iea.org/reports/world-energy-investment-2023/overview-and-key-findings

[313] https://energyinnovation.org/wp-content/uploads/2023/01/Coal-Cost-Crossover-3.0.pdf. The authors point out that in addition to cost savings, there would be large local capital investments made and since the power is generated locally, transmission issues are reduced.

spending on energy generation, rather a shift[314]. Total annual energy sector investment, which includes everything in the small pie chart above, such as electric vehicles, and manufacturing energy use, would have to rise from the current average of $2.3 trillion per year to $5 trillion by 2030 before declining somewhat[315]. This represents an increase of roughly 1% of modeled global GDP at that time. For comparison, the military budgets of the US, China, and Russia, are over 3% of GDP.

Agriculture and Land Use and Greenhouse Gases

In the big pie chart, roughly one quarter of greenhouse gas emissions fall outside the energy sector. Two of the largest of those are agriculture (11%) and land use changes (6%). Agriculture also uses energy, but the emissions we're talking about here come from other sources and processes. The gases emitted include:

- Methane which comes primarily from livestock digestion (known as enteric fermentation) and the way livestock manure is managed. It contributes the most to agricultural emissions of greenhouse gases.
- The second largest contributor is nitrous oxide, which results mostly from agricultural fertilizer application to soils.
- Carbon dioxide emissions come from increased decomposition of plant matter in soils and from converting lands to agricultural uses. Those emissions are partially offset by the increased plant matter stored in cropland soils.

Methane is degraded by reacting with OH in the upper atmosphere and has an average life of about 8 years in the atmosphere, but it is an even more powerful greenhouse gas than CO2. Every methane molecule released now has 28 times the warming power of a CO2 molecule over a 100-year time span, and a much higher short-term warming power. Nitrous oxide molecules are in the atmosphere for an average of 150 years and have a warming potential 285 times that of CO2. When calculating the contribution of agricultural greenhouse gases, these warming potentials are used to calculate their CO2 equivalent which is what is graphed above. The chart below shows how various agricultural uses contribute to emissions.

[314] All dollar figures in the report are constant 2021 US dollars. Total green energy, which includes nuclear as well as renewables, would have to rise to $1.6 trillion by 2030. "Net Zero by 2050." n.d. IEA. Accessed September 21, 2023. https://www.iea.org/reports/net-zero-by-2050. Page 153 ff

[315] https://www.iea.org/reports/net-zero-by-2050 page 47. Note that this includes the cost of increasing the availability of electricity in poorer countries, so increased generation and consumption.

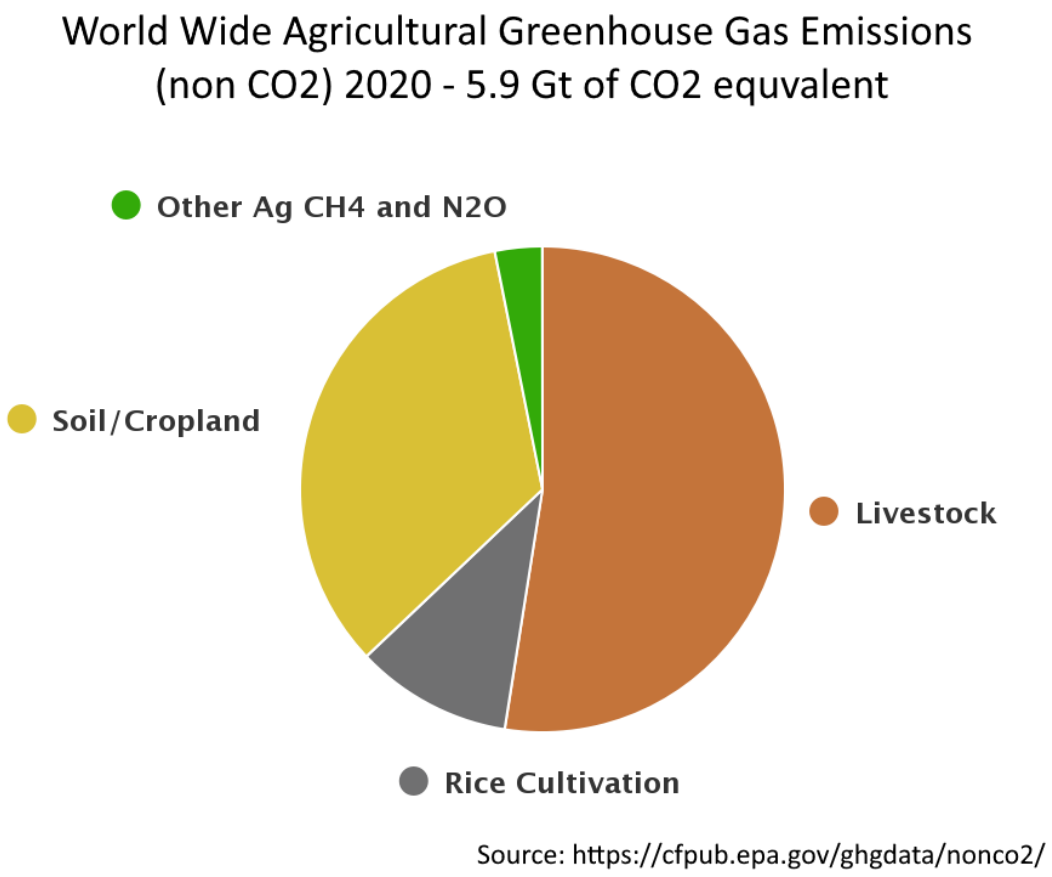

Figure 75: Worldwide Greenhouse Gas Emissions from Agriculture, other than CO2. Source: https://cfpub.epa.gov/ghgdata/nonco2/

How can these agricultural emissions be reduced, and at what cost?

To have a decent possibility of limiting global warming to 1.5 degree C, the Intergovernmental Panel on Climate Change (IPCC) set the following targets for agriculture, forestry, and land-use change in 2018:

- Eliminate CO2 emissions entirely by 2050.
- Reduce methane (CH4) emissions by 25 to 35 percent by 2030 and by 50 to 60 percent by 2050 (versus 2010 baseline)
- Reduce nitrous oxide (N2 O) emissions by 10 to 15 percent by 2030 and by 20 to 30 percent by 2050 (versus 2010 baseline)

In a report on ways to reduce agricultural emissions, McKinsey and Company notes that achieving these targets:

.. would mean major changes for agriculture, from how we farm, to how we eat and waste food, to how we manage our forests and natural carbon sinks.

Achieving these major changes may be more challenging for agriculture than for other sectors. Although the pace of emissions reduction remains too slow across the board, other sectors have identified many of the technologies that could substantially reduce emissions: these options don't necessarily exist in agriculture. Agriculture is also significantly less consolidated than other sectors; reducing emissions requires action by one-quarter of the global population. Finally, the agriculture sector has a complicated set of objectives to consider alongside climate goals, including biodiversity, nutrition needs, food security, and the livelihood of farmers and farming communities.[316]

The report goes on to identify 25 technologies currently in use that could achieve 20% of the target agricultural emissions reductions by 2050. The good news is that many of these changes, such as better rice paddy water management, actually provide cost savings to farmers. The bad news is of course that it's only 20% of the target, which in itself is less than 25% of agricultural emissions.

Other changes to agriculture will happen for reasons not directly related to greenhouse gas reduction. Land itself, like the ability of the earth to absorb our greenhouse gas waste, has essentially reached its limit. In particular raising animals for meat causes the most greenhouse gas emissions while using 80% of agricultural land and contributing only 20% of the calories people consume. As GDP rises in low- and middle-income countries, their citizens want more meat, which is unsustainable. We will defer the further discussion of agriculture to the section dealing with land as a limiting factor.

I think it is fair to say that currently we only know how to reduce a portion of agricultural greenhouse gases at a reasonable cost.

Balancing Cost versus Benefits of Reducing Greenhouse Gases

We've listed the benefits of reducing greenhouse gases, but only quantified some. It is difficult to put precise numbers on the relationship between greenhouse gas levels and economic damage such as coastal flooding and lost agricultural productivity. The climate models are designed to give us as detailed a geographic and temporal picture as possible of rainfall changes, sea level rise, and of course temperature increases, which one can then attempt to translate into damages. But assigning costs to this putative damage is going to involve a healthy dose of uncertainty.

It is even more difficult to assign a value to human health and mortality. For example, the 2022 heat wave in Europe is calculated to have cost 60,000 lives. What price does one assign to a human life? In the US, when considering technology, it is considered to be worth about $7 million to prevent a death. Multiplying the two, this single heatwave in one part of the world,

[316] The report is available at https://www.mckinsey.com/~/media/mckinsey/industries/agriculture/our%20insights/reducing%20agriculture%20emissions%20through%20improved%20farming%20practices/agriculture-and-climate-change.pdf.

caused $420 billion in “damage”. But even then, we can’t confidently apportion all of that to climate change.

Finally, there are almost completely unquantifiable “damages”. One is the decline in the numbers of animals and plants of all kinds. The combination of habitat loss and climate change is leading to an increase in species extinction[317]. How does one “value” a species and how much is related to climate change? Another unquantifiable damage from greenhouse gas emissions is simply what we don’t know, in other words, risk. There are feedback loops that occur as the earth warms: hotter sea water holds less CO2, methane is released as permafrost melts, glaciers slip into the ocean and raise sea levels faster as they are undercut by melt water. These feedback loops are incorporated into climate models as they are discovered and quantified, but there is always the risk of runaway effects we haven’t anticipated. We do know that as long as we emit CO2 and other greenhouse gases at current levels, the world will continue to warm and associated damages will increase. Continuing to emit current levels of CO2 would, within a century, boost CO2 levels to over 750 parts per million and temperatures to around 4°C above pre-industrial levels. The last time those conditions occurred was about 35 million years ago during the Eocene Epoch when the planet was mostly ice-free, which today would cause a sea level rise of 70 meters (210 ft)[318]. In the US, both Florida and Louisiana have an average elevation of just 31m (100 feet) above sea level, most coastal cities worldwide would be underwater, huge stretches of land would become sea, and enormous population movements would have to occur. Bangladesh, with a population of 170 million, is only an average of 5m above sea level. The purely economic costs of such warming are unimaginably high, let alone the human and environmental costs. And costs would continue to get worse after that. We have to cut emissions, the only questions are when, by how much, and how.

Part of the problem of climate change is the rate at which the earth is warming. If we had a thousand years before New York City and Florida would find themselves 40 meters (120 feet) below sea level, we would have a chance to “mitigate” and “adapt”, but under a business-as-usual scenario, we have at most 100 years. This is far faster than other warming events in earth history[319]. Current greenhouse gas reduction planning is based on trying to figure out what will happen by 2100 under various scenarios. Translating those scenarios into damages that can be weighed against costs of abatement is subject to huge variability.

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[317] The rate of species extinctions has increased 1,000 - 10,000 times “background” according to some estimates, but much of that is due to habitat loss. Rapid climate change (in a period of say, 2 million years) has certainly been a factor in mass extinctions in the past, but we’re not there yet. See https://www.forbes.com/sites/grrlscientist/2023/07/19/modern-sixth-mass-extinction-event-will-be-worse-than-first-predicted/?sh=2b3fe2ad4ab6 and https://ourworldindata.org/mass-extinctions

[318] Stern, Nicholas. 2013. “The Structure of Economic Modeling of the Potential Impacts of Climate Change: Grafting Gross Underestimation of Risk onto Already Narrow Science Models.” *Journal of Economic Literature* 51 (3): 838–59.

[319] If CO2 releases continue at current rates we will warm as much in a couple of hundred years as the earth cooled over the last 50 million. See Also see https://earth.org/data_visualization/a-brief-history-of-co2/.

Still, everyone loves numbers, even shaky ones, so what follows are some estimates of the damage.

In “The Cost of Climate Change,” a book published by the Natural Resources Defense Council, the (many) authors conclude that *even when meeting current targets*:

Global economic damages of climate change are projected to be smaller under warming of 1.5°C than 2°C in 2100 (Warren et al.,2018c). The mean net present value of the costs of damages from warming in 2100 for 1.5°C and. 2°C (including costs associated with climate change-induced market and non-market impacts, impacts due to sea level rise, and impacts associated with large-scale discontinuities) are $54 and $69 trillion, respectively, relative to 1961–1990. [320]

The authors note that:

Balancing the costs and benefits of mitigation is challenging because estimating the value of climate change damages depends on multiple parameters whose appropriate values have been debated for decades (for example, the appropriate value of the discount rate) or that are very difficult to quantify (for example, the value of non-market impacts; the economic effects of losses in ecosystem services; and the potential for adaptation, which is dependent on the rate and timing of climate change and on the socio-economic content).

They also note that the possible damage, even from these reduced emissions targets, goes up substantially when the risk of tipping points which would carry us over the targets are considered. The damage expected from global warming of 3°C - 4°C would be hugely higher.

In 2006, a study commissioned by the British government put damages from business-as-usual climate change at an ongoing 5% of global GDP and an updated version of the model used in that report found that business as usual would cause damages of about $1.9 trillion annually by 2100 and cost about 1.8 percent of US GDP[321].

In the IPCC’s Fifth Assessment Report (2014), they estimated that the global economic impact of a 2.5°C increase in global mean temperature above pre-industrial levels could be between 0.2% and 2.0% of global GDP by 2100[322]. These economic losses are incomplete, and more likely to be underestimated than overestimated, and of course the higher temperatures associated with business as usual will have higher damages costs.

[320] Page 264 (chapter 3) of “Impacts of 1.5°C of Global Warming on Natural and Human Systems” available at https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter3_Low_Res.pdf
[321] https://en.wikipedia.org/wiki/Stern_Review and https://www.nrdc.org/sites/default/files/cost.pdf
[322] P79 Report available at https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf.

The administration of US President Barack Obama developed a central-case damage estimate of $50 per ton of carbon dioxide in 2019. With emissions of around 54 gigatons of CO2e per year, that amounts to about $2.7 trillion, or about 2.7% of global GDP.

A 2021 report by Swiss RE, one of the world's largest reinsurers (they back up consumer facing insurers), says that climate change can be expected to shave 11 percent to 14 percent off global GDP by 2050 compared with growth levels without climate change. That amounts to as much as $23 trillion in reduced annual global economic output worldwide as a result of climate change[323]. Insurers are already feeling the effects of climate change, their finely honed actuarial models seem to have underestimated the risk.

In May of 2022 the Deloitte Center for Sustainable Progress (DCSP) released a report indicating that if left unchecked climate change could cost the global economy US $178 trillion over the next 50 years, or a 7.6% cut to global gross domestic product (GDP) in the year 2070[324].

So much for various stabs at quantifying damages. The "benefit" of greenhouse gas emissions reductions lies in avoiding these damages. Greenhouse gas reductions also include the benefits unrelated to climate change as we mentioned earlier including health benefits from reduced fossil fuel pollution which are quite substantial, and job creation. In 2022, renewable energy jobs reached nearly 14 million and these are "good paying"[325].

On the flip side of the cost benefit calculation, what would it cost to limit global warming to 1.5°C or 2°C in 2100? Before we look at current estimates it's worth noting that the costs of reducing emissions have historically come down while the estimates of damages from warming have gone up. We humans are an extremely ingenious lot, and it is guaranteed that science, engineering, and the market will drive down costs. In 2007, the McKinsey Company published an article on the costs per ton of reducing CO2 emissions by using various technologies[326]. Solar was so expensive it wasn't even included. Since then, solar panel prices have declined 94% from $4.56 per watt to $0.27 per watt in 2021 dollars[327]. As a result, solar is now the least expensive way to generate electricity in many cases. That said, industrial policy helped both solar and wind get started and build scale. The Chinese and the Europeans, to their credit and

[323] https://www.swissre.com/institute/research/topics-and-risk-dialogues/climate-and-natural-catastrophe-risk/expertise-publication-economics-of-climate-change.html
[324] https://www.deloitte.com/global/en/about/press-room/deloitte-research-reveals-inaction-on-climate-change-could-cost-the-world-economy-us-dollar-178-trillion-by-2070.html#:~:text=Deloitte's%20Global%20Turning%20Point%20Report,a%20systemic%20net%2Dzero%20transition.
[325] https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_895440/lang--en/index.htm
[326] A cost curve for greenhouse gas reduction
[327] This is the panel price; the installed price is higher but has declined over 80% for commercial installations. Panel prices from https://ourworldindata.org/grapher/solar-pv-prices, installed prices can be found in Just The Facts: The Cost Of Solar Has Fallen More Quickly Than Experts Predicted - CleanTechnica

economic gain, invested in solar and wind, while the US cut back on renewable energy research and deployment under Regan[328].

Keeping in mind the certainty that prices of green technology will come down with time and scale, there are a range of prices for such technologies. One way to quantify these prices is in dollars per ton of CO2 (or rather CO2 equivalent, CO2e) saved over the greenhouse gas emitting technology. For example, a windmill with a 30-year lifetime, costing $3 million to buy and install, and having operational costs of $45,000 per year, would generate electricity for $36 per megawatt hour when all costs, including capital, are considered[329]. A coal fired power plant releases about a ton of CO2 per megawatt hour, so replacing a coal fired power plant with windmills costs $36 per ton of CO2 not sent up into the atmosphere compared to coal. A fully depreciated coal fired power plants cost $50 per megawatt hour *just to operate* so it actually pays to replace them with new windmills[330]. One could also abate the same amount of CO2 using solar for $28 per ton or nuclear costing over $100 per ton in the US (nuclear is much lower cost in some other countries). This is a great way to measure the long-term bang for buck of replacing existing technology and deciding between which green technologies to employ. One can rank technologies from least costly to most costly by the cost per ton of CO2e reduced when all costs are considered.

However, if we're going to come up with what we will have to spend in the short run to meet emissions targets, we mainly want to consider capital costs, meaning the cost to build or implement a technology, not to run it. In the case of the windmill mentioned above, it would supply about 940 average US households with their electricity so with a capital cost of $3 million, the cost per household would be a onetime $3,191[331]. Replacing a coal fired power plant would take roughly that investment per household served, after which there would be a huge savings in the cost of electricity since wind is free and coal is not. Of course, the onetime cost could be financed just like a home loan for a swimming pool or a roof replacement and built into the cost of the electricity, which is how we came up with the $36 per megawatt hour. In the US the average retail price of electricity is 14 cents per kilowatt hour, or $140 per megawatt hour. That of course includes the cost of the grid and the profits of the utility.

When put in terms of cost per household, the capital costs of green electricity generation, not just for new power needs, but to replace existing fossil fuel power plants, are both highly affordable and good investments that pay dividends going forward. In fact, as we noted above, the operational costs of coal fired power plants are so high that replacing them actually saves money, even with the capital costs of solar included. Worldwide, power consumption per household is much lower than in the United States, and the capital costs per household are

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[328] Just The Facts: The Cost of Solar Has Fallen More Quickly Than Experts Predicted - CleanTechnica

[329] This is the levelized cost of electricity for new land based windmills per https://www.eia.gov/outlooks/aeo/electricity_generation/pdf/AEO2023_LCOE_report.pdf with the $5.5/MWH IRA credit added back in.

[330] https://www.lazard.com/media/2ozoovyg/lazards-lcoeplus-april-2023.pdf

[331] Output calculation includes the fact that windmills only run at 42% of capacity on average. Details at https://www.usgs.gov/faqs/how-many-homes-can-average-wind-turbine-power#:~:text=At%20a%2042%25%20capacity%20factor,than%20940%20average%20U.S.%20homes.

accordingly lower. Developing countries are mostly adding electricity generation capacity using solar, which has the added benefit that it can be installed locally without a long-distance grid.

Once the windmills and solar fields are built, and electric rates potentially go down or stabilize, investment in heat pumps for air conditioning and heating, and electric cars (or plug-in hybrids) for transport, make sense. The greening of the electric supply is affordable, comes with long term cost savings for us consumers, and needs to be done to underpin most other energy related greenhouse gas reductions.

But we digress on our hunt for the total cost of meeting current warming targets of 1.5°C or 2°C. The most direct first attack on this problem was made by McKinsey and Company in the report I mentioned from 2007. That listed various technologies and interventions and their cost in CO2e reductions per ton using engineering methods. Here is the McKinsey and Company global version of that graph from 2009. These “marginal abatement cost curves” have been used to design various programs to encourage reductions.

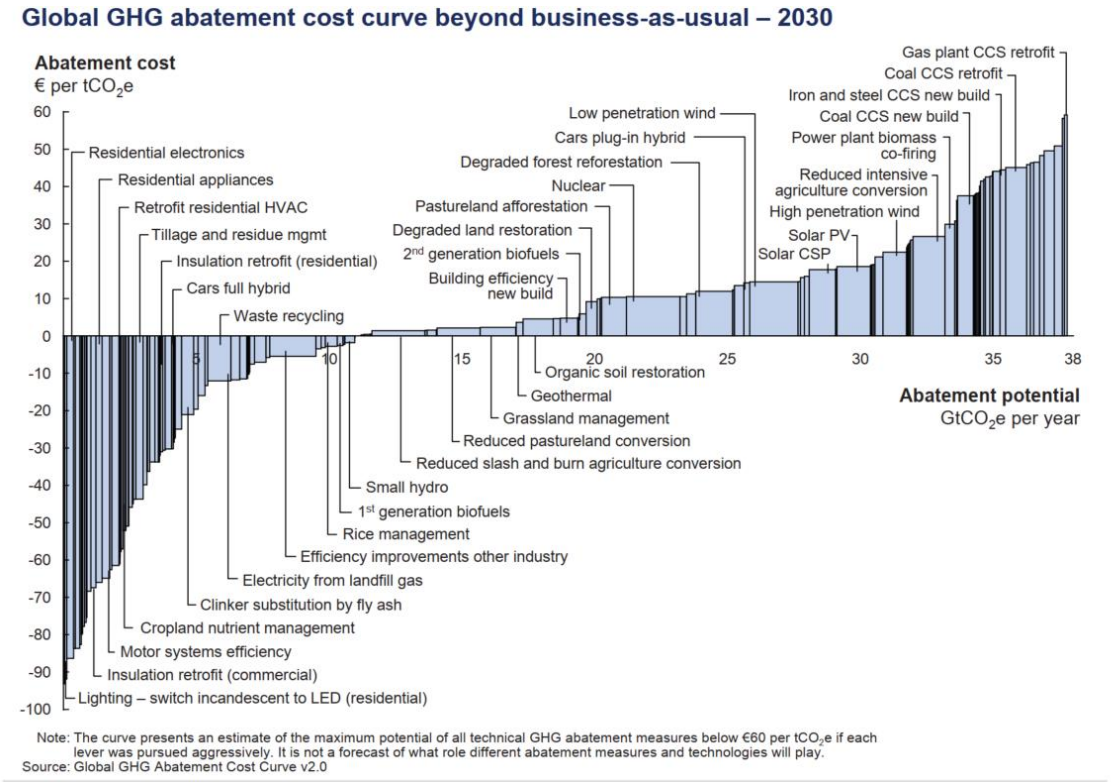


Figure 76: Marginal Cost Abatement Curves Source: Exhibit from “Pathways to a low-carbon economy: Version 2 of the global greenhouse gas abatement cost curve”, September 2013, McKinsey & Company, www.mckinsey.com. Copyright (c) 2023 McKinsey & Company. All rights reserved. Reprinted by permission[332]. WW111

[332] This paper is an excellent way to get familiar with the overall scope and needed actions to reduce warming to targeted levels. Available at https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/sustainability/cost%20curve%20pdfs/pathways_lowcarbon_economy_version2.ashx

This curve is a wonderful way to illustrate how to reduce emissions using the technology and costs available at the time the graph was created. The vertical axis shows the cost of saving a ton of CO2 or equivalent, and the horizontal axis shows how many gigatons of CO2e could be saved by applying the technology. For example, saving a ton of CO2e by generating electricity using nuclear power would cost about 10 euros per ton (about $13 in 2009) above business as usual and could potentially save about 2.5 gigatons of CO2e per year. If all the actions costing below 60 euros per ton of CO2 saved were taken, 38 gigaton per year of CO2e would be saved, which would be more than half the business-as-usual figure of 70 gigatons. Note that a lot of abatement opportunities *save* money while reducing emissions. For example, switching incandescent lights to LEDs saves about 85 euros of actual costs to a family or business for every ton of CO2 it removes. The cost of abating all 38 gigatons of CO2e can be found by simply adding up the areas of all the little blocks on the chart since the vertical axis is the cost per ton, and the horizontal axis is the number of tons saved. The cost-saving abatements are subtracted from the ones that have positive costs.

The authors of the 2009 McKinsey report estimate that if all these actions were taken in the most efficient manner, the additional cost per year worldwide would be $218 to $328 billion in dollars annually by 2030 above business as usual. That includes both depreciation and operating costs. To get to that point we would need to do a lot of upfront investing. The report estimates that $580 billion of additional investment above baseline would be needed per year in 2020 climbing to $885 billion per year in 2030. These are in 2009 dollars, $885 billion in 2009 was worth $1.2 trillion in 2022. Many of these investments would yield long-term energy savings. With worldwide 2022 GDP of $96 trillion we're talking about very manageable investment costs as a percentage of GDP. It is important to note that this is not the full cost of these investments, just what would have to be spent above what would be spent anyway in a business-as-usual scenario to meet climate goals.

Using this estimate of the expenditures required to limit warming to 1.5 to 2.0 degrees C, the cost/benefit ratio compared to the damages resulting from business-as-usual scenarios looks quite favorable. The costs involved, even during the phase of intensive investment, are about an additional 1 percent of world GDP, compared to the damages of inaction which are several percent of GDP according to the estimates we've cited.

That was the engineering view in 2009. In fact, as we have seen, the prices of some key technologies such as solar cells have come down faster than even experts expected and the same would be true for many other technologies if implemented at scale. Remember when a 42-inch HDTV cost $17,457?[333]

The report goes on to note that timing is important because every gasoline powered car, methane power station, or other carbon emitting investment has an average lifetime of about 14 years. The sooner we invest in green technology the greater the benefits.

[333] 2001 Fujitsu Plasmavision 42-inch PDS4221 (RRP $17,457)

A more recent set of abatement curves was included in the International Panel on Climate Change (IPCC)'s 2023 Synthesis Report. In the chart below various types of abatements are shown along with their cost and amount of CO2 equivalent they would keep out of the atmosphere.

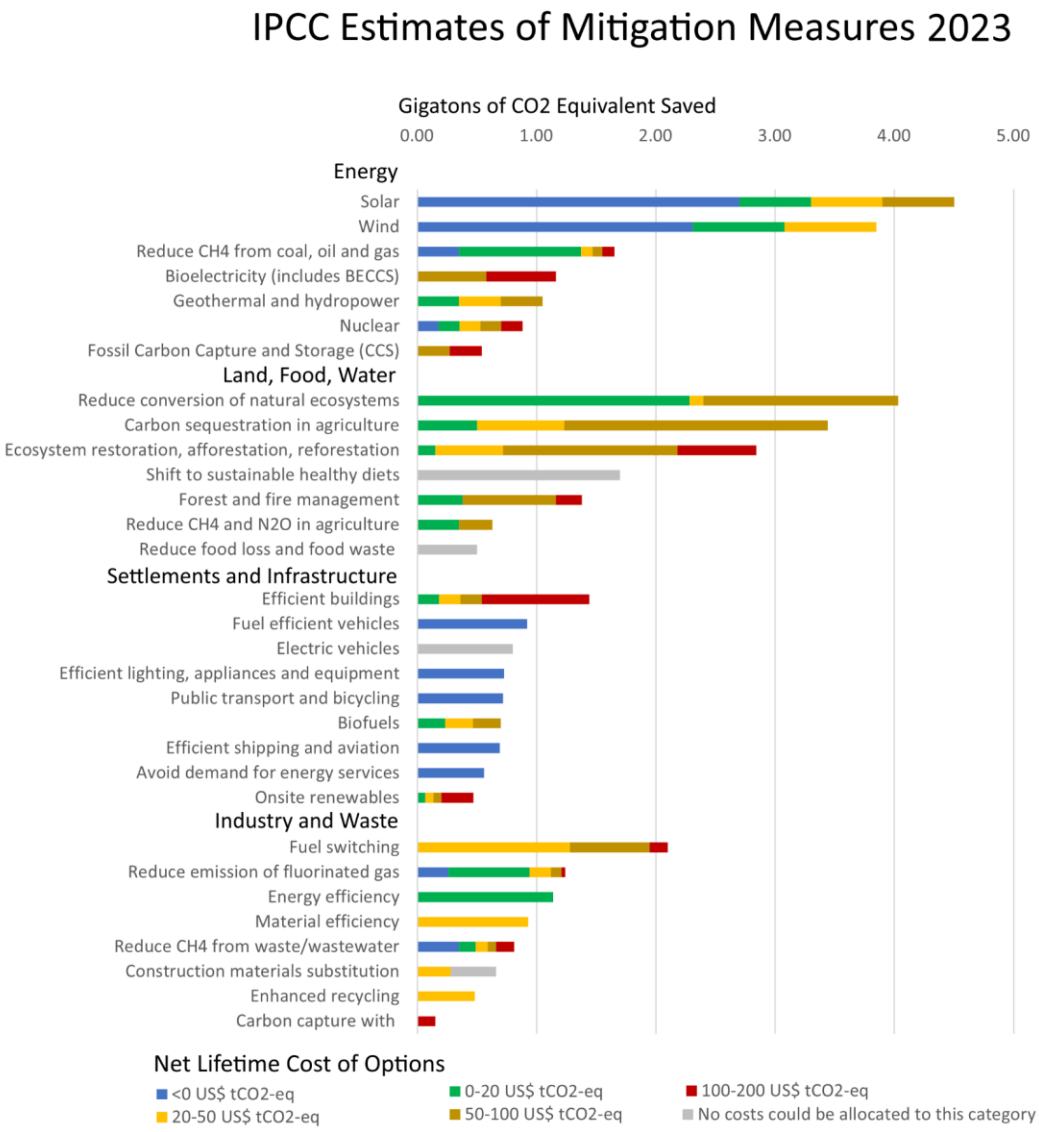


Figure 77: Abatement (aka Mitigation) methods, their cost, and amount of CO2 Equivalent reduction. Source: IPCC Data from the 2023 Synthesis Report[334] WW112

[334] Data from IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, (in press). CC BY 4

The authors point out that employing mitigation options that cost less than $100 per ton of CO2 equivalent would reduce world emissions to half of the 2019 level by 2030. This gives us an idea of the upper limit for costs to meet mitigation goals: half of 2019's 54 billion tons of CO2e emissions is 27 billion tons. If *all* the mitigation options employed cost $100 per ton removed, the net lifetime cost to remove half of them would be $5.4 trillion. A lot of the mitigation options cost less than $100 per ton, in fact some make money, so that is an upper estimate. However, the upfront capital costs would be considerably higher in some cases, such as solar, with the savings following later. Still, with 7 years left until 2030 the investment required seems highly manageable. The same may not be true of other factors though. "Reduce conversion of natural ecosystems" has one of the highest potentials for CO2e reduction, but how do you get there? Politics will play a huge role in determining what gets done and when, even for reductions that have free market economics in their favor.

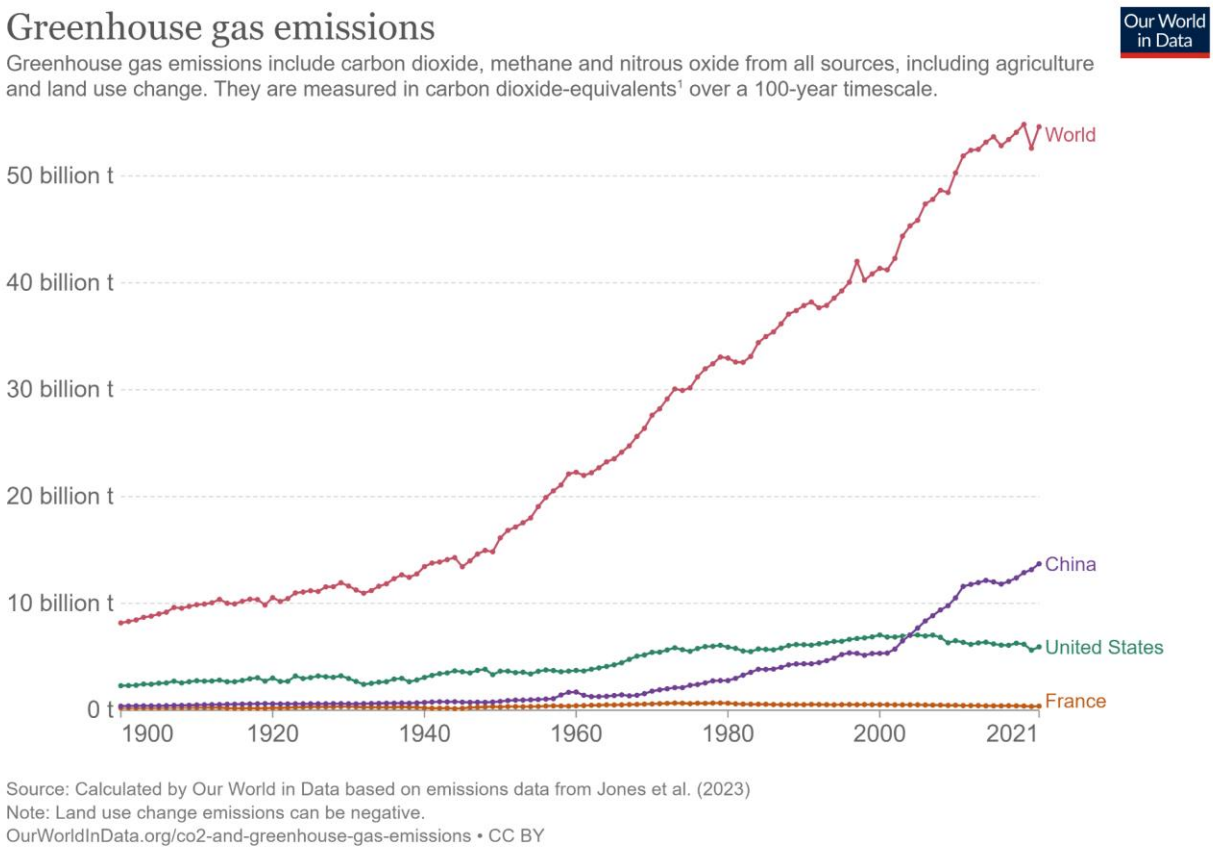
Getting to Net Zero

Where We Are Now and Trends

The Paris Climate Agreement called for actions to limit global warming to 1.5° C or at least "well below 2° C" based on the IPCC's assessment of the consequences of greater warming.

To meet this target, 2010 levels of greenhouse gas emissions have to be reduced by 45% by 2030, and to "net zero" by 2050. "Net zero" means that any residual emissions have to be balanced by increased sequestration of carbon.

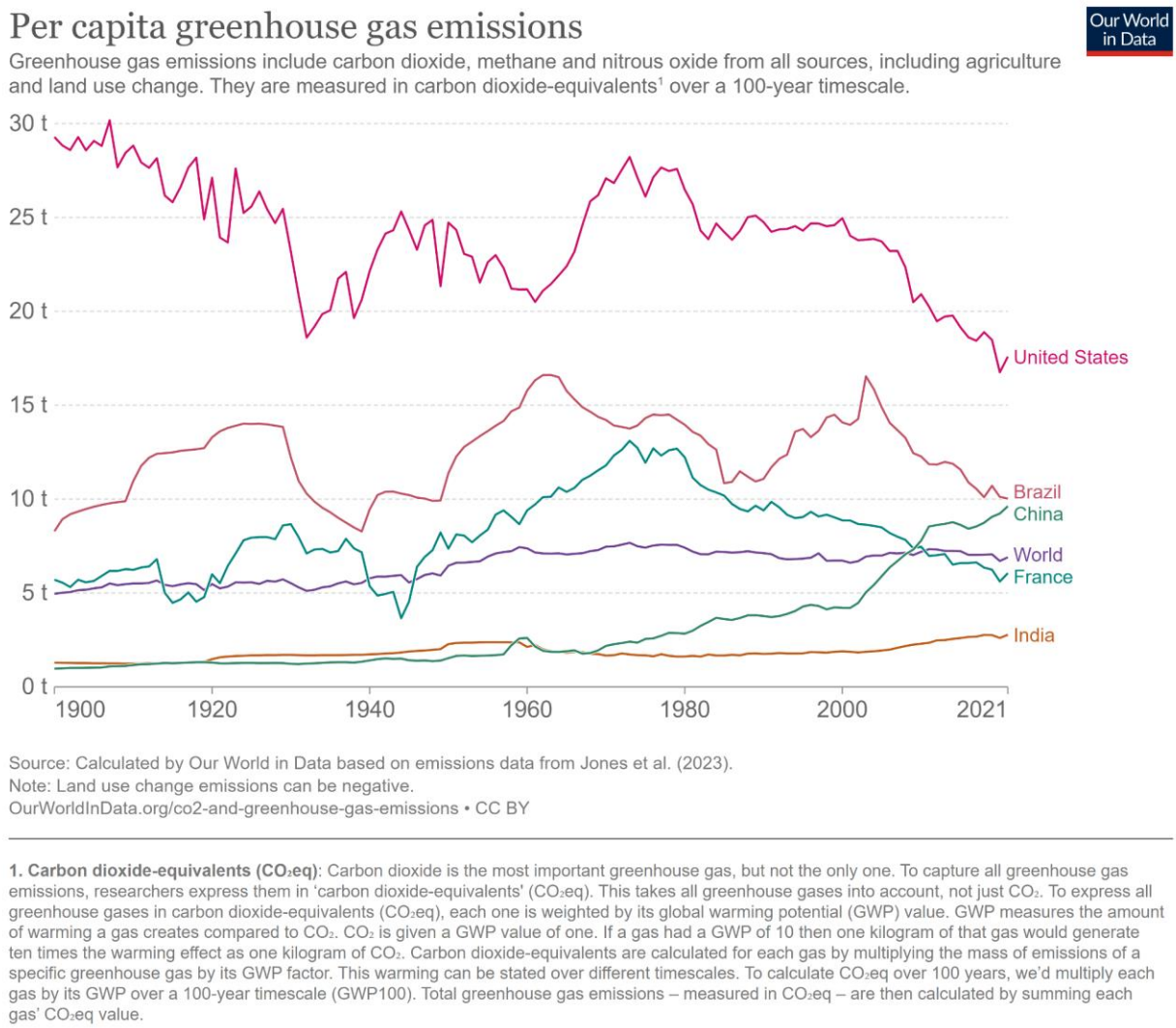
So how are we doing? The two charts below tell the story of CO2e emissions overall, and per person.



1. Carbon dioxide-equivalents (CO_2eq): Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in 'carbon dioxide-equivalents' (CO_2eq). This takes all greenhouse gases into account, not just CO_2. To express all greenhouse gases in carbon dioxide-equivalents (CO_2eq), each one is weighted by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO_2. CO_2 is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO_2. Carbon dioxide-equivalents are calculated for each gas by multiplying the mass of emissions of a specific greenhouse gas by its GWP factor. This warming can be stated over different timescales. To calculate CO_2eq over 100 years, we'd multiply each gas by its GWP over a 100-year timescale (GWP100). Total greenhouse gas emissions – measured in CO_2eq – are then calculated by summing each gas' CO_2eq value.

Figure 78: Greenhouse Gas Emissions in CO2e. Source: Our World in Data https://ourworldindata.org/greenhouse-gas-emissions

World CO2e emissions have increased from about 50 gigatons in 2010 to 54 gigatons annually in 2021. Hardly confidence inspiring. These charts are from Our World in Data. If you head over to the website, you can add other countries, change the timeline and investigate individual greenhouse gases. China is the largest emitter of greenhouse gases but also has the largest installed base of wind and solar power.



1. Carbon dioxide-equivalents (CO_2eq): Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in 'carbon dioxide-equivalents' (CO_2eq). This takes all greenhouse gases into account, not just CO_2. To express all greenhouse gases in carbon dioxide-equivalents (CO_2eq), each one is weighted by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO_2. CO_2 is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO_2. Carbon dioxide-equivalents are calculated for each gas by multiplying the mass of emissions of a specific greenhouse gas by its GWP factor. This warming can be stated over different timescales. To calculate CO_2eq over 100 years, we'd multiply each gas by its GWP over a 100-year timescale (GWP100). Total greenhouse gas emissions – measured in CO_2eq – are then calculated by summing each gas' CO_2eq value.

Figure 79: Per Capita Greenhouse Gas Emissions in CO2e. Source: Our World in Data https://ourworldindata.org/greenhouse-gas-emissions

When we look at emissions of CO2e per person, the story is mixed. The US is still the largest emitter per person, at 17.58 tons per person per year in 2021, but that's a decline of almost 16% since 2010 (20.9 tons). China has seen a steep rise in emissions despite recent heavy investment in renewable energy. Note that emissions include methane and nitrous oxide which are primarily from agriculture and constitute about 17% of world CO2e emissions.

Just looking at the current CO2e trends is gloomy, but there is a reason for optimism. Green electric generation underlies many of the potential reductions going forward. If everyone drove an electric car, that would do nothing to curtail emissions if the electricity was generated from fossil fuels, but once the electric supply is greened, those electric cars become part of the solution. And the electric supply is greening, Bloomberg notes that renewable energy investment in the first half of 2023 was a record $358 billion ($716 billion annual rate), with solar accounting for most of that. China accounted for about half of the solar investment, with the US

a distant second at $25.5 billion[335]. Two charts from the IEA tell the story of power investment. The first shows that spending on renewables and storage and grids now far surpasses spending on fossil fuel power, the second shows fuel supply investment which includes oil and gas exploration and extraction, pipelines, and the like. In an all (or mostly) electric future, very little would have to be spent on fuel supply.

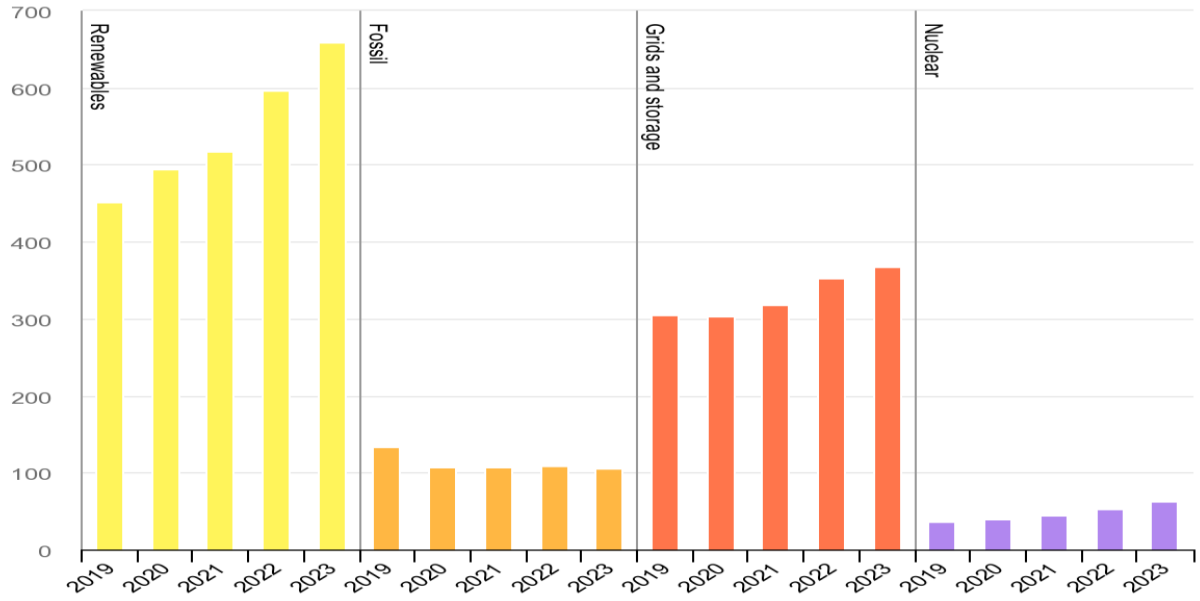


Figure 80: Investment in power generation and transportation.

[335]https://about.bnef.com/blog/renewable-energy-investment-hits-record-breaking-358-billion-in-1h-2023/

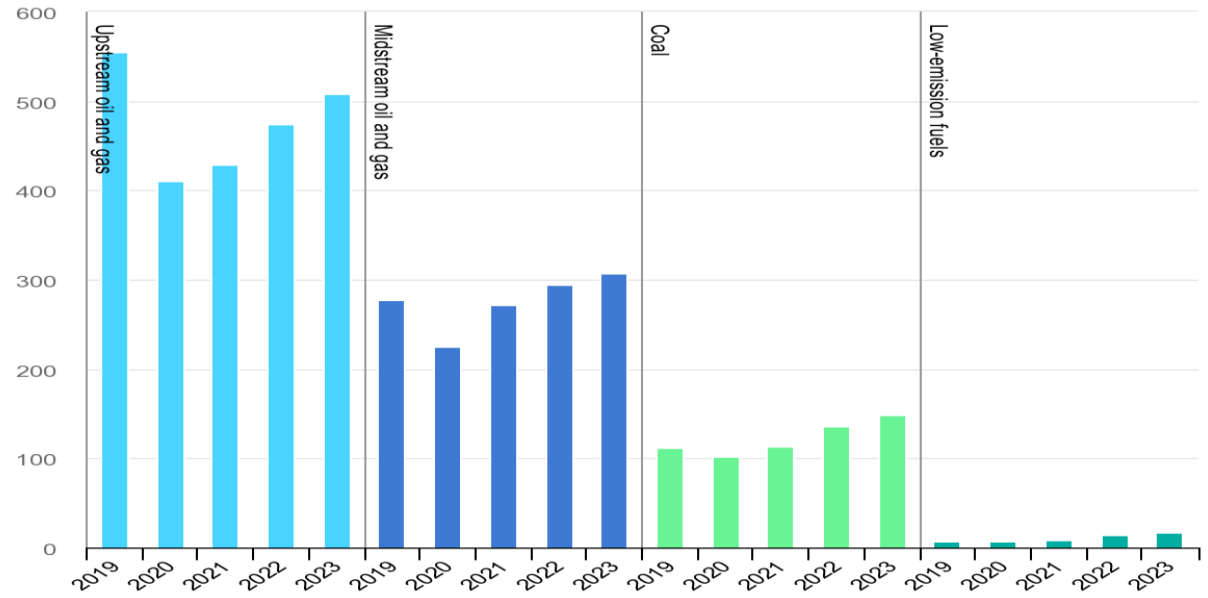


Figure 81: Investment in fuel supply. Source for both figures: International Energy Agency[336]

Bloomberg recently calculated that global spending on renewable energy investment needs to rise to about $1.2 trillion per year between 2023 and 2030, roughly double today's rate, to stay on track to get to net zero by 2050[337]. That is about 1% of global GDP, and that includes what is needed to meet rising demand, so not just for abating existing sources. For example, China is planning to build a record 160GW of new wind and solar capacity in 2023, but that is not quite enough to keep pace with increased post-pandemic demand[338]. Chinese plans call for enough wind and solar to more than meet increased demand and start reducing emissions in the near future.

The chart below shows sources of electricity for three countries and the world. For the world as a whole, two major sources of green energy we haven't discussed much are hydropower and nuclear. According to the International Energy Agency (IEA) only about half of the world's economically viable hydropower has been tapped, but new plants are large, expensive and often contentious[339]. Hydro is one of the most flexible power sources since a plant's output can be scaled up or down very quickly. Nuclear is the other major current source of green energy. As the chart shows, France invested heavily in nuclear power and releases virtually no CO2 from electricity production. The steep price declines in wind and solar have made nuclear a relatively expensive green power option, but it is attractive because it provides steady output, unlike wind and sun. There are new plants being built in Asia, particularly India and China, and

[336] IEA, Power investment, 2019-2023, IEA, Paris https://www.iea.org/data-and-statistics/charts/power-investment-2019-2023, IEA. License: CC BY 4.0
[337] https://about.bnef.com/blog/renewable-energy-investment-hits-record-breaking-358-billion-in-1h-2023/
[338] https://www.carbonbrief.org/analysis-chinas-co2-emissions-hit-q1-record-high-after-4-rise-in-early-2023/
[339] https://www.iea.org/reports/hydropower-special-market-report/executive-summary

paths to net zero call for a doubling of nuclear electricity generation by 2050. In the US, nuclear capacity is being maintained mostly by extending the lives of existing plants[340].

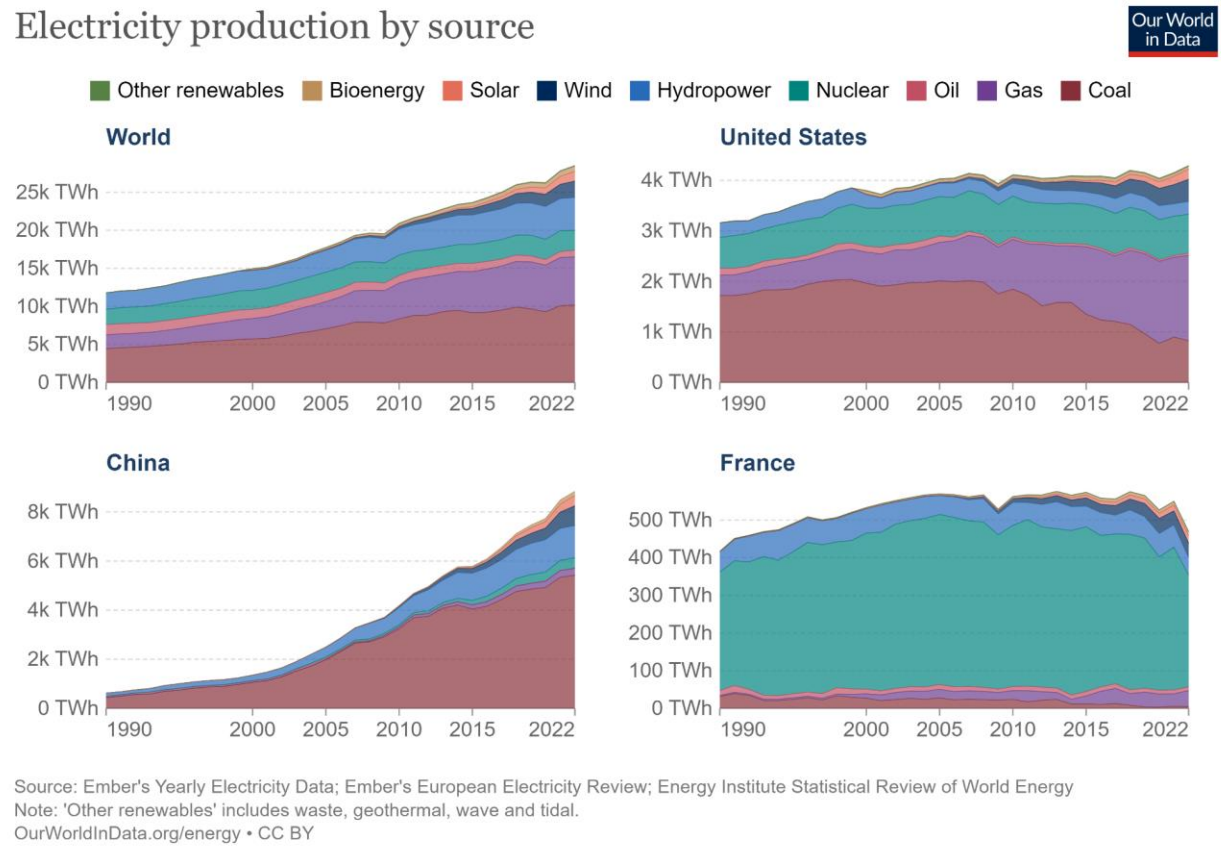


Figure 82: Electricity production by source Credit: Our World in Data[341] WW110

In sum, it looks like the world is mostly meeting new demand for electricity generation through green sources, although China in particular, is building a lot of coal power plants supposedly to back up its variable sources such as hydropower[342]. However, we also need to replace existing fossil fuel electricity generation. It is important to remember that fossil fuels are not free, and every fossil fuel power plant replaced with windmills or solar cells, which have zero input energy costs, results in long term savings. Electricity generation from these renewables is an investment that pays substantial dividends, even without factoring in the climate and health consequences of burning fossil fuels.

The energy sector generates about 3/4 of human greenhouse gases, and electricity generation is key to reductions in that sector. Much of the energy used in transportation (15% of worldwide emissions) can be switched to electricity, and sales of electric cars and plug-in hybrids are

[340] https://world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx
[341] https://ourworldindata.org/electricity-mix
[342] It may seem odd to call hydropower variable, but a drought in China reduced the level of hydropower drastically in 2022. See https://www.reuters.com/business/energy/chinas-new-coal-plants-set-become-costly-second-fiddle-renewables-2023-03-22/

increasing. Currently one in seven cars sold globally is electric or a plug-in hybrid, one in four in China[343]. But that means that 6 out of 7 cars sold globally use gas or diesel, and since cars last about 14 years, we have the problem of sunk costs. Transport is not on track to meet climate targets of 1.5 or even 2.0 degrees Celsius.

Two other sectors that use a lot of energy are buildings and construction. While investments in building energy efficiency were a substantial $237 billion in 2021, overall operational emissions from the sector rose because growth in floorspace outpaced efficiency savings[344]. Electrification can help here: the use of heat pumps for heating in addition to cooling eliminates the need to burn fossil fuels. In Sweden, a cool country, 29% of heating is by heat pumps, and in the US about 40% of new housing uses heat pumps. But existing houses, apartments, and condos still need to be converted to meet climate goals. Worldwide there were only about 17 million heat pumps installed in 2021[345]. A 2022 UN report title says simply, "CO2 emissions from buildings and construction hit new high, leaving sector off track to decarbonize by 2050."

The last main energy consuming sector is industry. Once again, electrification is key, but process changes, efficiency, and new technologies will help. The fossil fuel industry itself is a major contributor to greenhouse gas emissions partly through the venting of methane (also called natural gas) into the atmosphere when extracting oil. Cement production too is a major contributor of CO2 at about 8% of the world total. As with many industrial processes, there are already ways to reduce the carbon footprint of cement production, and more will be found[346]. Under pressure from investors as well as to minimize risk, many companies have pledged to reach net zero emissions by 2050, however I think it is fair to say that most of this is in the planning and research stage.

Finally, there are also greenhouse gas emissions not related to energy, for example the methane released from cow manure and the nitrous oxide released from rice paddy fertilization. Neither of these examples is easy to deal with. "Digesters" exist for managing methane from dung, but there are substantial capital costs, and fertilizer is part of what has made it possible to grow more food on a limited amount of agricultural land. The CO2 reduction curves in Figure 77 show large possible reductions from "reduced conversion of natural ecosystems" and "carbon sequestration in agriculture' '. An American University site explains:

Soils hold three times the amount of carbon currently in the atmosphere or almost four times the amount held in living matter. But over the last 10,000 years, agriculture and land conversion has decreased soil carbon globally by 840 billion metric tons of carbon dioxide (GtCO2), and many cultivated soils have lost 50–70% of their original organic carbon. Because soils have such a

[343] https://www.weforum.org/agenda/2023/03/ev-car-sales-energy-environment-gas/

[344] https://www.unep.org/news-and-stories/press-release/co2-emissions-buildings-and-construction-hit-new-high-leaving-sector#:~:text=Key%20global%20trends,2015%20to%20152%20in%202021.

[345] https://www.greenmatch.co.uk/blog/global-heat-pump-statistics

[346] See for examples https://psci.princeton.edu/tips/2020/11/3/cement-and-concrete-the-environmental-impact.

large storage capacity, enhancing soil storage by even a few percentage points makes a big difference[347]*.*

One data point: in the US, agricultural emissions have risen by 7% since 1990[348]. Second data point: World agricultural emissions have gone from 5.0 Gigatons in 1990 to 5.79 Gigatons in 2019.

In summary, while there is good news in generating electricity from renewables, and this is extremely important as a first step in the energy sector, the curve of worldwide greenhouse gas emissions is at best flattening. The investment required to bend the curve to where it needs to be to meet emissions targets is quite manageable economically as a fraction of world GDP, but much more needs to be done. The primary barriers to action are political and financial, not technical, and some needed actions will take longer than others in any case. The graphic below shows the projected bend in the emissions curve resulting from currently implemented national policies as well as national targets and pledges under the Paris Agreement (discussed in the next section). The pink “no climate policies” is highly uncertain.

[347] https://www.american.edu/sis/centers/carbon-removal/fact-sheet-soil-carbon-sequestration.cfm#:~:text=What%20is%20Soil%20Carbon%20Sequestration,absorb%20and%20hold%20more%20carbon.
[348] https://epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture

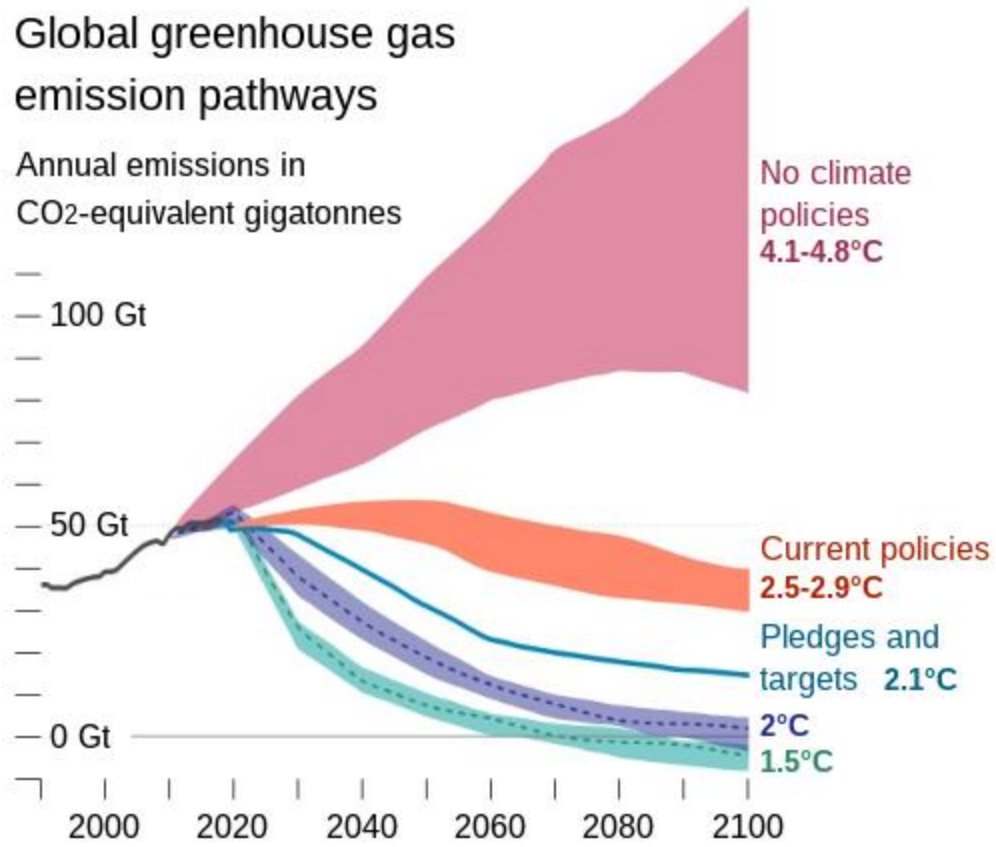


Figure 83: Projected CO2-equivalent emissions. Source: Hannah Ritchie and Max Roser via Wikimedia Commons[349]
WW113

How to Get to Net Zero (or try to)

The Paris Climate Accords and NDCs

Greenhouse gases know no national borders, and it would be unreasonable to expect any country to make the investment to cut its emissions unless other countries are doing the same. To that end there have been several world climate conferences, the most recent taking place in 2015 in Paris, which resulted in the Paris Climate Accords, also often called the Paris Agreement. Under French guidance, these negotiations avoided some of the pitfalls of earlier negotiations and built on Intended Nationally Determined Contributions which countries submitted prior to the conference. After signing the treaty, these pledges of action to meet climate goals become simply Nationally Determined Contributions, or NDCs. The Paris Agreement is a legally binding treaty which specifies that countries will report their progress and update their NDCs on a regular basis, but the NDCs themselves are not legally binding[350]. The US 2021 NDC for example is simply this: “To achieve an economy-wide target of reducing its

[349] This graphic more or less concurs with IPCC AR6 Figure 2.5. Full attribution Hannah Ritchie and Max Roser, adapted for svg and smartphone by Eric Fisk, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

[350] The US objected to the word “shall” which implies legal binding, and the word “should” was applied to meeting NDC targets.

net greenhouse gas emissions by 50-52 percent below 2005 levels in 2030." The rest of the US NDC is an introduction, a brief sector by sector overview of how we intend to reduce emissions, and a section which clarifies the baseline and other items[351]. The whole thing is 24 pages long, so hardly a detailed plan of action, rather an "ambition". The stated aim of the Paris Agreement was to keep emissions to 1.5°C or "well under" 2.0°C.

How would the world do if all the current NDCs were met? According to Climate Action Tracker, an organization that tracks country emissions, if 2030 targets were met, the world would warm by 2.4° C by 2100, if longer term pledges after 2030 are included, temperature could be kept to 2.0° C above preindustrial levels. Current real-world actions and policies are on track for 2.7°C (4.9°F) by 2100, an increase more than double the current 1.2°C warming[352]. In short, the NDCs aren't adequate to keep warming below 2.0°C let alone 1.5°C and current implementation is even further off target. But we should point out that temperature increases under business as usual are estimated to be in the catastrophic 3-4° C range.

In addition to the NDCs the Paris Agreement called for a fund to help finance climate mitigation and adaptation in poorer countries. The wealthier countries agreed to contribute $100 billion a year to this fund. As of 2023, contributions are approaching that level but some countries, most notably the US, have contributed much less than their share.

In 2023 the IPCC issued the mandated 5 year "taking stock" report of progress on meeting climate goals, to be followed in November 2023 by COP28, the follow up to COP21, which resulted in the Paris Agreement. This will be a chance for countries to update their NDCs to make them more "ambitious".

The Climate Action Tracker provides a wealth of detailed information on a country's targets and pledges under the Paris Agreement as well as implemented policies and actual progress. You can find this info at https://climateactiontracker.org/countries/. The two largest greenhouse gas emitters in the world, China and the US are rated "highly insufficient" and "insufficient" respectively. The US NDC is "almost sufficient" (in short, adequately ambitious) but policies and actions to meet the 2030 target of a 50% reduction are inadequate, although the Inflation Reduction Act did provide a big boost. According to the Climate Action Tracker, China's emissions are expected to plateau at a high level in 2025 and stay there for the rest of the decade. While China more than meets its NDC for energy production from wind and solar, energy demand has risen at a similar pace and much of current energy production is from coal.

Policies To Get to Net Zero

Getting to Net Zero involves science, engineering, politics and policies. We've looked a bit at the science and engineering, and getting most of the way there is both possible and reasonable in cost at scale, even with today's technology, and newer and less expensive technologies are in

[351] https://unfccc.int/sites/default/files/NDC/2022-06/United%20States%20NDC%20April%2021%202021%20Final.pdf
[352] https://climateactiontracker.org/global/cat-thermometer/

the pipeline. That leaves politics and policies, two closely related subjects. Economists love to weigh in on policy.

Carbon Taxes, Subsidies, and Regulations

Greenhouse gases are a classic externality in economics as we've mentioned. If you want to choose whether to generate electricity from coal or wind, the waste from coal in the form of CO2 doesn't figure into the accounting. If you had to pay, say $100 per ton of CO2, for waste disposal, maybe by capturing the CO2 and burying it, the calculation becomes quite different. In the case of burning fossil fuels, there are additional externalities: the particulates in the gases that go up the smokestack have health consequences which can be quantified. In theory most economists favor market mechanisms for dealing with externalities. If we could say precisely that a ton of CO2 emitted from burning fossil fuels resulted in $100/ton of climate related damage and $50/ton of health consequences, we could simply add these to the price of burning the fuels and the free market would deal with it. In the case of generating power from a coal plant versus windmills, a tax of $150/ton on emitted CO2 would even the scales so to speak, and the power company would minimize costs by choosing the lower cost option. Even if coal still came out cheaper (it wouldn't), the money raised by the $150 per ton tax on CO2 could be used to abate or compensate for the climate and health consequences. In general, such a tax would result in a lot of research and investment in alternative technologies.

Interestingly, in the US back in the day, some Republicans favored a carbon tax because it is a free-market mechanism and requires less bureaucracy than a cap-and-trade system. But from a political perspective anything that can be called a tax, even if revenue neutral, is a difficult proposition in the US[353]. In addition, climate damage is cumulative, the damage from a rise of 5°C is not five times the damage from 1°C, in fact it may be completely catastrophic. There is also the problem of the short window within which we need to accomplish the required GHG reductions. Carbon taxes usually increase automatically over time so that the lowest cost abatements happen first while allowing time for technology to tackle higher cost abatements. Still, the blunt tool of a carbon tax probably cannot guarantee we meet targets on time by itself, even where politically feasible, although it would help enormously.

Another way to achieve GHG reductions using market mechanisms is "cap and trade". In a typical cap and trade system, a government (country, state) issues CO2 allowances. Each allowance allows the owner to emit a ton of CO2 and is good for one year. Companies either bid for these allowances or are given them, either way they have to have enough to cover their emissions for a year. At the end of the year, companies have to show they have sufficient allowances to match their emissions or pay a penalty. The "trade" part of cap and trade is a market where companies can sell allowances to other companies. If a company can figure a way to reduce its emissions it can sell some of its allowances, and another company can buy and "bank" them against future emissions. Why would a company "bank" allowances? Every

[353] The entrenched fossil fuel interests have virtually unlimited money with which to influence public opinion and political will.

year the total number of allowances issued goes down to meet GHG reduction goals, and a company which faces high costs of abatement currently, will find it less expensive to buy and save allowances than to reduce emissions. In this way the market drives emissions reductions with the least expensive reductions happening first.

Cap and trade and carbon taxes are both market based. A carbon tax directly sets the price of emitting greenhouse gases, while a cap-and-trade system, by limiting the supply of allowances, drives their price up as well. In both cases it is the cost of emitting greenhouse gases that drives reductions. But while a carbon tax is universal, cap and trade can only be applied to major emitters because of the complexities of administration - imagine if you had to buy allowances to cover the cost of the CO2 you emit by driving and heating your house. That said, in California which has a cap-and-trade system, 80% of greenhouse gas emissions are covered, while companion programs achieve reductions in areas not covered by cap and trade[354].

The European Union has a long-established cap and trade system which both auctions allowances in the power sector and gives free allowances to other industries such as manufacturing with the number of free allowances declining from year to year. In 2022 the EU allowance price rose to an average of $83 a ton of CO2e and, worldwide, allowance sales amounted to $63 billion[355].

Carbon pricing, either through a carbon tax, or through a cap-and-trade system, can be very effective when an industry, say energy generation, is “carbon intensive”. The same is somewhat true of consumers: the oil price increases of the early 1970’s spurred the development and sales of high gas mileage cars[356]. The opposite, carrots versus sticks, way to use pricing and markets to spur private innovation and investment is for a government to provide subsidies. In the US, the Inflation Reduction Act provides large subsidies to encourage businesses and homeowners to reduce emissions, mostly through tax credits. For example, for clean energy generation projects, companies can get a 2.75 cents per kilowatt hour production tax credit, meaning that they can take that amount off their taxes for every kilowatt generated. Since the cost of generating electricity with natural gas, say, is comparable with wind at about 4 cents a kilowatt hour, this is quite a significant subsidy and tilts the playing field to clean energy production[357]. Subsidies are an easier sell politically and can be combined with other policy objectives. The Inflation Reduction Act subsidies favor domestically produced electric cars for example. Also, in many cases buyers respond more to the upfront cost of a purchase than its

[354] https://ww2.arb.ca.gov/resources/documents/faq-cap-and-trade-program#:~:text=If%20an%20emitting%20entity%20covered,times%20whatever%20is%20still%20owed.
[355] https://www.reuters.com/business/sustainable-business/record-63-billion-raised-carbon-allowance-sales-2023-report-2023-03-22/
[356] For a while anyway until prices moderated. Also partly due to the CAFE standards https://www.pewtrusts.org/~/media/assets/2011/04/history-of-fuel-economy-clean-energy-factsheet.pdf
[357] A detailed but accessible guide to the IRA can be found at https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf. There are briefer summaries such as https://www.epi.org/blog/the-inflation-reduction-act-finally-gave-the-u-s-a-real-climate-change-policy/#:~:text=The%20dominant%20strategy%20the%20IRA,lead%20to%20reduced%20GHG%20emissions.

life cycle cost. If an electric car costs $10,000 more than a comparable gas-powered car, a buyer may not buy it even if the electric car's life cycle cost is considerably less than the gas powered one when fuel, maintenance, and longevity are considered. In such cases a subsidy on the initial purchase price of the car works better than a carbon tax on gasoline[358]. Of course, carbon taxes and subsidies can be combined.

There are times when taxes and subsidies don't work well. A home builder may choose to put in a gas furnace because it's cheaper than an electric heat pump and it's the homeowner who will be paying for the gas. In such cases, regulations are needed. Home building regulations, also known as local building codes, have long specified the insulation levels for walls and windows, and one that specifies that heating and cooling not use fossil fuels is simple to add.

In short there are many levers that governments can operate to reduce GHG emissions. More recently large companies have gotten involved in lobbying for climate action and in "greening" their own operations. Very little of the huge surpluses the oil companies have been making have gone into green investment according to the IEA[359], but other companies have realized that uncertainty over climate change is a significant risk factor when planning investment. Obviously, insurance companies are terrified, but the concern is not limited to them and a group of 131 companies with annual sales of a trillion dollars recently urged quicker phaseout of carbon fuels[360].

Importance of Scale and Industrial Policy

The falling cost of solar cells is no accident. While the technology was largely developed in the US, China essentially owns the market. How did that happen? It's an interesting story[361]. The Germans and then Spain and Italy instituted major financial incentives for generating solar power starting in the 2000's and were overwhelmed by demand. China saw the opportunity to sell solar cells at scale to these countries, and at the same time build a high-tech industry. They bought foreign solar companies and invited others to move to China, where they found cheap, skilled labor and received tax credits. Most of the cost reduction in recent years has been from economies of scale which require very large factories, and China put up $47 billion in financing to help companies build large semi-automated plants. Finally, when supply capacity caught up with demand from abroad, China started its own program of buying solar energy at generous

[358] The IRA rules on this are a complex mess and the choice of a "nonrefundable" tax credit for vehicles means that lower income people can't partake.
[359] Much of it is going into dividends and stock buybacks and also debt service. See https://www.iea.org/reports/world-energy-investment-2023/overview-and-key-findings.
[360] https://www.reuters.com/sustainability/cop/nestle-volvo-among-130-companies-urging-cop28-agreement-ditch-fossil-fuels-2023-10-23/#:~:text=Nestle%2C%20Volvo%20among%20130%20companies%20urging%20COP28%20agreement%20to%20ditch%20fossil%20fuels,-By%20Tommy%20Wilkes&text=LONDON%2C%20Oct%2023%20(Reuters),to%20phase%20out%20fossil%20fuels.
[361] An overview is provided in a Scientific American article at https://www.scientificamerican.com/article/why-china-is-dominating-the-solar-industry/

prices to build up its solar energy generation capacity. In the meantime, US solar companies found it impossible to compete with the prices of Chinese solar cells.

In short, China did what any well-run company would do: saw a market direction and opportunity and invested heavily in it. That is an industrial policy success story. The larger story of solar is one of governments purchasing technology at scale to kick start an industry and drive down prices through innovation and scale.

Carbon Offsets

Delta Airlines claims to be "the world's first carbon-neutral airline". Electric planes don't exist, so how can Delta be carbon neutral?

In many carbon trading schemes, a company can buy carbon credits to balance out its emissions. A carbon credit is earned when a ton of CO2 that would go into the atmosphere is somehow saved. If a company "saves" as much CO2 emission as it causes, it can claim carbon neutrality. One of the main sources of carbon credits is "preventing" deforestation of the Amazon and works simply by paying someone not to chop down and burn the trees. The market for these offsets is largely unregulated and an investigation found that "Verra rainforest credits used by Disney, Shell, Gucci and other big corporations were largely worthless, often based on stopping the destruction of rainforests that were not threatened, according to independent studies."[362]

Of course, real carbon offsets do exist. Delta and Shell could pay to install verifiable direct carbon capture and sequestration on difficult to abate sources, but of course this would cost much more. In any case the numerous problems with voluntary carbon credits suggest they should simply be eliminated or at least limited to verifiable and regulated emissions reductions, probably with a minimum price well above $100/ton and adjusted upward over time.

Engineering Cost Estimates vs Real World Behavior

The abatement curves we looked at earlier are based on the then-current engineering cost estimates of abating a ton of CO2e. Economists have pointed out that some of these estimates are unrealistic given real-world behavior and, in some cases, don't accord well with empirical studies. For example, while the abatement curves show that residential insulation retrofit saves money and thus costs less than zero per ton of CO2 saved, one comprehensive study of a free program of residential weatherization concludes that it actually costs around $350 per ton of CO2 saved[363].

[362] https://www.theguardian.com/environment/2023/may/30/delta-air-lines-lawsuit-carbon-neutrality-aoe
[363] https://www.sciencedirect.com/science/article/abs/pii/S0301421518301836 (click View Open Manuscript)

This is not an argument for not trying, but rather an argument for broad market-based approaches, for not tying programs to technologies but rather results, and for evaluating real world costs and effectiveness[364].

Climate Change Summary

In brief, the "sustainability" issue of climate change is really the unsustainable way we emit greenhouse gases. When we burn fossil fuels, we are simply dumping our trash into the atmosphere, much like taking out your household trash and dumping it in the backyard. There are a lot of humans and we're dumping 37 billion tons of waste CO2 into the atmosphere every year. There is a linear relationship between human released CO2 and the level of CO2 in the atmosphere and rising temperatures, and without limiting greenhouse gas emissions the earth will, within a century, become a really unpleasant place for humans and a great many other animals to live. But the temperature rise won't stop there. So, the sooner we reduce emissions, the less ongoing future damage will be done.

Fortunately burning fossil fuels for energy is really ancient technology like the bow and arrow, bloodletting, and doing laundry on rocks by the river. We have better technology now. Nuclear is a great, fossil fuel free, way to generate energy, but is somewhat expensive. Fortunately, high tech windmills and solar cells generate electricity more cheaply than fossil fuels even without considering climate change and health costs. Solar doesn't even require a grid, and unlike fossil fuels it's widely distributed, and sunlight and wind are free. Unlike coal, oil or gas.

We've looked at some of the ways we can reduce CO2 emissions, and the good news is that the investment required, while substantial, is quite manageable. And the operational costs going forward are much lower in many cases. We looked at what it would cost to replace a coal power plant with a windmill and found that it pays to tear down even a fully depreciated coal power plant and replace it with windmills. The cost of electricity from windmills, including the capital cost, is lower than the operating cost of the coal plant. Thinking about what it would take to "decarbonize" a family brings the required investment into focus:

- Electricity: replacing fossil fuel burning power generation with renewables saves money, so cost is zero to your family (your electric rates stay the same)
- Switching from a gas-powered car to an electric or plug-in hybrid: You're going to replace your car eventually and the price of electric cars (which are easier to build) will come down to match that of gas-powered ones. Operational costs (electricity vs gas maintenance) will be lower with the electric car. Zero cost to your family.
- Heating and cooling your home: heat pumps are already used widely in warm locations. In places where families use fossil fuels to heat their homes, heat pumps will have to

[364] For the range of costs of climate interventions and policies per ton of CO2e abated extracted from the economics literature, see Gillingham et al in "The Cost of Reducing Greenhouse Gas Emissions." at https://www.aeaweb.org/articles?id=10.1257/jep.32.4.53.

replace furnaces. This can require a significant one-time investment of say $20,000 in the US, but government subsidies are available to cover much of the cost.

There are two problems with this rosy picture. While the capital costs are quite reasonable, we have assumed that they will be met over time. You won't ditch your two-year-old gas car for an electric one until you feel the need for a new car. There will be a shortage of qualified heat pump installers, and they will be expensive. Windmills and solar fields can only be constructed so fast, and undepreciated gas-powered generation plants are sunk costs. In short, the quicker we want to reduce carbon emissions, the higher the net capital costs.

The other problem is political. This is not a book about politics, but we can't ignore the strong ties between implemented policy and money interests. There's a lot of money made from fossil fuels. There will be a lot of pressure to slow decarbonization, push ineffective carbon offsets, and adopt expensive technologies such as carbon recapture and hydrogen from fossil fuels.

The above discussion focuses primarily on CO2 emissions from energy production. We have also seen that there are less tractable greenhouse gas emissions from agriculture and land use.

That said, the greenhouse gas abatement curves we've looked at show that we have the technology to get to "net zero" emissions by 2050 at a reasonable cost when measured against country and world GDP. The problem in the end is more political than technical or even financial.

Land

With 8 billion people on the planet, climate change isn't the only sustainability issue we humans are facing. It takes a lot of land to feed 8 billion people and will take more as population heads to 10 billion. Agriculture requires water and in many places on earth we take more water from river systems than goes into them. Fish are a wild population threatened by overfishing. After climate change, perhaps the most serious sustainability problem we have is land use for agriculture.

Agriculture - The Meat of the Problem

There is a limited amount of biologically productive land on earth, and we humans currently use about 50% of it for agriculture. The graphic below from the Our World in Data article "Land Use"[365] shows the use of land for food production over time. Also note the tiny amount of land used for cities, towns, and villages ("Built-up Area" in the graphic).

[365] Hannah Ritchie and Max Roser (2013) - "Land Use". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/land-use' [Online Resource]

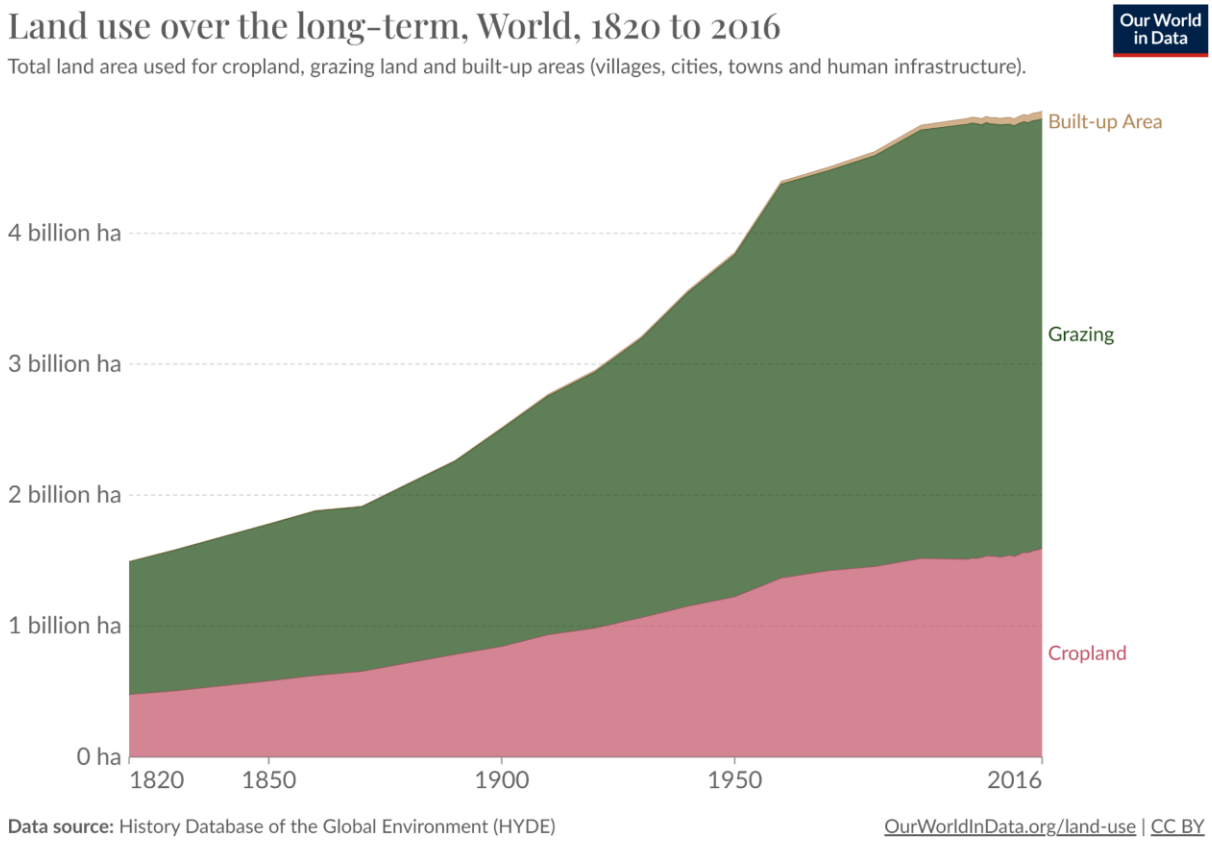


Figure 84: Land Used for Crops, Grazing, and Habitations. Source: Our World in Data, article by Hannah Ritchie and Max Roser

There were roughly 1 billion humans on the planet in 1820 and 7.5 billion in 2016, a factor of 7.5 times, so the increase in agricultural land use of only 3.3 times is a testament to the incredible productivity increases of mechanized agriculture and the “green revolution”. Not only were agricultural productivity increases able to feed the world on less land per person, but we have largely eliminated the cyclical starvation that used to exist in some regions.

Given that, would it really be a big deal to feed an extra 25% more of us in 2050? In order to answer that question, we have to look at agricultural land use a bit more closely.

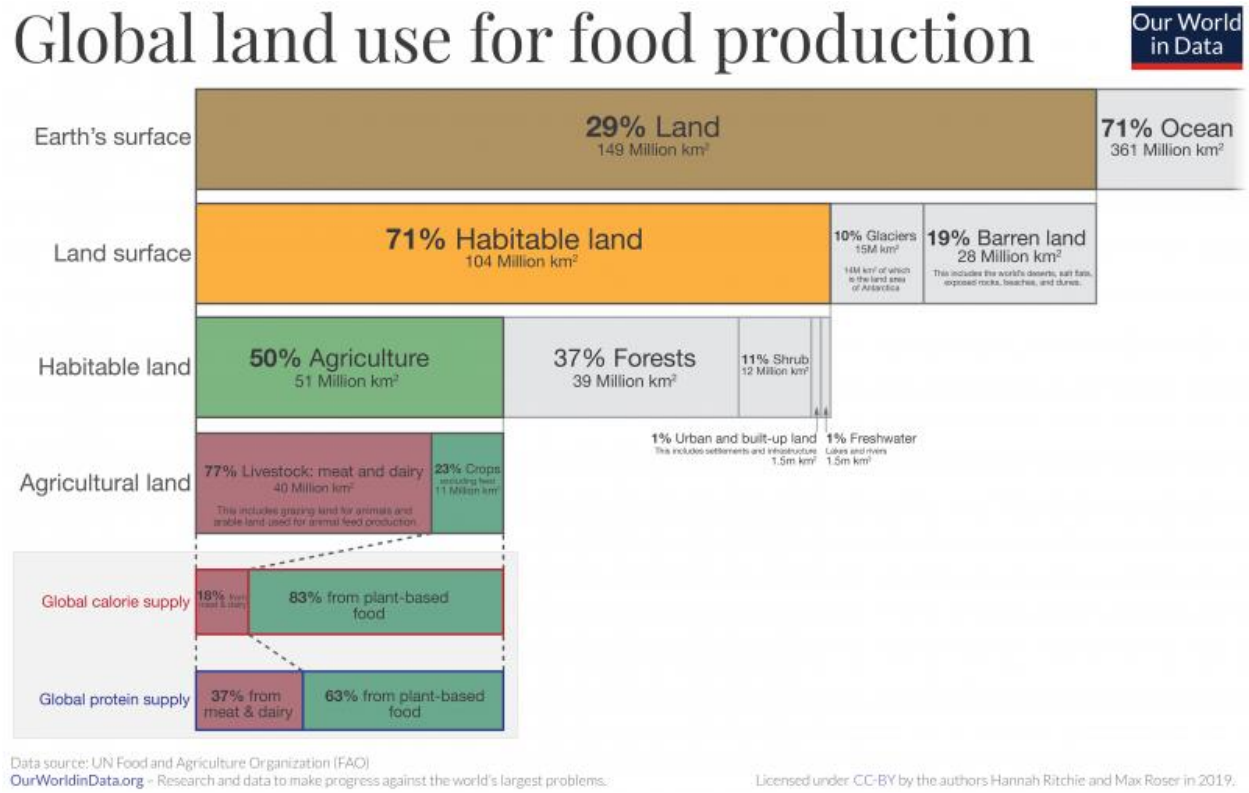


Figure 85: Land Used for Food Production. Source: Our World in Data, article by Hannah Ritchie and Max Roser

If diets and agricultural productivity were to stay the same, an extra 2 billion people would require that 63% of habitable land be devoted to agriculture, up from about 25% in 1900[366].

But diets will not stay the same. As countries get richer, people buy more meat, and, as the graphic shows, most of the world's calories come from crops but three quarters of the agricultural land is used for livestock production, either for grazing directly or for crops grown to feed animals. In the US, a lot of corn is grown to feed cows and in China a lot of soybeans to feed pigs. Growing meat is inefficient in that a lot more food energy goes in than comes out. The table below shows this inefficiency by type of meat. Chickens, for example, turn 11% of the calories in their feed into calories in the meat that is eaten, and only 20% of the protein in their feed into meat protein. Clearly cows are considerably more inefficient.

[366] https://ourworldindata.org/land-use#:~:text=Over%20the%20last%20few%20centuries,area%20was%20used%20for%20farming.

Table 21: Meat growth inefficiencies. The last column shows how much of a weight of feed is converted into a weight of edible meat. The first two columns have similar statistics for the conversion of inputs into outputs but account also for losses due to waste and spoilage. Source: https://awellfedworld.org/feed-ratios/

	Calories in feed to calories in meat %	Protein in feed to protein in meat %	Feed Conversion (feed weight to meat edible weight) %
Poultry	11%	20%	22%
Pigs	10%	15%	11%
Cows	1%	4%	4%

If everyone in the world ate meat like an American (125 kg = 275 lb. per year, a lot of it beef) or a Brazilian (97 kg) or even an Italian (69 kg) we would need more than 100% of all habitable land on earth to provide for the required pasture and feed crops. Conversely if everyone on earth ate like a Chinese (61 kg, but mostly pork), an Algerian (19 kg), or an Indian (4.5 kg) we would need less land than currently farmed. Clearly an increasing worldwide demand for meat, beef in particular, will push up the amount of agricultural land required even in the absence of further population growth.

How much is the demand for meat likely to grow? In the charts below, we can see that world per capita consumption of meat has increased steadily as people's incomes have increased and the relative price of meat has fallen. Chinese consumption of meat, primarily pigs, rose sharply but has recently leveled off, as has overall consumption of meat in the US. In France meat consumption has declined over the past two decades. We can also see that consumption of poultry, the most efficient of meats, has been relatively increasing.

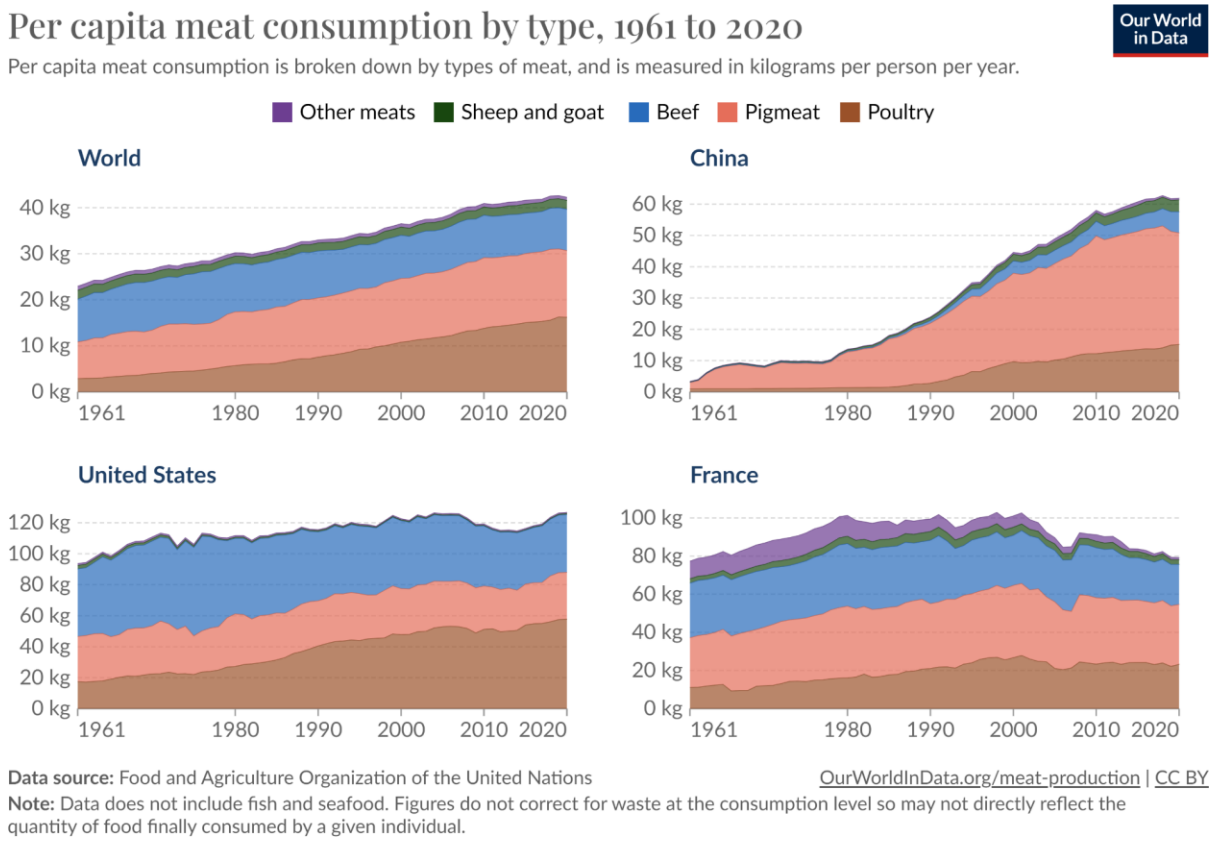


Figure 86: Per Capita Meat Consumption. Graphic Source: Our World in Data https://ourworldindata.org/meat-production

In an article entitled “Are We Approaching Peak Meat?” the authors find that meat consumption grows with GDP per capita until a certain level is reached, after which there is no correlation between these measures[367]. The GDP per capita they report is $40,000 (2019 dollars) which would imply a pretty large increase in demand for meat, but the graphs above show that there is a lot of variability between countries. Demand in China seems to be leveling off despite a still growing GDP per capita of $12,000, and in France, meat consumption is declining even though people only eat about half as much meat as we do in the US. Even in the US, chicken consumption has increased relative to beef, and it takes less feed to grow the same weight of chicken. So, meat consumption depends on a lot of factors including culture, price, and distribution of income. All we can say is that given past trends, demand for meat will continue to increase in developing countries leading to an overall increase in demand worldwide, and that demand is likely to be substantial. Given the inefficiency of meat production relative to primary crops, this will drive the need for additional agricultural output, which in turn will lead to more land cultivation unless agricultural productivity can grow fast enough to keep up.

[367] Whitton, Clare, Diana Bogueva, Dora Marinova, and Clive J. C. Phillips. 2021. “Are We Approaching Peak Meat Consumption? Analysis of Meat Consumption from 2000 to 2019 in 35 Countries and Its Relationship to Gross Domestic Product.” Animals: An Open Access Journal from MDPI 11 (12). https://doi.org/10.3390/ani11123466. I think further multivariate analysis is called for.

Before we look at whether agricultural productivity can keep up, let's look briefly at the situation in some specific countries. The US is blessed with a lot of highly productive agricultural land compared to its population. In fact, the US has 1.21 hectares (3 acres) of agricultural land in use per person, while China has .37 hectares (.91 acre) and India .13 hectares (.32 acre)[368]. With 3 times as much agricultural land per person as China, and 10 times as much as India, the US can support current levels of consumption. So, where's the beef, so to speak? Agriculture, like oil, is traded worldwide. The US is a huge exporter of agricultural products including dairy products and meats as well as soybeans for animal feed, but perhaps surprisingly, our exports of agricultural products at $177 billion in 2021 were almost exactly balanced by our imports of agricultural products at $171 billion[369]. Even in Sub-Saharan Africa, agricultural imports and exports are almost balanced, with the difference due to countries rich in resources such as oil[370]. The point is that agriculture is truly a worldwide business and has to be thought of that way. Less grain fed to livestock anywhere in the world makes land available for more efficient crops which reduces the total demand for agricultural land. Since overall, the bulk of agricultural land is used to produce meat, eating less meat would reduce the amount of new farmland required to feed an increased population, or could even reduce current usage.

But of course, we're not going to repeal the laws of supply and demand, and as people get richer, they will want more meat, although maybe less cow and more pig and chicken. Can that be accomplished without expanding the amount of farmland? In particular, can we produce more of what people want using the same amount of land?

While the increase in agricultural productivity has been dramatic over the last half century, both in crop and in meat production (think factory farming), further increases in productivity are likely to be slower as countries reach the productivity frontier. Worldwide agricultural total factor productivity growth[371] slowed to 1.14 percent per year in the decade from 2011 to 2021, which is well below the 1.9 percent growth rate required to sustainably grow agricultural output to meet population growth, according to the Virginia Tech 2023 Global Agricultural Productivity (GAP) Report[372]. The chart below from that report shows that these productivity gains were not evenly distributed. As we have noted before, most of the growth in output in Sub-Saharan Africa was due to increasing land under cultivation, while in South Asia and China almost all the growth was from increased productivity. In the United States, productivity growth was stagnant, almost

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[368] https://www.brookings.edu/articles/unpacking-the-misconceptions-about-africas-food-imports/#:~:text=SSA's%20top%20exports%20are%20mainly,oilseeds%2C%20and%20frozen%20meat%20products.https://ourworldindata.org/grapher/agricultural-area-per-capita?country=OWID_WRL~OWID_NAM~OWID_SAM~OWID_AFR~OWID_EUR~OWID_ASI~USA~CHN~IND

[369] https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/agricultural-trade/#:~:text=Total%20U.S.%20agricultural%20trade%20rose,in%202021%20to%20%24171%20billion.

[370]

[371] Total factor productivity (TFP) is growth in output not due to increasing inputs such as land.

[372] https://globalagriculturalproductivity.org/wp-content/uploads/2023/10/2023-GAP_Executive-Summary_FINAL.pdf Agnew, J. & Hendery, S. (2023). 2023 Global Agricultural Productivity Report: Every Farmer, Every Tool. Virginia Tech College of Agriculture and Life Sciences. The report is based on USDA Research Service data.

all the increase in output was explained by increasing inputs such as fertilizer. While crops differ, US agriculture is probably close to the productivity frontier and this suggests that that new growth in agricultural productivity follows the expected curve of fast at first, and slower later, as countries adopt best practices, scale, and use of capital. Looking at the chart also makes it clear that the growth of land under cultivation in Africa is unsustainable. We looked at some of the reasons for this trend in the section on agricultural productivity and concluded that economic development will be key to both slowing population growth in Africa and in increasing per-capita GDP. With growth in GDP and non-farm employment will come investments required to boost agricultural productivity, including infrastructure investments to help get products to market and reduce waste.

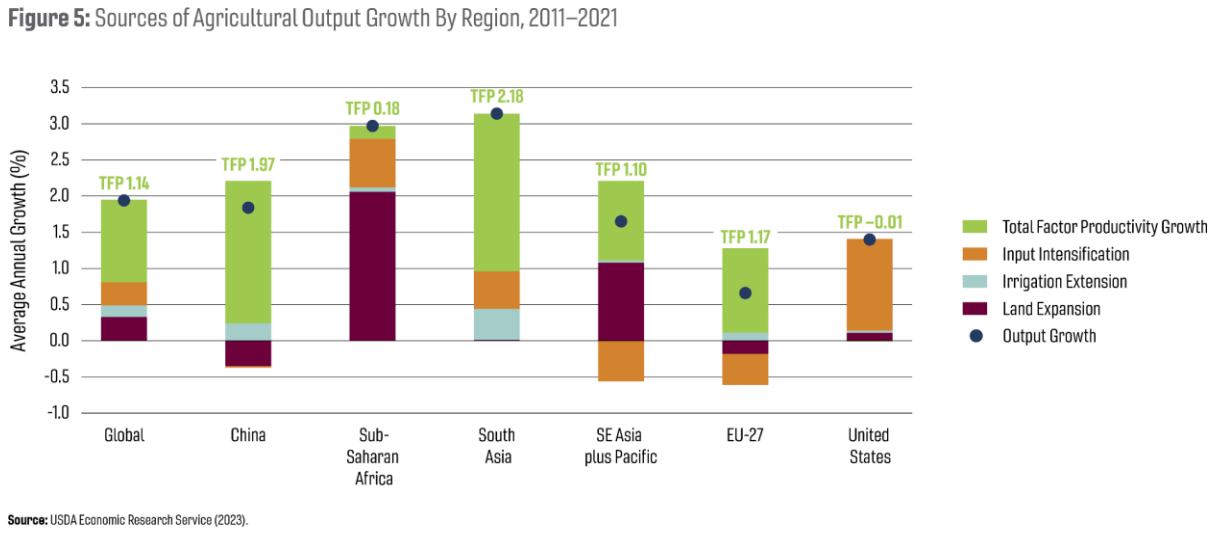

Figure 87: Sources of agricultural output growth by region. Source: Virginia Tech 2023 Global Agricultural Productivity (GAP) Report based on US Department of Agriculture Economics Research Service data. Used with permission.

Clearly productivity gains can help reduce the amount of added agricultural land required to meet demand. Anything that can be done to help that along, especially in Africa, would be good. But it seems highly unlikely that productivity gains by themselves will be sufficient to meet the demand of 10 billion people with more disposable income.

Up to now, we haven't made the connection between climate change and land use, but the two are intimately related. Deforestation, and methane emissions from raising livestock, are drivers of the greenhouse gas emissions from agriculture, which we saw was one of the major sources outside the energy sector. Chopping down the Amazon to raise cattle is not good for climate change. The methods we discussed for reducing greenhouse gas emissions apply to both of these agricultural sources. Reducing deforestation in the interest of climate change would also address its conversion to farmland, and requiring methane capture from raising livestock would raise the price of meat considerably, which would reduce demand. Meat could of course be taxed directly in proportion to its effect on both climate change and land use, although that is unlikely given political realities. For some time now there has been declining demand for meat in

some countries and a switch from beef to chicken in others, so cultural and health effects may help keep growth down. Finally, in addition to plant-based meat substitutes, work is progressing on cultured meats. In theory the latter could be more efficiently grown than meat on the hoof.

The flip side of agriculture's impact on climate change is climate change's impact on agriculture. NASA used the output of climate models as input to state-of-the-art global crop models to predict what would happen if greenhouse gas emissions stayed on current track. These predictions, specifically focused on corn and wheat, found that maize (corn) crop yields would decline 24%, while wheat could potentially see growth of about 17%[373]. Other studies find mostly reductions in yields from climate change including to rice crops in Asia[374]. In short, climate change may make it more difficult to feed the world and increase variability in output from year to year.

Extinction is Forever

There have been five mass extinction events in earth's history in which 75% or more of species were eradicated. Human-lead habitat destruction and climate change so far are not anywhere in that ballpark. We haven't yet competed with the asteroid that ended the dinosaurs with the sudden impact of 10 billion Hiroshima sized atomic bombs[375]. None-the-less current extinction rates are between 1000-10,000 times higher than the "background" extinction rate seen before modern times[376]. Besides extinctions, there are widespread reductions in animal populations as would be expected from habitat reduction. The International Union for Conservation of Nature (IUCN) has undertaken the enormous task of analyzing the populations of 150,000 species and finds that 42,100 (28%) of them are threatened with extinction. That includes 41% of the amphibians, 27% of the mammals, 34% of the conifers, 36% of the corals, and 13% of the birds, among others[377]. Other scientists analyzing this data calculate that many other species not on the threatened species list are also showing population declines that precede extinction. They point out that 48% of the covered species are declining in population from habitat loss, fragmentation and degradation, the widespread use of pesticides, herbicides and other chemicals, overexploitation and hunting, and the effects of invasive species, aggravated by runaway climate change[378]. Clearly cutting down forests for agriculture is not going to help this situation, especially in the tropics where many of these species live.

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[373] https://climate.nasa.gov/news/3124/global-climate-change-impact-on-crops-expected-within-10-years-nasa-study-finds/

[374] https://www.frontiersin.org/articles/10.3389/fpls.2022.925548/full

[375] https://abcnews.go.com/US/asteroid-wiped-dinosaurs-powerful-10-billion-atomic-bombs/story?id=65537028#:~:text=Scientists%20have%20found%20hard%20evidence,atomic%20bombs%20of%20the%20same

[376] https://www.forbes.com/sites/grrlscientist/2023/07/19/modern-sixth-mass-extinction-event-will-be-worse-than-first-predicted/?sh=2b3fe2ad4ab6

[377] https://www.iucnredlist.org/ Interesting to note that the birds are doing relatively better. They are the only dinosaur descendants to survive the Yucatan asteroid. Something to be said for mobility and feathers.

[378] https://onlinelibrary.wiley.com/doi/10.1111/brv.12974

Here is the population story for African elephants. Turns out there is a forest species and a grasslands species, both threatened, the former critically, by habitat loss and poaching for ivory.

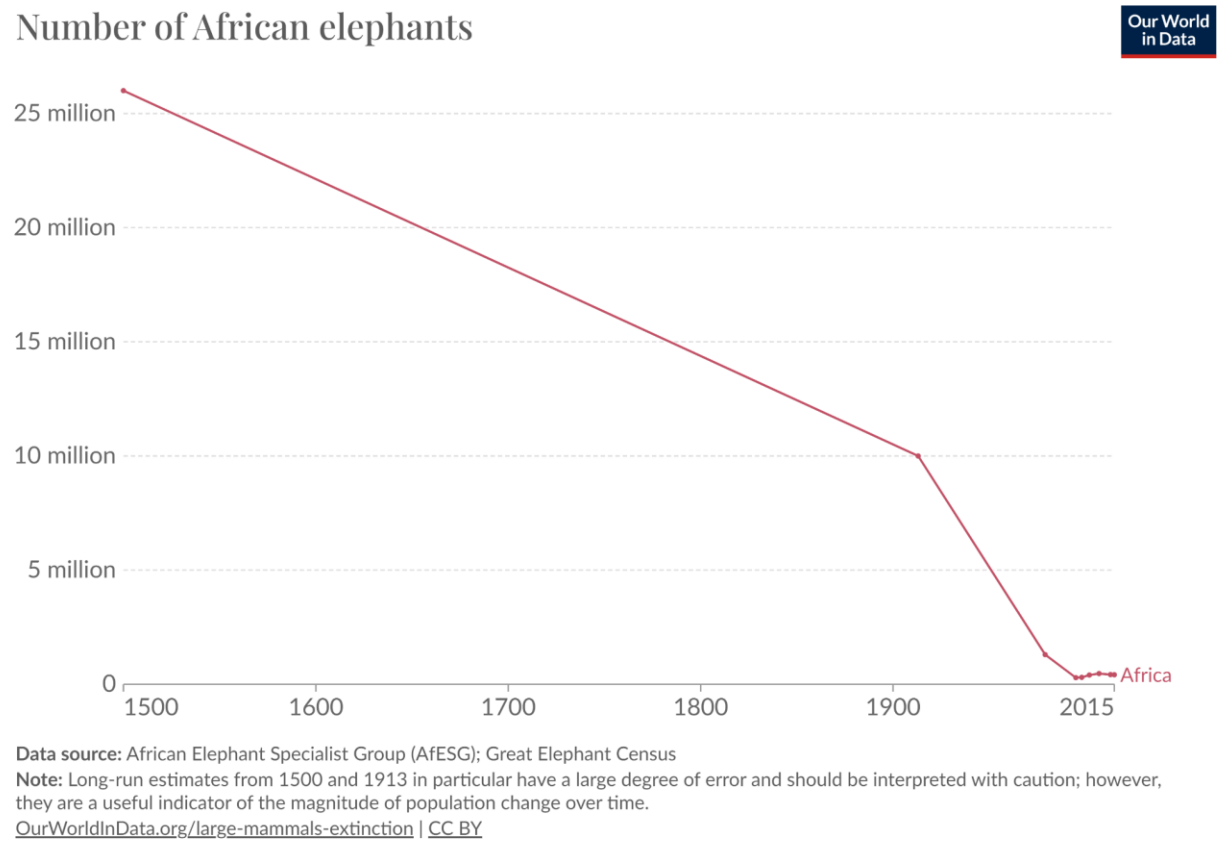


Figure 88: Number of African Elephants. Graphic Source: Our World In Data

There are about 415,000 African elephants left in the world and their population is still declining. Compare that to 8,000,000,000 humans.

We should leave a little room on the earth for our fellow inhabitants.

Other Sustainability Issues

Climate change and land use are the two heavy lifts of sustainability that we have to solve. With such a large human population, though, we have to treat almost everything we extract from nature sustainably. After all, it turned out that the atmosphere was limited, at least in its capacity to absorb our waste. We won't discuss other sustainability issues other than to mention them, but they include managing **water** where that is a scarce resource, such as in the US Southwest and Sub-Saharan Africa; **fisheries** so that the 200 million tons of food we extract from the seas doesn't cause the commercial extinction of species; and certain **minerals** such as phosphorus which is an essential ingredient of fertilizer. Concrete is made with **sand** which, believe it or not,

is a finite resource. Estimates say we could run out of construction grade sand by 2020[379]. While we've looked briefly at agricultural land requirements, we haven't looked at what is needed for agriculture to be sustainable. There are many other physical world sustainability issues, such as the impact of plastics on the environment and the illegal trade in wild animals.

Like climate change, all of these issues require regional or global cooperation. It really is one world, dominated by humans.

[379] Scientific American, February 2024, p 62

Part III - One World

I started this survey of world economics with the intention of trying to get the big picture as free from preconceptions as possible. Of course, like all of us, I had some, but I worked hard to try to follow where the data lead, and not cherry pick statistics and studies that supported my preconceptions. As a result, I found myself surprised at times. Take for example the relationship between wages and productivity. I had read that worker wages in manufacturing had not increased as much as labor productivity, which looks unfair. But further examination showed that increased labor productivity requires increased capital investment, and that production cost savings are largely passed on in the form of lower prices for manufactured goods. So, the relationship is far from straight forward.

“Not straightforward” certainly applies to trying to untangle economic statistics. How does one pinpoint the effects of technology change, trade, and migration on the distribution of income? Especially when things change all the time. We have looked at some of the econometric studies on issues like this, but I think it's fair to say that economists differ, and they tend to produce studies that support their positions (they’d say they have “serial correlation”). For a non-economist sorting through the assumptions and simplifications involved in these studies to try to arrive at a balanced view requires quite an effort, but they are essential input in understanding the dynamics of the big picture. Other statistics, such as the distribution of income over households are comparatively straight-forward.

The Big Picture

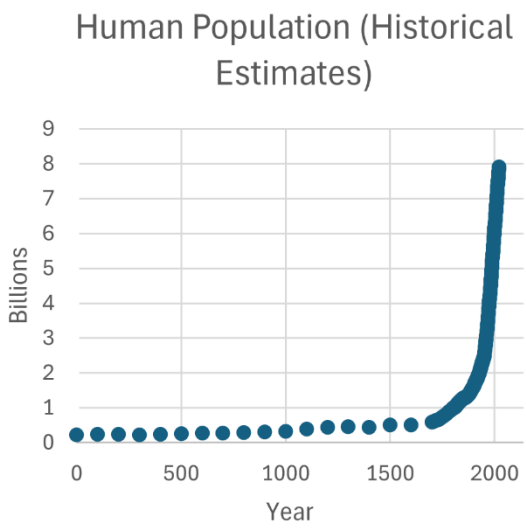
Any attempt to look at “world economics” broadly in a reasonable number of pages will necessarily be an incomplete outline. We’ve looked at some widely accepted tenets of modern economics and examined data and research that looks at the drivers of economic growth, the distribution of income and wealth both within countries and worldwide, and some of the issues of globalization and sustainability that are hallmarks of our times. We conclude that humanity forms one highly interconnected economic system which is rapidly running into the limits of what our planet can support. What follows is a summary of a summary.

Humans Dominate the Planet Physically

We have entered the Anthropocene, the geologic age named for humans, with a vengeance[380]. Throughout much of human history, population growth was checked by disease, famine, and war. With the advent of the scientific and industrial revolutions death rates declined precipitously thanks to better hygiene, vaccinations, increased food production and better transport. In Europe, birth rates of 30-35 per 1000 inhabitants per year were essentially matched by death

[380] The Anthropocene Epoch has not been approved yet as an international standard, but will be once a more or less irrelevant start date is agreed upon.

rates of 30 per 1000 in 1800. By 1900 the death rate had halved, but birth rates remained high[381]. The result has been an explosion in the human population.



Not only is the human population, at 8 billion and growing, far greater than that of any large species before us, but the animals we raise for food outweigh all wild birds and large mammals by a factor of ten[382].

Our waste gases are changing the climate of the planet at a rate not seen since about 50 million years ago when there were major ongoing volcanic eruptions. While productivity increases in agriculture have allowed us to grow vastly more food on each hectare of land, increasing demand for meat as the world grows richer would require the use of more arable land than exists on the planet on present trends. As a result, the amount of wild land on earth has fallen and with it the populations of wild animals. Humans are indeed now "stewards of the earth"[383]. No one nation can take on that role by itself, it will require us to work together to reach a future that is within the ability of the earth to support.

Of course, this growth in human population is very much a success story for us and our technology. We are a spectacularly successful species. Fortunately, as we have seen, the birth rate falls as people become better off. The worldwide birth rate has fallen from over 5 births per woman in 1960 to near the replacement rate of 2.3 births per woman now. This is already causing a slowdown in population growth with "peak human" predicted to be in the range of 10 to 11 billion people, but that is still a huge increase. Reaching a sustainable future is well within the capability of humanity even with current technology. The investment required is also quite manageable and pays huge future dividends. But at present the effort is progressing too slowly.

The World Economy is Thoroughly Globalized and It's Not Going Back

Economically the world has been knit together through "globalization". Lower transport costs, financial fluidity, the rapid dissemination of technology, and communications that make it easy to integrate production and services across the globe have created an interdependent world

[381] Van Bavel, J. 2013. "The World Population Explosion: Causes, Backgrounds and -Projections for the Future." *Facts, Views & Vision in ObGyn* 5 (4): 281–91.
[382] Humans make up just 0.01% of Earth's life – what's the rest? - Our World in Data
[383] In addition to the science, the major religions all preach that humans must care for the earth. See Religions and the Environment (UN) and Opinion: Christians Are Called To Be Good Stewards Of The Earth (Liberty University student newspaper).

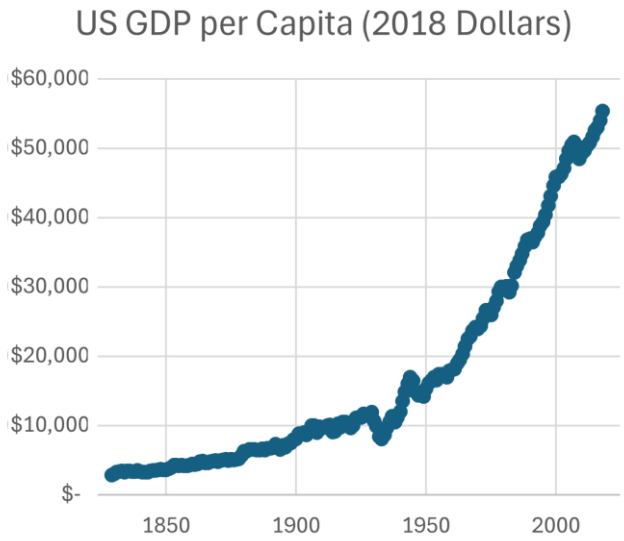
economy in which, for most countries, the value of imports and exports combined is around half the size of their GDP. It is highly unlikely that globalization will give way to economic isolationism: smaller countries simply cannot produce everything they need and larger countries such as the US, where trade is 25% the size of GDP, gain enormously from it. Since trade is often a contentious issue in the US and other “advanced economies” we’ve looked in depth at both the theory and economic data on trade and found that the dislocations often attributed to trade are, in fact, mostly due to automation and productivity increases. While it took 80% of the population to grow food in the US in the 1700’s, it now takes less than 1% of the population. Automation has also greatly reduced the need for labor in manufacturing. Manufacturing accounted for about 30% of employment in the US in 1960 and about 8% today. Some part of that decline, perhaps one fifth at one point, was trade related, but even in advanced countries such as Germany with a huge trade surplus the decline in manufacturing employment has been similar. Overall trade has enormously benefited the inhabitants of rich countries, 80% of whom now work in “services”, through lower prices and a wider selection of goods and services. Unfortunately, the decline in manufacturing employment, regardless of cause, has created economic hardships for displaced workers and specific regions. It is important to understand the causes, however. Trade is often scapegoated, and its benefits underappreciated in the wealthy countries. While people can see rising prices, prices that stay the same over time, or fall in real terms, aren’t so easy to see.

Developing countries also have benefited from trade. It has provided funding, through foreign investment, for economic development and capitalization. We’ve looked a bit at this process in China, where foreign firms invested in clothing manufacturing in the special economic zones, and later in electronics.

One of the benefits of free trade is that it naturally leads to the efficient production of goods and services, an effect we discussed in terms of both theory – comparative advantage – and in the data. When trade barriers are removed there is an initial “trade shock” which leads to affected industries and their workers suffering, but in the end overall productivity increases. It is the memory of this adjustment period that lingers, but, in a world of lower trade barriers, countries’ economies adjust and then evolve more naturally in line with productivity changes. China still produces a lot of clothes, but a lot of that business has moved to what are now lower labor cost countries and China has moved up the productivity ladder to produce more capital-intensive goods.

Productivity Has Made the Rich Countries Rich

We in the “advanced economies” are vastly richer than we were 100 years ago, on average. At least so the statisticians say, we’ll get into why it may not feel that way in the last chapter. The chart below shows the long term estimated GDP per capita adjusted for inflation in the US. The production of food and manufactured items is so efficient now that most people work in service jobs in advanced economies. Income and productivity are directly related, the more output value you can produce per hour of work, the higher your labor productivity and usually your income.



We've noted that while most of the labor productivity gains are due to improved technology and scale, some of the gains are due to increased use of capital. That means that wages can't go up at quite the same rate as labor productivity gains but increases in productivity remain the main driver of income gains. Historically many services have had lower productivity growth than manufacturing, so we might expect overall productivity and income growth to be slower in the future in advanced economies. AI may upend that expectation if it significantly increases major service sector productivity.

Productivity is Rising in the Developing Countries but Unequally

Worldwide, productivity growth is faster in what are called the developing countries than in the advanced economies. No surprise because capital investment in such an economy can leapfrog directly to the latest technology, while advanced economies are already there.

Because income is closely linked to productivity, this means that income is also rising in developing economies, with a direct relationship between capital investment, productivity, and income. But there are large differences between countries in their rate of productivity growth, and even countries with high productivity growth rates, such as China, are expected to take decades to catch up to still growing advanced economy per-capita income levels. Does this matter? We'll consider that in the final chapter, but it does mean that "labor" will continue to be cheaper for a long time in the developing economies than in countries on the productivity frontier. Labor intensive businesses will move around the globe continuously as countries climb the productivity ladder, other things being equal.

Other things are of course not equal, which explains why productivity is growing faster in some developing countries than others. Economists find that faster growing countries have been characterized by better initial education levels, greater political stability, and governance, and greater or deepening economic complexity. The last factor is almost tautology: it says that as your economy gets more diversified it develops synergies that can increase growth. With stability and a reasonable level of business friendliness, a market economy will attract investment and participate in "global value chains" (i.e. trade other than basic commodities) which in turn will fuel further growth. Corruption, wars, and lack of an educated workforce will impede investment whether foreign or domestic. Urbanization, the flow of people from low

productivity agriculture to cities, is as much an effect of productivity growth and industrialization as it is a cause.

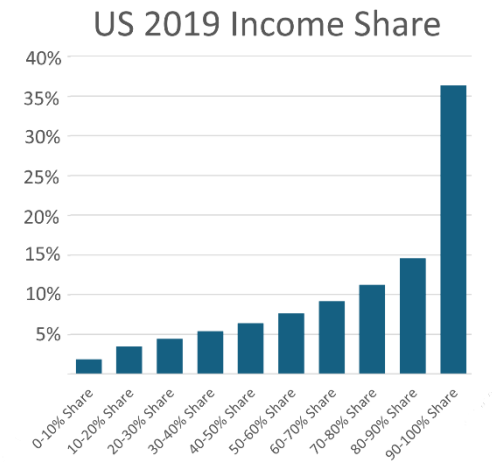
On top of these drivers of per capita economic growth sits demographics: if your population grows faster than your economy, people get poorer in the aggregate. Low productivity growth rates in Sub-Saharan Africa are made worse by high birth rates. In many of the advanced economies, and in China, the aging population threatens aggregate productivity: retirees who don't work add to population but not to output. But demographics don't directly affect per worker productivity.

Low productivity growth rates plague some of the poorest countries in the world.

Income and Wealth Inequality Is High

The rich countries are very rich compared to the poor countries. The median daily cash income worldwide in 2018 was $7.50 in US purchasing power according to the World Bank. Try to survive on $7.50 a day in the US! The poor worldwide tend to live together in extended family groups to save money and pool resources. While they often don't have legal title to their land, in rural areas they farm small plots and own their house, albeit a mud hut or shanty. In Udaipur, a tourist destination region in India, a survey of poor households found that 14% owned a bicycle, 10 percent had a chair or a stool, and 5 percent owned a table. Fewer than 1 percent had an electric fan, a sewing machine, a bullock cart, a motorized cycle of any kind, or a tractor. No one had a phone[384].

The rich countries are indeed much richer than the poor countries. Per capita GDP in the US was $62,459 in 2018 while in India, a lower-middle-income country, it was a tenth of that at $6,689 in US purchasing power (and lower in dollars at exchange rates).



The differences in income between countries, large as they are, are dwarfed by the differences between families within countries or for that matter across the globe. In the US, one of the richest countries on earth, about 12% of the population falls below the official poverty line, which is an estimate of the point below which a household of a given size has pre-tax cash income insufficient to meet minimal food and other basic needs. Meanwhile at the other extreme are families making many millions of dollars in income annually and even more in capital gains.

[384] Banerjee, Abhijit V., and Esther Duflo. 2007. "The Economic Lives of the Poor." *The Journal of Economic Perspectives: A Journal of the American Economic Association* 21 (1): 141–67.

The chart shows the fraction of income going to each decile of households, which also gives the relative income of households. As we discussed, the top decile certainly sticks out, and when that is analyzed in detail there is an equally skewed distribution within just the top ten percent. We also noted (Figure 34) that taking a tiny slice of the top ten percent income bar and adding it to the lowest income bars would eliminate poverty. Transfers and taxes on declared income have only a modest effect on income distribution in the US.

Worldwide, household income distribution is similarly skewed with forty percent or more of national incoming going to the top ten percent.

Wealth distribution is even more concentrated than income distribution worldwide and within countries. Worldwide the top ten percent own three quarters of the wealth.

Migration, the Good the Bad and the Ugly

The world has always had migrations as people seek to better their fortunes or escape wars and persecution. There are nearly 300 million migrants in the world today, more than half of whom are “guest workers”. Europe and North America receive and host the most migrants. Some countries such as the oil rich kingdoms of the Middle East rely heavily on migrants for labor: nearly ninety percent of the population of the United Arab Emirates is composed of immigrants who are in the country under temporary labor contracts. Due to the decline in birth rates and the aging population in many advanced economies such as the United States and Germany, migrants make the difference between a declining workforce and a stable one. Migrants to the US are credited with preventing a post COVID recession by filling jobs for which businesses couldn’t otherwise find workers[385].

New immigrants’ skills often compliment the native-born population, agriculture in the US relies heavily on immigrants, but immigrants may also compete for some jobs such as in construction. As with trade, this additional supply of labor can dampen wage growth in those occupations but that reduces the prices of the affected goods and services for everyone else. Economic studies show that over a couple of generations new immigrants in the US and many other advanced economies become indistinguishable economically from the general population, so the long-term effect of immigration is a growth in the population and an equal growth in GDP.

In addition to job competition, new immigrants compete for shelter which can raise housing costs. In the US, immigration has an overall positive effect on tax collections at the Federal level, but state and local governments bear local service costs such as for education.

From the immigrant’s point of view, when they move from a low productivity country to a high one, their productivity and income prospects improve greatly. That is also the world economic

[385] Rovella, David. 2024. “US Companies Plead for More Immigrants Amid Tight Job Market.” *Bloomberg News*, March 5, 2024. https://www.bloomberg.com/news/newsletters/2024-03-05/bloomberg-evening-briefing-us-companies-want-more-immigrants. The availability of work of course also attracted migrants.

effect: such immigrants improve overall global GDP and productivity and send “home” much needed earnings.

The ugly side of immigration includes the wars and starvation that force many to risk their lives, the perennial negative politics in receiving countries, and the exploitation of migrants both on their way to their new homes and once they get there. Similarly to trade, in-migration to the wealthy economies has huge, largely underappreciated benefits and obvious social impacts which some view negatively. Surges in migration, like sudden changes in trade, create ethical, political, and short-term economic problems.

Ideally it would be great if the world could do a better job of controlling the drivers of immigration, such as extreme income inequality, wars, repression, and agricultural failures intensified by climate change. We’ll discuss some ideas in the final chapter.

Building a Better World – A US Perspective

How can we make things better? I'm going to offer some thoughts for my country, the US, first domestically and then working up to a more global picture.

The US, like all countries, is unique, but economically has much in common with other rich countries. Like our advanced economic peers, it takes less than two percent of us to grow more food than we eat, and about twelve percent of us to make all the other physical goods we produce, including manufacturing, construction, and mining. About 80% of us work in the huge and varied service sector. This is a pattern we see in other advanced economies even when they have balanced trade. Sixty years ago, articles advised US investors to buy stock in the leisure industry to cash in on all the extra free time people would have as productivity reduced the need for work. Instead, work expanded and absorbed the huge declines in work hours needed in agriculture and manufacturing. In retrospect this is not so surprising. There is no end to the demand for "health", especially with an aging population. Likewise, there is no ceiling to how much income or wealth is demanded, which drives employment in finance. Frankly, we *could* all work a lot less and survive just fine, if the fruits of productivity were more evenly distributed. There is precedent for that of course. It was unions and later law that gave us eight-hour days and five-day work weeks where ten-hour days and six-day work weeks had been common. That change to the rules of the labor market did nothing to damp the rise in productivity driven by private enterprise, if anything the reverse: as the cost of labor goes up, the incentive to increase labor productivity also rises.

Principles

So, what if anything, is "wrong" with the US economy now? It is difficult if not impossible to separate the role of economics from other factors in politics. When people feel that things are worse economically now than they were four years ago it's the feeling that carries the day, not the aggregate statistics. How much of that feeling is due to tribalism of numerous sorts, magnified by the media, versus say growing economic inequality? Since it's impossible to know, I will simply say how I think the US economy could work better based on my own principles, and what I feel are foundational values of our country. I'm not religious in either the theological or economic sense, my principles derive from the Enlightenment as did our country, and, in economics, I go with what works. To quote Wikipedia, "the Enlightenment included a range of ideas centered on the value of human happiness, the pursuit of knowledge obtained by means of reason and the evidence of the senses, and ideals such as natural law, liberty, progress, toleration, fraternity, constitutional government, and separation of church and state."[386] The Declaration of Independence says simply "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness. That to secure these rights,

[386] https://en.wikipedia.org/wiki/Age_of_Enlightenment

Governments are instituted among Men, deriving their just powers from the consent of the governed…". The Constitution and Amendments put these sentiments into more concrete form to become the bedrock of our constitutional democracy. However, while bedrock is a great foundation, that's all it is, many structures can be built on it, and that's where the democracy part comes in.

In a separate vein, what works in economics is market capitalism with considerable refereeing by the government to keep it somewhat aligned with the theoretical ideal free market and to prevent the economy from going off the rails periodically. This form of capitalism, often referred to as managed capitalism, is quite widespread in the world today. Simply put, it is widely adopted because experimentation with fully managed socialist economies at one extreme and laissez faire capitalist economies at the other have not worked well. To give some idea of how widespread this model is, remember that China, while not a democratic country, has a large capitalist market economy.

The ideals of the Enlightenment and market capitalism share some commonality. Both see the individual as having basic rights and the freedom to act in their own interests. Individuals in a democracy express their preferences through voting, and in the marketplace by buying and selling. Both require rules and the enforcement of rules to function anywhere near the ideal. But the marketplace is not a place to seek moral guidance or enforcement. People get their personal morals from different sources, many from religion, and Enlightenment principles are fine with that: freedom of religion is bedrock. However, our Constitution as amended makes it clear that the spheres of religion and state must be separated: laws are created by consensus in a legislature not taken from a holy book. In trying to figure out what makes for a more perfect union I always come back to the core Enlightenment principles listed above which prominently include individual equality and freedom in the pursuit of happiness.

US Spending and Taxes

There is no way around state involvement in any economy that has moved beyond the most basic system of barter. Modern economies are highly complex and require contract laws, civil and criminal courts, central banks, trade agreements, enforcement powers, and myriad other functions which, in the case of a democracy, are hammered out through the legislative process. Obviously, this is too much to deal with here. But we can look at how we raise and spend money as a nation and suggest ways that both can be used to address some of the issues we've raised.

US Spending

The US has a federal system, and states and localities raise and spend roughly as much as the Federal government. Actually, states and localities together spend more than the Federal government but raise less because the Federal government transfers a lot of money to them.

The graphic below shows 2017 government spending. The yellow area is transfers of revenue from the Federal government to states and localities.

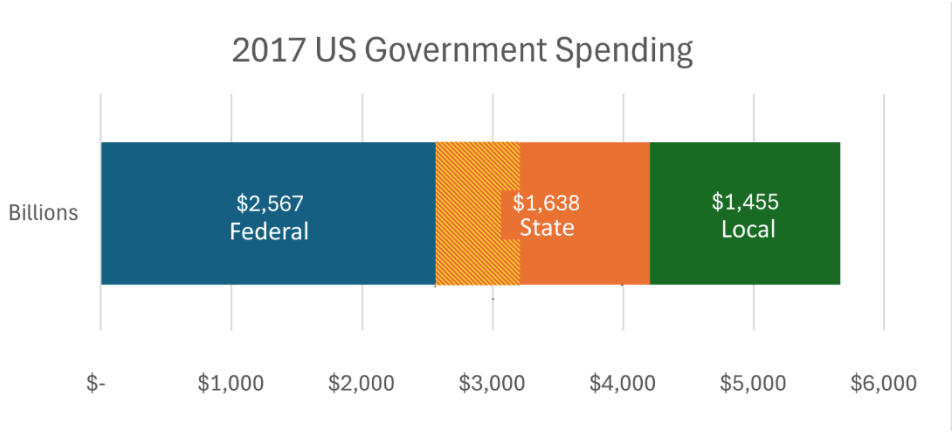


Figure 89 2017 US Government Spending. Yellow area is Federal transfers to state and local governments. Source see note [387]

Governments get most of their money from taxes, so "spending" by government at any level is really about buying stuff on behalf of taxpayers. We give up some of our purchasing power, say to add another cable channel to our lineup, to the government, say to help pay for a school or an aircraft carrier. Unfortunately, people, including many of the already immensely rich, don't like giving up purchasing power even for things they understand we need, so there are and will always be endless squabbles over who pays and what we buy through governments. It is also important to keep in mind that our tax dollars aren't loaded into a rocket and sent off into space. All of the money the government collects and spends goes to people or businesses, it is spending that drives the economy just like consumer spending does. In fact, much of it comes back to us, we pay Social Security taxes now so that we can spend our Social Security incomes later. Even foreign aid, military or otherwise, is often directed to purchases from US suppliers. In short government is an integral part of the economy, as any lobbyist knows[388]. In 2017 about 29% of US GDP flowed through our Federal, state, and local governments. Here's how we spent the money in 2022.

[387] : https://federalism.us/federalism-101/an-overview-of-federal-state-and-local-expenditures/#:~:text=Of%20the%20total%20amount%20of,30%20percent)%20in%20public%20spending and https://www.whitehouse.gov/wp-content/uploads/2024/03/hist12z1_fy2025.xlsx

[388] A great tool for exploring US spending which lets one drill down within each spending category is provided by the Treasury at https://www.usaspending.gov/explorer/budget_function

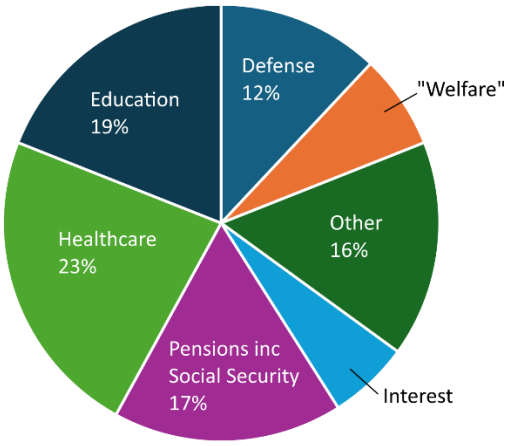


Figure 90 2022 Federal, state and local spending by function. "Welfare" includes food stamps, unemployment benefits, workers compensation, housing, cash welfare, earned income credit above tax liability and others but excludes health care (Medicaid). "Other" includes transportation, protection (police, fire etc.) and general government. "Spending through the tax code" not included. Source: see note[389]. WW134

Looking at it this way, spending 30% of our income on healthcare, pensions, education, defense, plus everything else governments do, like roads and police, might not seem like a bad deal. As we have seen, education and infrastructure are keys to having an advanced economy and few of us want to give up our pensions or do without healthcare.

Budgets are contentious at all levels of government (I've attended Town Meeting for 25 years in my hometown), and certainly lobbying and special interests often get their way (ditto), but we can't possibly deal here with 52 states and innumerable local budgets. Let us look at the roughly half of spending that flows through the Federal government and the taxes that are collected to fund it.

Here is the Federal budget from fiscal year 2023.

[389] Percentages are approximate given the way the Census collects data. These numbers are taken from a Wikipedia entry in turn based on https://www.usgovernmentspending.com/year_spending_2022USbt_25bs2n whose author must be commended for his effort and transparency.

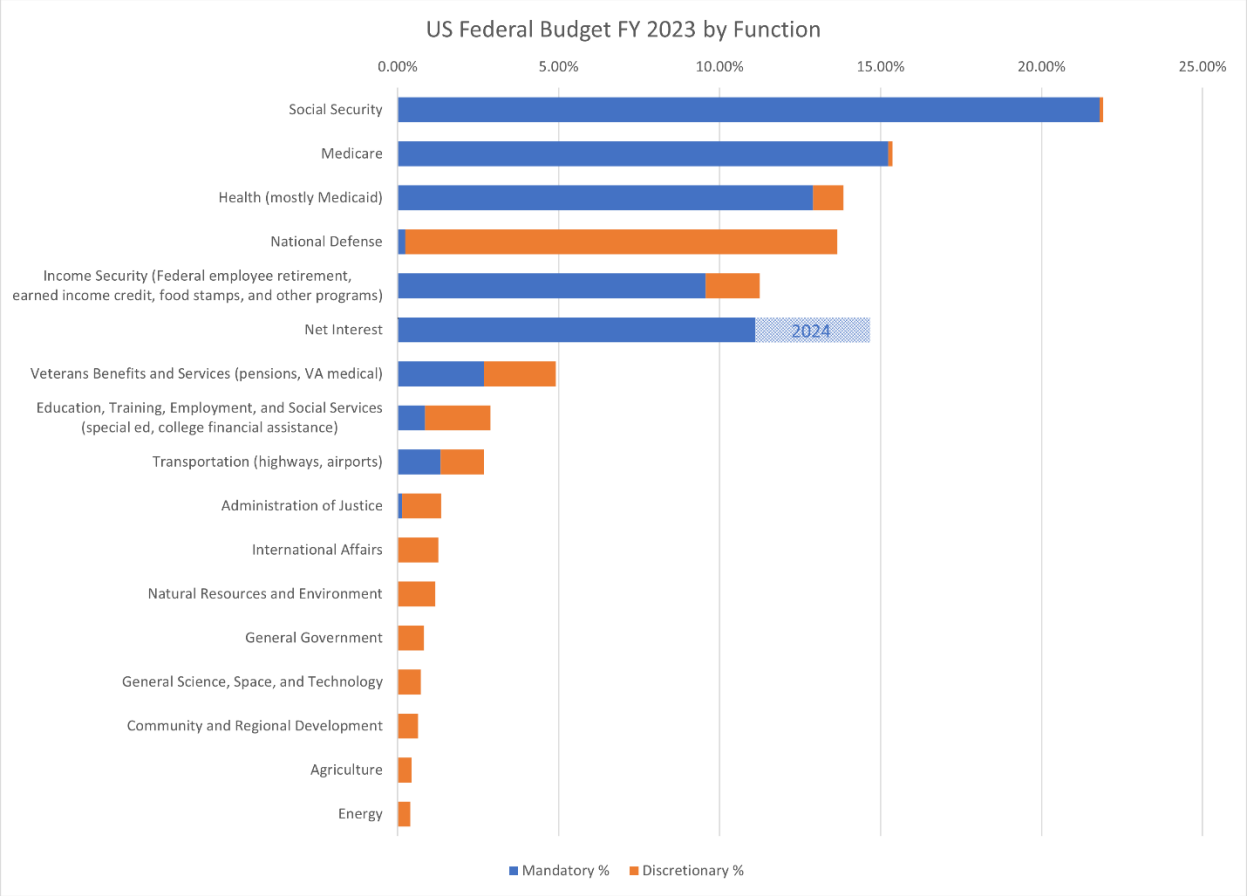


Figure 91 US Federal 2023 Budget. Source: https://www.govinfo.gov/app/collection/budget/2023/BUDGET-2023-PER except for actual net interest from treasury data WW128

We can see a number of interesting things about the budget from the chart. First, most of it is "mandatory," meaning Congress set up programs such as the Social Security Act where the legislation, until amended, provides a formula for making payments. Congress could, if it wanted, abolish Social Security, or lower or raise payments, but unless it does so, the formula used to calculate benefits "entitles" people to certain payments which have to be included in the budget. If you subtract mandatory and defense spending, you are left with 15% of the budget for everything else. We should note that a lot of the federal budget directly transfers money, it doesn't "spend" it. The social insurance programs of Social Security and Medicare are transfers. Here is how the budget has changed since 1940:

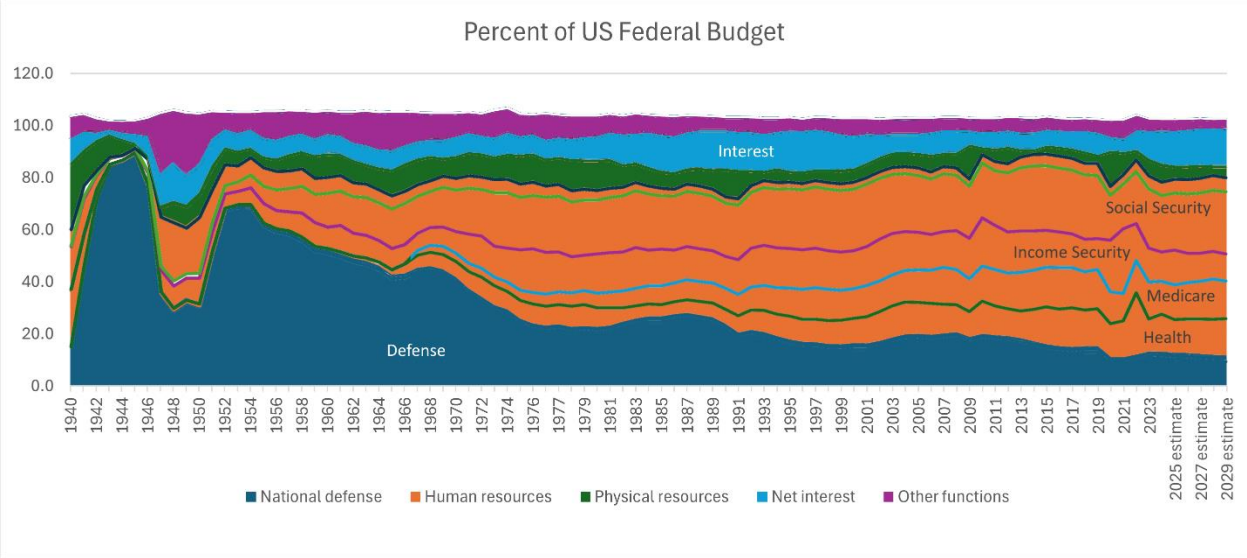


Figure 92 US Federal Budget by Major Function. "Income security" includes Federal employee retirement, unemployment, housing and food assistance. "Physical resources" includes energy, natural resources, housing, transportation, and commerce. In addition to health-related spending, "Human resources" includes the subitems shown as well as education & training and veterans benefits and services not counting health. "Health" includes all health related other than Medicare (Medicaid, Veterans medical care, research, etc.) Source: https://www.whitehouse.gov/omb/budget/historical-tables/ Table 3.1. The chart omits offsetting receipts (less than 1%) which explains the slight deviations from 100%. WW132

A significant chunk of the Federal budget involves transferring money to medical providers. The overall Federal budget hasn't changed much as a percent of GDP since 1975 but Medicare and Medicaid have gone up from a combined 8% of the budget to 28% in that time. We've looked at how much of an outlier US medical costs are, those costs are passed on to both private insurance and taxpayers. The fix is to reduce the costs, around 17% of GDP, to be in line with other rich countries, at 12% of GDP for universal coverage, a task in progress. Even then, though, health care costs are not going down to historical levels because there is simply more and better medicine now and the population is getting older.

Defense spending has declined as a percent of the budget and US GDP. It is currently around 3.5% of GDP.

Interest on the $34 trillion national debt was $658 billion in 2023. Those payments are tied to interest rates and the hatched area in Figure 91 shows that as interest rates have risen recently the payments on the debt have also and are now about the size of defense spending[390]. About 1/3 of our national debt is held by foreign governments and entities, those payments dwarf foreign aid. If we don't want to "send money overseas" we should reduce our deficit and borrowing.

[390] The chart shows budget authorization for 2023 but actual spending expected in 2024. Actual net interest payments in 2023 were 10.7% of the budget in 2023.
https://www.whitehouse.gov/omb/budget/historical-tables/ Table 3.1

The fact the budget hasn't grown much as a percent of GDP despite the large run-up in medical costs is again a testament to the growth of productivity. But what has grown is the deficit as a percent of GDP and along with it the national debt. The chart below shows expenditures and deficit as a percent of GDP. The spike in expenditures around 2020 is associated with emergency COVID spending together with a dip in GDP.

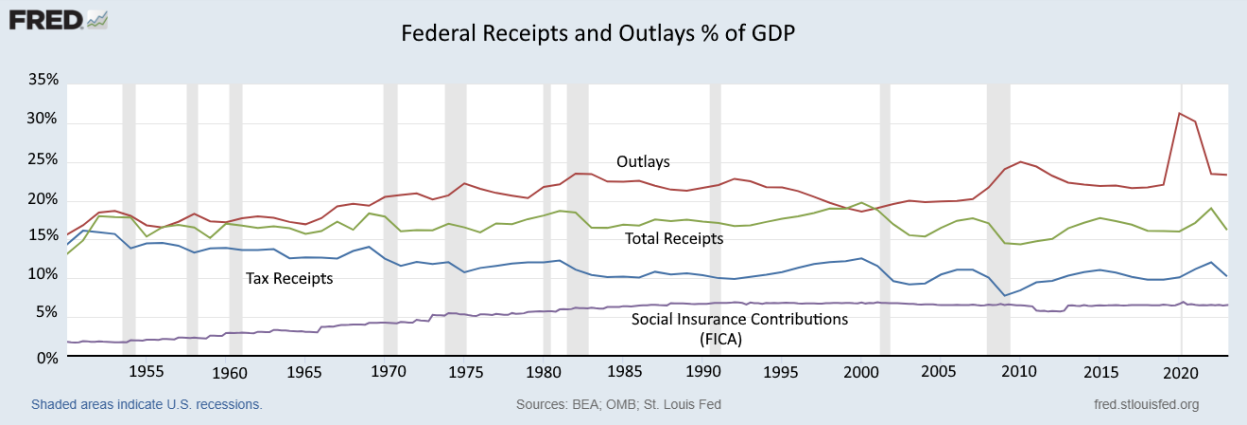


Figure 93 Federal Current Expenditures and Taxes as a Percent of GDP by Year. Total receipts is the sum of Tax receipts and social insurance contributions (Social Security, Medicare). The spike around 2020 was COVID spending combined with a dip in GDP. Source: BEA Table 3.2 via the Fed data interface, FRED. WW135

As the graph shows, tax revenue has fallen as a percentage of GDP while outlays have gone up slightly, resulting in more borrowing and larger deficits. In FY 2023, actual expenditures were $6.13 trillion, but revenues were only $4.44 trillion, the remaining $1.70 trillion was borrowed. In other words, we borrowed nearly 30% of our federal budget[391]. The options to reducing the deficit are (1) cut entitlements such as Social Security and Medicare, (2) cut the defense budget, (3) raise taxes back to historic levels on the wealthy who have benefited most from tax cuts since Regan. There simply isn't a substantial amount to cut anywhere else.

Taxes

As Figure 93 suggests, income tax collections as a percent of GDP have come down, while Social Security and Medicare taxes (FICA taxes) have stayed pretty constant.

[391] With higher interest rates recently, all the interest paid to bondholders has resulted in a fiscal stimulus, not quite what the Fed had in mind by raising interest rates.

Table 22 Tax Rates/Brackets for married filing jointly. Sources: https://www.whitehouse.gov/omb/budget/historical-tables/ historical income tax rates, https://www.ssa.gov/oact/progdata/taxRates.html, https://taxfoundation.org/data/all/federal/historical-corporate-tax-rates-brackets/

Year	Highest Marginal Personal Income Tax rate	Number of Brackets	FICA rate	Highest Corporate Income Tax rate	Capital Gains rate
1960	91%	25	6%	52%	25%
1975	70%	33	11.70%	48%	35%
2000	40%	5	15.30%	35%	20%
2023	37%	6	15.30%	21%	20%

Table 22 shows the highest marginal tax rates and number of brackets for some years. A tax bracket is a range of income. For example, in 2000, income below $43,850 was taxed at a 15% rate, any income above that and below $105,950 was taxed at 31% rate, etc. As can be seen, during the boom times following WWII there were many brackets and the top marginal rate was over 90%. The wealthy now pay a maximum rate of 37% on income above $693,750. Corporate income tax rates have also come down, but FICA rates have gone up.

Tax Revenue Sources

The chart below shows that most Federal revenue came from individual income taxes (53%), Social Security and Medicare payroll taxes were 33%, corporate income tax contributed 9.5%, and everything else was around 5%. Estate and gift taxes contributed less than 1%. To make up the budget deficit, we borrowed more than the payroll taxes bring in.

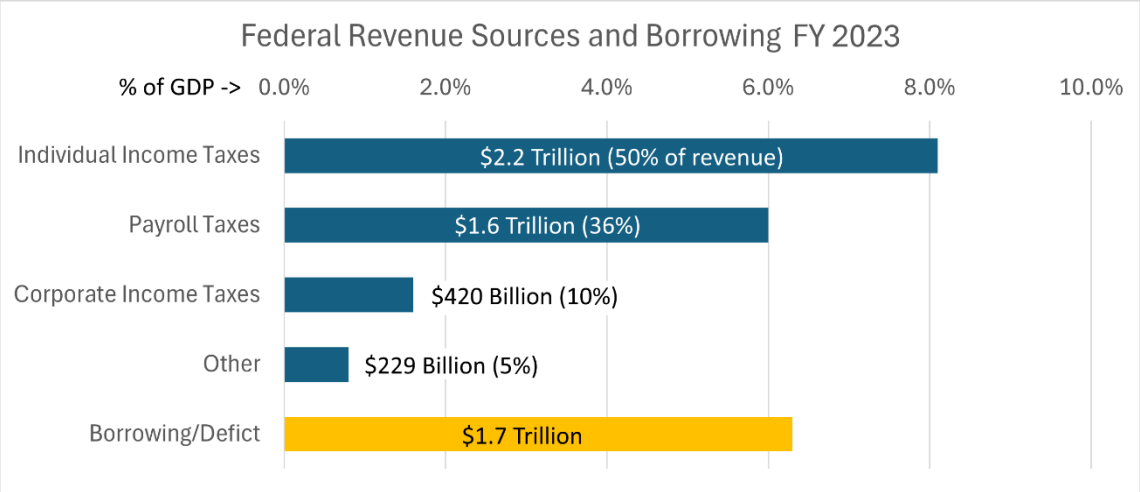


Figure 94 Federal Revenue Sources and Borrowing 2023 as a percent of GDP. Source: https://www.cbo.gov/publication/59727 WW131

Let us look at these sources in a bit more detail.

Individual income taxes are paid on total income which includes wages, realized capital gains, dividends, and pass through business income. Depending on income, the tax rate on realized long-term capital gains and qualified dividends is from 0% to a maximum of 20%. Long-term capital gains are assets, such as a stock or business, that is sold after a year. Qualified dividends are mostly stock dividends. The tax rates for both are lower than the W-2 income tax rate. As we have discussed, capital gains and dividends go mostly to the wealthy. There is no tax on unrealized capital gains during your lifetime meaning you can accumulate any amount of wealth without it being taxed until you sell it, and then you pay a 20% capital gains tax.

Payroll taxes include both the Social Security tax and the Medicare tax. Social Security taxes are pretty high: 6.2% of wages paid by the employer and 6.2% paid by the employee for a combined 12.4%[392]. But that is up to a wage limit of $160,200. Someone earning $10 million a year in wages pays the same as someone earning $160,200. There is no lower limit on the wages, so the bulk of this tax falls on the middle class. The Medicare tax rate is 1.45% for both employer and employee and there is no cap. Payroll taxes are not paid at all on capital gains and passthrough business income.

Corporate income taxes are supposed to be 21% on profits, but many highly profitable US companies pay nothing as we'll explain later. The corporate income tax only applies to "C Corps", not to S-Corps, Limited Liability Corps, and other corporate forms in which profits flow through to owners as non-wage income.

Estate taxes, the only wealth tax, bring in less than 1% of revenue for reasons we will go into further.

Spending Through the Tax Code

One can download the Internal Revenue Code, Title 26 of the laws of the US, from a congressional site. The Federal tax code is 7,058 pages long. By comparison, Title 24 - Hospitals and Asylums, is 89 pages. Clearly it is a life's work to get a handle on the tax code and keep up to date with changes. All recent Presidents have decried the complexity of the tax code and promised to try to simplify it and eliminate "loopholes". The Mercatus Center, often described as a conservative think tank, said of the 2017 Trump administration tax reform effort "If recent history is a guide, and if special interests are able to dictate the terms of the debate on Capitol Hill, an attempt to de-rig the tax code will turn into a re-rigging."[393] The liberal Center for American Progress' analysis of the resulting legislation suggests that indeed re-rigging occurred

[392] Self-employed pay both parts, currently 15.3%. The split between employer and employee is cute but employers figure the cost of labor based on all costs including taxes and benefits. So, the entire amount really is "paid for" by employees in the form of lower after-tax wages. That is fair in that we employees also get the benefits of guaranteed, inflation-protected, life-long income with survivor benefits.
[393] https://www.mercatus.org/economic-insights/expert-commentary/tax-reform-will-trump-really-stand-special-interests

just as it has in the past[394]. Economists from across the conservative/liberal spectrum agree on the need for tax reform, as they do on a surprising number of economic issues.

The tax code is long and complex for many reasons, including the accumulation of provisions over the years, frequent amendment, the need to provide detailed instructions for the many types of entities and transactions covered, and special tax breaks which are often referred to as "spending through the tax code" or simply "loopholes".

Tax breaks are often ostensibly enacted to serve some desirable end. It is estimated that "spending through the tax code" cost over $1.6 trillion in 2023. Here are some of the biggest breaks for individuals:

Table 23 Federal Tax Expenditures[395]. Note that in this table, Earned Income Credit outlays, not just tax credits, are shown. Those are also shown in the table on Federal Outlays above.

Row	Expenditure	Cost (Billions)
1	Reduced Rates of Tax on Dividends and Long-Term Capital Gains	$238.80
2	Defined Contribution Plans	$193.40
3	Exclusion of Employer Contributions for Health Care, Health Insurance Premiums, and Long-Term Care Insurance Premiums	$187.40
4	Credit for Children and Other Dependents (includes Earned Income Tax Credit)	$184.70
5	Defined Benefit Plans	$94.70
	Total (All 165+ Expenditures)	**$1,721.20**

The total is about the same as all discretionary spending in the budget. What purposes do these tax breaks serve?

Capital gains tax rates (row 1) have long been lower than income tax rates. One reason given is the need to account for inflation in figuring gains. If you hold a stock worth $10,000 and inflation runs 3% a year, in twenty years your stock would have to be worth $18,610 to have kept up with inflation. So, it would be unfair to have to pay a tax on the $8,610, you would have been better off spending the $10,000 in the first place[396]. But what about dividends? Stock dividends are corporate profits distributed to shareholders. In 2003, the tax on those distributions was lowered for several stated reasons, one being that corporate profits were already taxed, and taxing the

[394] https://www.americanprogress.org/article/broken-promises-special-interest-breaks-loopholes-new-tax-law/
[395] The source for this table is the Tax Foundation https://taxfoundation.org/blog/largest-tax-expenditures-saving-investment-tax/ which is based on a Joint Committee on Taxation report. The Treasury also has data on all tax expenditures at https://home.treasury.gov/policy-issues/tax-policy/tax-expenditures.
[396] Some have suggested indexing capital gains to account for inflation, but for a lot of reasons doing so would be difficult.

distributions was double taxation. As we will see, actual taxation of corporate profits is spotty at best.

Defined contribution and benefit plans (rows 2 and 5) allow the employee and employer to contribute pre-tax money to retirement plans. This reduces income taxes and is designed to encourage individual retirement saving. Employer contributions are usually linked to income: the higher the income, the higher the matching contributions.

Credit for children and, as of 2017, other dependents (row 4) are partially refundable tax credits of up to $2,000 per child or $500 per dependent. You can get this credit in full if your jointly filing income is below $400,000. When enacted in 1997, it primarily benefitted middle- and upper-middle-income families since poor families could only claim a credit against any income tax they owed[397]. The credit is now partially refundable, meaning poor families can get a check of up to $1,600 annually per child even if no taxes are owed, subject to some conditions and limitations. Row 4 also shows Earned Income payments, both tax credits and the much larger amount that is refunded (i.e. payments when no further income tax is due). These are also shown in the line on spending for income security in Figure 91. Earned Income Tax Credit EITC refunds are primarily directed to low income working households with children and are the main remnant of the antipoverty program. EITC payments have kept many poorer families just above the poverty line.

While each of the above tax expenditures has a stated purpose or purposes, more than half the benefits go to the top twenty percent of households[398].

There are also “tax spending” breaks for corporations and certain industries such as oil and mineral extraction and agriculture that that are included in the trillion and half dollar total.

Tax Avoidance and Evasion

In addition to spending through the tax code, there are enormous losses of tax income through legal tax avoidance and illegal tax evasion. We will look first at tax avoidance.

Corporate Tax Avoidance

Between 2018 and 2020 a few of the US companies with income in the billions that paid zero in corporate income taxes include Archer Daniels Midland, Edison International, FedEx, Principal

397 https://crsreports.congress.gov/product/pdf/R/R45124/4#:~:text=The%20child%20tax%20credit%20was%20created%20in%201997%20by%20the,incur%20when%20they%20have%20children.

398 https://www.taxpolicycenter.org/publications/distributional-effects-individual-income-tax-expenditures-after-2017-tax-cuts-and-jobs/full. This data is charted at Policy Basics: Federal Tax Expenditures | Center on Budget and Policy Priorities (cbpp.org)

Financial, Salesforce.com and T-Mobile[399]. How is that possible? Simply put, these companies, and many others like them, report billions in profits to their shareholders but use tax provisions and dodges to report lower or no profits to the IRS. Between 2018 and 2020 in particular, the tax reform act of 2017, the "Tax Cuts and Jobs Act" or TCJA, allowed companies to write off capital investment immediately for tax purposes instead of depreciating it over a useful lifetime as is usual in accounting. A different, long-standing, way to avoid US taxes for US corporations is to "book" profits through foreign countries with ultra-low corporate tax rates. We have seen these tax havens before when we looked at countries that "own" more US assets then their entire GDPs (Table 9, page 54). Booking profits through a tax haven can be accomplished via a "corporate inversion" in which a company forms a corporate entity or buys a company in the tax shelter country and makes that company the corporate owner with the US company a subsidiary. A more popular route these days is using "transfer payments" along with intellectual property (e.g., patents or trademarks such as the Nike "Swoosh" which "belongs" to a paper subsidiary in Bermuda)[400]. How does this work? For tax purposes, companies can assign earnings to different subsidiaries around the world. For example, if a US based pharmaceutical company makes pills at a Puerto Rico subsidiary, it can assign the patent for that drug to the subsidiary and pay monopoly pricing for the "imported" pills. The pills can then be sold in the US for minimal markup over the already inflated price resulting in most of the profit being assigned to the Puerto Rican subsidiary where corporate taxes are much lower. The big pharmaceutical companies are avid users of this tax strategy, reporting 75 percent of their taxable income in foreign subsidiaries while notoriously charging their highest prices and making most of their sales in the US[401]. The IRS recently billed Amgen $11 billion in back taxes and penalties for one of these transfer payment schemes.

Apple is a notoriously profitable company and has in the past been a poster child for tax avoidance. Wikipedia's account is almost funny for those of us not familiar with the world of international tax gaming:

> ASI is an Irish-registered subsidiary of Apple Operations Europe ("AOE"). Both AOE and ASI are parties to an Irish advanced pricing agreement which took place in 1991. ASI is the vehicle through which Apple routed €110.8 billion in non–US profits from 2004 to 2014, inclusive. ASI's 2014 structure was an adaptation of a Double Irish scheme, an Irish IP–based BEPS tool used by many US multinationals. Under the Double Irish structure, one Irish subsidiary (IRL1) is an Irish registered company selling products to non–US locations from Ireland. The other Irish subsidiary (IRL2) is "registered" in Ireland, but "managed and controlled" from a tax haven such as Bermuda. The Irish tax code considers IRL2 a Bermuda

399 https://itep.org/corporate-tax-avoidance-under-the-tax-cuts-and-jobs-act/?gad_source=1&gclid=Cj0KCQjw6PGxBhCVARIsAIumnWZnXISBtQLAZ_T9qEAYliR-p49ts3WvOGeJXE5f3OWamzI3dJI1F0gaAthfEALw_wcB_.
400 https://www.icij.org/investigations/paradise-papers/swoosh-owner-nike-stays-ahead-of-the-regulator-icij/
401 https://www.finance.senate.gov/chairmans-news/wyden-releases-new-findings-in-ongoing-pharma-tax-investigation

> company (using the "managed and controlled" test), but the US tax code considers IRL2 an Irish company (using the registration test). Neither country taxes it[402].

While in this case the sales occurred outside the US, at that time Apple would have been liable for US corporate taxes on these profits. By leaving the profits overseas Apple was able to avoid taxes until the money was brought back to the US. The 2017 tax reform included a tax break on bringing back money accumulated overseas, and Apple is making use of that to repatriate around $250 billion of accumulated cash at a lower tax rate[403]. American Fortune 500 companies held an estimated $2.6 trillion offshore in 2017, presumably as a result of tax avoidance schemes such as these[404].

Not all US companies can move profits around like this and so the corporate tax burden is unevenly distributed and favors large international companies, especially ones with a lot of intellectual property. In 2022, corporations overall paid total income taxes of 16% ($425 billion) on domestic profits of $2,736 trillion which, given the corporate tax rate of 21%, leaves 5% or $136 billion uncollected for one reason or another[405]. To make collections fairer, the Inflation Reduction Act of 2022 included a minimum corporate tax applicable to large companies of 15% of the profits they declare to shareholders.

Individual Tax Avoidance

In 2021 ProPublica reported some findings on a trove of IRS data it had received. The article starts as follows:

> In 2007, Jeff Bezos, then a multibillionaire and now the world's richest man, did not pay a penny in federal income taxes. He achieved the feat again in 2011. In 2018, Tesla founder Elon Musk, the second-richest person in the world, also paid no federal income taxes[406].

How is it possible for multibillionaires to pay little or nothing in taxes in a year when their wealth increases by billions? The trick is to have unrealized capital gains but low or no net income. If the value of Bezos' Amazon stock goes up by $2 billion in a year but he does not sell any of it,

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402 https://en.wikipedia.org/wiki/Apple%27s_EU_tax_dispute#:~:text=ASI%20is%20an%20Irish%2Dregistered,from%202004%20to%202014%2C%20inclusive see also Apple Sidesteps Billions in Taxes and Profits at Apple's subsidiary in Ireland rise to $69bn

403 https://www.forbes.com/sites/kellyphillipserb/2018/01/17/apple-says-it-will-bring-cash-back-to-us-pay-38-billion-in-repatriation-tax/?sh=34f293002222

404 https://www.imf.org/en/Publications/fandd/issues/2019/09/tackling-global-tax-havens-shaxon

405 Profits source: Corporate profits with inventory valuation and capital consumption adjustments from U.S. Bureau of Economic Analysis, "Table 6.16D. Corporate Profits by Industry" (accessed Tuesday, June 4, 2024). Taxes paid source: US Treasury Dept https://fiscaldata.treasury.gov/americas-finance-guide/government-revenue/

406 https://www.propublica.org/article/the-secret-irs-files-trove-of-never-before-seen-records-reveal-how-the-wealthiest-avoid-income-tax

he doesn't have to pay any taxes on that unrealized capital gain. So said the Supreme Court in 1920. Ever since that time, the rich have been able to use a tax avoidance strategy called "buy, borrow, die" which works like this: (1) buy or build assets such as a company, (2) instead of paying yourself a salary or selling stock, borrow money using your assets as collateral, (3) never sell your assets and pass them on to your heirs or favorite charities when you die. Repeat.

It may not be immediately obvious why borrowing money would be a better idea than selling stock or taking a high income. Consider, if the maximum tax bracket is 37%, you would have to pay roughly that rate if you took a million dollars a year in salary. Or you could sell assets such as stocks and pay a 20% capital gains tax on the appreciation. But if you borrow a million dollars instead, using your stock as collateral, you only pay, say, 3% interest annually. Meanwhile, your stocks or other assets often grow at much higher rates, so you are effectively making money by borrowing on your wealth. There is no tax on borrowed money, and in fact if you use the money to buy investment property, the interest is tax deductible. Unlike the interest on a credit card.

What happens when you die? Federal estate tax only applies to estates worth over $13 million net of debt and charitable bequests. Surviving spouses are exempt. What is more all estates get what is called "stepped up basis" meaning that the stock, business, real estate, or other assets you inherit are immediately assigned their value as of the date of inheritance. If you subsequently sell the asset, you only pay capital gains tax (maximum 20%) on the gain since you inherited it, not on the entire gain since the asset was first bought.

What about estates larger than $13 million? To quote Investopedia, "The portion of the estate that's above this $12.92 million limit in 2023 will be taxed at the top federal statutory estate tax rate of 40%. In practice, various discounts, deductions, and loopholes allow skilled tax accountants to reduce the effective rate of taxation to well below that level."[407]

These techniques and others allow the rich to build wealth while avoiding income and capital gains taxes. Depending on the size of the estate, most or all of that wealth can be passed on to heirs with a stepped-up basis thus permanently avoiding even capital gains taxes on the increase. This kind of tax avoidance is less effective for those earning most of their income as wages, which includes everybody right up to the 99th percentile as we saw in Figure 36 (page 134).

Tax Evasion

Above we looked at legal ways corporations and individuals avoid taxes. Tax evasion refers to illegal methods of reducing taxes. Estimates of the annual loss just for US Federal taxes run as high as $1 trillion per year, although the official IRS "tax gap" between what it collects and what

[407] https://www.investopedia.com/articles/personal-finance/120715/estate-taxes-who-pays-what-and-how-much.asp

it estimates is due was $688 billion in 2023[408]. That means that about 85% of taxes due are paid eventually, leaving about one dollar in six unpaid. Most tax evasion is simply understating income in a way that is easy for auditors to detect, but wealthy individuals can use shell companies and accounts in tax haven countries to hide money in ways that are difficult to untangle. High value tax audits take considerable resources and, until recently, the IRS was starved of resources despite the fact that each dollar spent on investigating complicated tax returns yields about six dollars in taxes and fines[409].

Tax Reform

It should be clear that the US needs tax reform. We have seen that inequality has increased enormously over the last half century while at the same time top marginal tax rates have gone down from 90% to 37% contributing further to that trend. Income growth at the upper end of the scale has accelerated while there has been little growth for the middle class and poor. Wealth concentration is at historic levels. The 7,000 pages of the tax code are loaded with provisions that restrict the tax base. Tax avoidance and evasion reduce revenue by $1 trillion a year. Spending through the tax code reduces revenue another $1.5 trillion. Tax "cuts" have primarily benefited the wealthy. Meanwhile spending as a percentage of GDP has hardly changed but the pressure of paying for healthcare has squeezed budgets.

Here are some broad ideas for how to tackle tax reform that ignore politics. This is by way of starting a conversation. A central concept is to treat any income the same regardless of source.

- The tax code should be rewritten entirely. That does not mean throwing away what is there, but it does mean going through the whole thing provision by provision and line by line. In many cases whole provisions should be eliminated.
- Jettison most or all of the "spending through the tax code" provisions to broaden the tax base. Replace the child tax credit with a universal basic income as described in the section that follows. Tax realized capital gains at income tax rates after indexing for inflation. Tax dividends at income tax rates. (tax all income the same!).
- Remove the cap on Social Security contributions (tax all income the same!).
- Apply FICA taxes to pass through income (tax all income the same!)
- Reinstitute the progressive income tax rates of 1960. Nobody needs more than $10,000,000 a year to live on.
- Increase penalties for tax evasion. The "expected value" of tax evasion is highly positive now if you are clever about it.
- Join other countries in fighting tax avoidance through tax havens, and in establishing an international minimum corporate income tax. That requires an international effort which is already well underway, but the US (Congress) needs to endorse it.
- Broaden the current 15% corporate minimum income tax to cover all sizable companies.

[408] https://www.budget.senate.gov/chairman/newsroom/press/whitehouse-offshore-tax-evasion-by-big-corporations-the-wealthy-cheats-american-people#:~:text=The%20IRS%20estimates%20tax%20cheats,gap%20could%20be%20%241%20trillion.
[409] https://www.cnbc.com/2024/02/22/tax-evasion-by-wealthiest-americans-tops-150-billion-a-year-irs.html

- Get rid of the “stepped up basis” on inheritance.
- Tax inheritances as income to the recipient with a deduction.

These changes could increase annual revenue by a couple of trillion dollars without increasing middle class taxes. Indeed, since the tax base is broadened, rates could come down, but we need money for major investments which will pay dividends way into the future. That story follows the one about a universal basic income below.

Let me mention a couple of taxes I’m not for. I’m not for a high corporate tax rate because that would put a tax on business, and in particular US businesses. While I’m against a higher corporate income tax rate, I’m for the elimination of tax shelters, which can only be done at the international level. Let’s go for a low but uniform corporate tax rate that all companies pay.

Another tax I’m not for is a tax on wealth. This may seem surprising given that wealth is even more concentrated than income. The top one percent of the income distribution in the US holds more wealth than the bottom 80 percent[410]. But there is no need for a wealth tax to address wealth inequality, a properly designed, progressive, income tax is sufficient, and there are a lot of difficulties in trying to implement a wealth tax. It's pretty easy to move wealth around or hide it, and valuation is difficult. Furthermore, I’m just fine with Jeff Bezos being extremely wealthy, I don’t begrudge him his superyacht. Bezos came from a middle-class background, as did many of the wealthiest, and built a business that significantly increased productivity in a number of areas. Whatever one might think of some of the tactics involved, the Carnegies, Fords, Morgans, Gates’, Musks, and Bezos’ of the world move the productivity needle. But what about their heirs? Here we run into one of my prime Enlightenment principles: equality of opportunity. It is also amusingly somewhat Nietzschean, and certainly free market: if we assume that human talent is widely distributed, then to maximize productivity, everyone should have an equal chance to make their contribution and earn their economic and other rewards. Realistically, if you can pass on a few million dollars to each of your kids, great. But beyond that, no. As Bill Gates has said “It’s not a favor to kids to have them have huge sums of wealth. It distorts anything they might do, creating their own path.”[411] And it certainly isn’t fair to the homeless kid. High marginal income tax rates and inheritance taxes could be designed to ensure that vast wealth is not passed on from generation to generation.

Would these proposals kill the golden goose of market capitalism? A tiny bit of thought shows not. By taxing personal income, money reinvested in business is not taxed. Businesses are just as free to grow and reinvest as they are now. In terms of consumption, a graduated tax on income with a simple per person deduction shifts demand a bit. Fewer super yachts, but more reasonably priced houses get sold. This is especially true when combined with a universal basic income (UBI). In fact, the US is famously demand driven (sorry supply-siders) and transferring spending power from the wealthy to the middle class and poor would drive the economy. Postulating a dearth of investment is almost laughable in an era in which money sloshes from

[410] Six facts about wealth in the United States | Brookings
[411] Mick Jagger Bill Gates May Not Leave Massive Inheritance

one bubbly investment to another, and where empirical studies find no correlation between savings and growth in rich countries.

Poverty, Mobility and the Universal Basic Income in the US

From an economic viewpoint, how does the US diverge now from the ideals on which it was founded and how could we go about getting closer to those ideals? For me, equality starts with equality of opportunity. Born equal doesn't really work if, for example, you're born a slave. Or poor in a country where opportunity is highly dependent on your circumstances at birth. Providing a good education for a poor child does not deprive a richer child of a good education, but it does increase opportunity for the poor child. Children grow up to be more productive, and both they and society richer, when education levels are higher as we saw in the section on developing economies. Beyond education, the "American Dream" is based on the idea of equality of opportunity: work hard and you'll get ahead should apply to all.

Note that equality of opportunity does not imply equality of outcome. But the economic circumstances of a child's parents do affect the child. That doesn't mean we should strive for absolute economic equality, but it does mean that measures designed to help families achieve the basics of a stable life are helpful in the quest for greater equality of opportunity. A homeless child is obviously disadvantaged, and most certainly not "responsible" for that lack of opportunity. Again, from an economic perspective, lower productivity makes us all poorer and greater productivity makes us all richer.

In the discussion on Economic Mobility (page 179) we found that US intergenerational income mobility is similar to other rich countries for the middle class, even the Scandinavian ones, but lousy for the poor. In short, we have a persistent economic "underclass" of people who find it hard to work their way out of poverty: if you're born to poor parents your chance of rising in the income ranks is relatively low. Is there anything we can do about this that is in accordance with US ideals and a managed capitalist economy?

Of course there is. Some ideas include universal free preschool the way we already have universal free primary and secondary education. For younger children, free childcare is also an option. Studies show that *quality* programs of this type increase mobility substantially and have a net positive payback: returns for every $1 spent on such programs has been calculated as ranging from $2 for the short term to $17 when the child is followed through adulthood. Fewer grade repeats, special-ed classes, incarcerations, and higher lifetime earnings translate into these returns on investment for both the individual and society[412].

[412] https://learningpolicyinstitute.org/product/untangling-evidence-preschool-effectiveness-brief?gad_source=1&gclid=Cj0KCQjw_-GxBhC1ARIsADGgDjvRaThMKiAJ5_PiSlXCT0lzC0e_4IDScZnrA911I83KUxB2pFIKYawaAp0cEALw_wcB

Many economists, including conservative ones, have suggested looking at a universal basic income or guaranteed basic income to reduce poverty and improve economic mobility[413]. These programs give people a fixed amount of money every month. A universal basic income goes to everyone as the name suggests, while a guaranteed basic income provides regular fixed amounts to poor families. The name "basic income" suggests such programs would provide enough to live on, but the numerous pilot programs that have been run only provide $500 to $1,000 per month. Still, they have been highly successful. Such small contributions to income paradoxically increase employment. They lead to higher rates of business formation, and they lead to large improvements in life satisfaction. In some cases, they lead people to work fewer hours, but they spend more time taking care of children or elderly parents. And of course, they lead to lower rates of poverty and reduce or eliminate the money required for means-tested poverty programs. In short, it has been repeatedly shown that a universal basic income works[414].

Could we afford a universal basic income (UBI)? Of course we can, the US is a very rich country and UBI is entirely a transfer from the top of the income scale to the lower end, it is in no sense "spending". A universal basic income would almost certainly increase demand which would drive up total output and hence income for the country and per capita[415]. All that would change would be the distribution of that income. Let us look back at Figure 34 (page 132) on income distribution in the US which is copied below. In this chart, each bar represents 10% of households, the poorest on the left and the richest on the right. The small $10K rectangle shows the effect of moving $10K from the highest rectangle to the lowest one. This is basically the effect of a guaranteed minimum income of $833 per month for the poorest households. It would also be the effect of a universal basic income which was tax neutral for all groups except the top and bottom. In short it would hardly be noticed by the top 10% and would make a major difference for the poorest households. There would be no change for the rest of the income distribution.

[413] Conservative economists like Milton Friedman and Greg Mankiw among many. See this interview with Mankiw Harvard Conservative Economist Backs UBI | Greg Mankiw

[414] An experiment to inform universal basic income | McKinsey and Universal basic income has been tested repeatedly. It works. Will America ever embrace it? - The Washington Post

[415] As is often noted, consumer spending drives the economy, and a UBI would likely increase demand

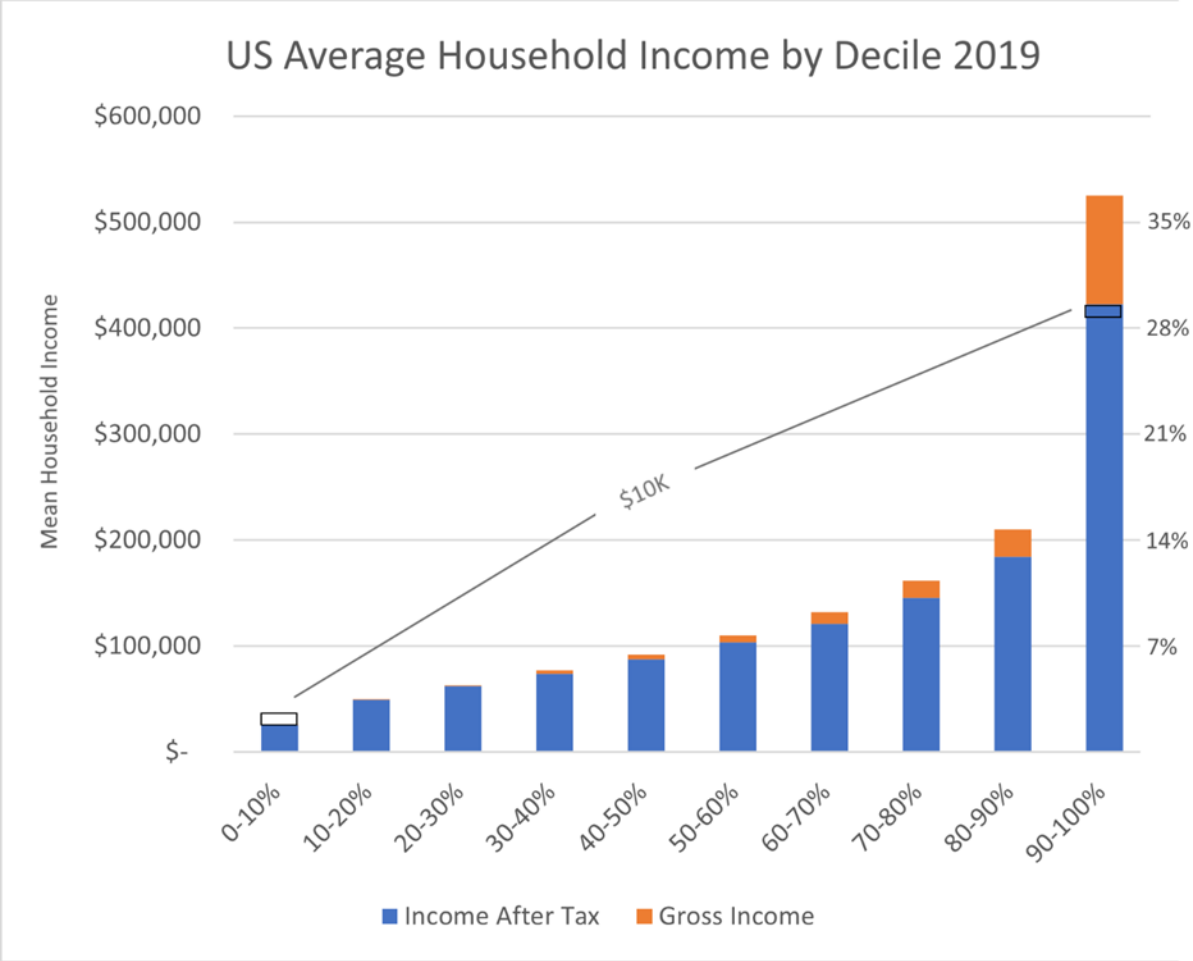

Figure 34 US mean (average) household income by decile group. Note that since the groups include the same number of households, this also shows the distribution of income: the 0-10% group has 1.8% of the total income while the 90-100% group has 36.6% pre-tax. The small black rectangles on the first and last bars are $10,000. Data source: https://www.bea.gov/data/special-topics/distribution-of-personal-income WW126

Even this chart exaggerates the effect on most in the top 10% since income within that group is highly skewed as we discussed. This $10K represents an increase in taxes of less than two percent for the top decile and no tax increase whatsoever for everybody else. As we've seen, since 1960, tax rates for the wealthy *have been more than halved* in the US, in fact in 2018 the 400 richest people in the US paid a lower rate of tax, 23%, than the bottom half of income earners, 24%, so again this hardly represents a significant burden on the wealthy[416]. Other ways to finance a Universal Basic Income have been proposed including Andrew Yang's idea of a value added tax[417]. Some conservative economists ("conservative" does not imply Republican in 2024) like the UBI because it reduces the role of government: everyone gets a check which

[416] Opinion | It's Time to Tax the Billionaires

[417] You can find Yang's 2020 proposals at https://2020.yang2020.com/policies/the-freedom-dividend/ . I much prefer an income tax to a VAT for a variety of reasons, not just repressiveness. Some models show that a VAT has a much larger negative effect on GDP growth than a personal income tax, it requires another complicated tax and the US has outperformed the many countries that use a VAT.

reduces the need for government bureaucracies that hand out means test benefits, and lets people make their own choices in the market[418]. Left leaning economists like UBI for the same reasons and because it reduces inequality.

There is historical precedent for a universal basic income. In 58 BC the Roman Tribune, Publius Clodius established an allotment of free grain for all Roman citizens to help deal with economic dislocations. That system lasted for about five hundred years. In America Thomas Paine suggested UBI as a way to compensate people who lost their right to hunt, fish, or farm on frontier lands as that land was sold to private owners. Nixon proposed a negative income tax for the poor in the 1970's. The state of Alaska distributes a "dividend" on oil production from public lands of between $1,000 and $2,000 annually to all residents. Recently, as we mentioned, local experiments with UBI have had good outcomes.

In the graph above and in the section on income and wealth inequality we saw that both income and wealth are exponentially unequal and growing more so in the US, as well as the world in general. Such extremes of income and wealth are not really in line with democracy and the egalitarian values of the Enlightenment. Back in the days of the Revolution, discussions of how to organize a state both in principle and as a pragmatic matter were widely pursued. The abuses of the industrial revolution, the trusts, and the great depression in the US more or less forced the government to act to create a balance between unfettered capitalism and widespread misery.

It is time for us to again have an explicit discussion about how we organize our economy. Along with science and engineering, market capitalism is the engine that is largely responsible for the economic gains of the last two centuries. It's not going anywhere, nor should it. But it is unacceptable that a country as rich as the US, with a GDP of $70,248 for every man, woman, and child in 2021 should have tens of millions of people living in poverty even to the extent of being homeless. A universal basic income can help solve this problem through market means: the added income would allow people to find their own housing, no complex government subsidies required. The market responds by producing more housing. I would argue that a universal basic income should be sized to a supplement a working income, Andrew Yang's proposal for a $1,000 per adult basic income does that nicely. It is enough to make life more tolerable for someone working a full-time minimum wage job, but not enough to replace a working income.

A UBI is not the only way for us to more widely benefit from the enormous gains in productivity that we've seen but many of us haven't felt. Healthcare is free and by right in most of the other advanced economies. Forget the forms, the paperwork, the 15% to 30% of healthcare spending that goes to administrative overhead, including insurance[419]. And why should US businesses be

[418] For a conservative view of UBI see https://www.gainesville.com/story/opinion/2020/10/08/guest-columnist-conservative-look-universal-basic-income/3594284001/

[419] https://www.healthaffairs.org/do/10.1377/hpb20220909.830296/#:~:text=Administrative%20spending%20accounts%20for%2015,of%20administrative%20spending%20is%20wasteful.

saddled with the costs of healthcare when foreign ones aren't? In the section on Healthcare Costs (page 74), we discussed the reasons why free market conditions don't exist in healthcare, and why it is so much more expensive in the US than in other countries. Other uses for our "productivity dividend" could include lower cost or free higher education, universal high-quality daycare and preschool, better maintained and additional infrastructure, and public amenities such as the national and local parks. Much of this redirection of national income would yield higher productivity and eliminate or lower the costs of programs that subsidize low-paying, low productivity work[420].

US Infrastructure and Climate Change

When we looked at tax reform, we noted that a lot of additional revenue would be generated by the suggested changes. Long term, that could be used to reduce tax rates over a wider base, but the immediate future calls for major investment in infrastructure, especially right now to deal with global warming. In the section on Sustainability (page 213) we looked at what is required for tackling climate change and found that the capital costs are substantial but manageable, and many have high rates of return. Private investment in wind and solar renewable energy infrastructure is already huge, and substantial government incentives have been put in place, but more needs to be done. Much of what is needed is at the level of individual households: over time cars have to be electrified or run on biofuels, and houses that use fossil fuels for heating have to be converted to heat pumps. People, me included, often look at the upfront cost of an investment rather than carefully considering life cycle costs, so the upfront costs of heat pumps and electric cars should be similar to, or lower than, the fossil fuel alternative. Electric cars, excluding the batteries, are actually cheaper to produce and run than gas powered cars, and we can assume that the West will soon get its collective act together and start producing electric cars competitively rather than relying on exorbitant tariffs to fend off Chinese ones that address real consumer needs at realistic prices. The use of fossil fuels in housing is not as straight forward. In some areas of the US, companies offer to install and lease homeowners and landlords heat pumps with no upfront cost, but operational savings depend on the current heat source. Maine homeowners are installing heat pumps at such a rate that half of households will use them by 2027[421]. In this case the operational savings are a major factor: most fossil fuel central furnaces in Maine use finicky oil heat which is expensive and has to be delivered. Subsidies for installation help with the upfront costs in Maine.

In general, economists feel it is better to use the market rather than mandates to achieve greenhouse gas reductions. One suggestion is a carbon tax - an idea that appeals to economists, conservative and liberal, because it operates via market mechanisms. The example of Maine we just mentioned shows how effective this can be: the high price of oil makes heat

[420] Workers and Walmart and McDonalds make so little that their employees often qualify and use public assistance such as food stamps. This is effectively a subsidy for low paying work.
[421] https://www.nytimes.com/2024/03/02/climate/heat-pumps-maine-electrification.html?unlocked_article_code=1.q00.ZwuT.zEO4dfyc_4YD&smid=url-share. There are 580,000 households in Maine

pumps more attractive, and people respond. A tax on carbon could be revenue neutral - the idea is not to increase taxes but to make fossil fuels comparatively more expensive and other sources of energy less so[422]. Simple, market oriented, and effective. A carbon tax incentivizes the most cost-effective CO2 reductions whether by households or industry and can be used by itself or in addition to a cap-and-trade system as detailed in the section on Policies To Get to Net Zero (page 246). Basically, it is not only possible for the US to get to net zero, but doing so would spur our economy and employment, move us out of archaic fossil fuel technology into the present, be good for business overall, and be fun as well. All it would take is a bit of enthusiasm and goodwill and savviness about the forces of disinformation. Think of it as a war effort where nobody gets killed, we build plowshares instead of swords, and we all end up richer in the end. Or wallow in expensive, unproductive, “climate mitigation” and wait for temperatures to rise to truly unsustainable levels. And what will our kids do then?

The Need for International Cooperation

The United States is located on planet earth, and while separated from other continents by oceans, those oceans don’t mean much in an era of drastically lower transportation costs, and mean nothing at all, aside from sea level rise, when it comes to climate change. Immigrants stream to our doors and to the doors of other rich countries because of poverty, economic disasters and wars. Money moves instantly to wherever returns can be maximized and taxes minimized. In short, we can’t pretend we’re an island, we are in fact thoroughly interconnected with the rest of the world, physically, economically and politically.

Following the success of the American Revolution, the individual states of the United States had to cooperate to defend the country, regulate commerce, adopt a basic set of rights, and hammer out how to administer a united government. Federalism doesn’t prevent states from adopting their own laws, as long as they don't conflict with the Constitution, or from maintaining their own cultures. Mississippi is culturally quite different from Massachusetts. As a practical matter, that level of cooperation isn’t going to happen at the world level unless aliens threaten to invade ala “The Day the Earth Stood Still”. But we should strive for stronger international cooperation recognizing that the world is now thoroughly interdependent. To me it is high time that countries no longer feel free to invade their neighbors or continue to snub their noses at international law and agreements for decades.

Just as poverty in the US should be a thing of the past, wars should be a thing of the past in the 21st century. Wars are tremendously costly, destabilizing, and a major driver of migration, to say nothing about the suffering of the victims of war, including soldiers. After the World Wars, Franklin Roosevelt was a major player in the creation of the United Nations which he viewed as

[422] Revenue neutral means the taxes collected on carbon would be returned in other ways, such as through a reduction in income taxes, the UBI, or subsidies for investment.

a crowning achievement of his political career[423]. In an attempt to ensure "never again", Eleanore Roosevelt chaired the UN committee that drafted the Universal Declaration of Human Rights which was then adopted with *no dissenting votes* by the nations of the world. It includes the basic concepts of dignity, liberty, equality, right to life, prohibition of slavery and torture, and right to property. The concepts are great, but countries are essentially free to ignore these principles as there is no enforcement mechanism. Individuals who are responsible for crimes against humanity can be prosecuted by the International Criminal Court, which the US has not joined. The UN can organize peace keeping efforts and interventions to try to address humanitarian disasters, but only with the unanimous consent of the Security Council. We should press for more cooperation in the effort to enforce international law, not discredit the existing institutions. And we should also be an example in that effort.

Climate change is another area where cooperation is essential. Global warming is… global. Virtually every country in the world has signed the "United Nations Framework Convention on Climate Change" and the 2015 Paris Agreement, under which each country set voluntary goals for greenhouse gas emissions reductions and other actions[424]. Last year, 2023, a review of progress in meeting these goals showed that there was a large "implementation gap" between the pledged reductions and actual ones. While the rich countries are responsible for most of the accumulated emissions to date, developing countries are now responsible for about two thirds of current emissions. Developing countries require more energy as they grow, but the cost of capital in many of these countries is high[425]. Rich countries such as ours can provide low interest loans to developing countries specifically for greenhouse gas reducing projects such as solar or wind farms. Even if the interest rate on such loans is the same as our domestic loan rates, this would be a big help in ensuring that developing countries pursue greenhouse gas reductions while growing. Low or no interest loans for such projects would be even better. In the past, US companies have benefited mightily from large infrastructure projects in developing countries, some of questionable utility. Currently the US and other G7 countries are pooling funding for infrastructure projects in response to China's Belt and Road development initiative which includes green infrastructure. Climate change investment, with or without the US, will be huge going forward and, as we saw in the chapter on climate change, while much of the technology was developed here, we have let this major market slip through our fingers so far.

The development of the rest of the world is much in our interest for other reasons. The current world population of 8 billion is projected to grow to over 10 billion under current trends. This quite recent explosion of the human population is simply unlike anything the earth has ever seen before, and unsustainable for a host of reasons. We have seen that as countries become richer their birth rate declines so the sooner developing countries get richer, the sooner we

[423] John Allphin Moore and Jr. Jerry Pubantz. The New United Nations: International Organization in the Twenty-First Century (Upper Saddle River, New Jersey : Pearson Prentice Hall, 2006)
[424] Even though the agreement is only voluntary, and signed by every country in the world, the US pulled out of it under one administration in 2020 and back in under another in 2021.
[425] Meaning that these countries pay much higher interest to borrow capital. In 2021 Ecuador's interest rate was over 12 percent while the rate in the US and Europe was under 4%. See https://wedocs.unep.org/bitstream/handle/20.500.11822/43923/EGR2023_ESEN.pdf?sequence=10

reach “peak human”. And of course, as we have discussed, as countries get richer and opportunities expand, there is less impetus for migration, and trade becomes more balanced. For our own good, we need to do everything we can to lower human population growth and the only sure way to do that is to help poor countries become wealthier. That is best done through trade and investment, which is good for the earth, our economy, and theirs as well. A win-win-win.

Trade also requires international cooperation. The World Trade Organization (WTO) provides a forum for the negotiation of trade agreements and the resolution of disputes. The large majority of countries, including the US and China and all the countries with the biggest economies are signatories to the agreements at the heart of the WTO. There are in addition, many regional and bilateral trade agreements. The WTO is the “referee” when it comes to violations of trade agreements, but it has no enforcement powers. Trade in a connected world requires fair and impartial arbitration.

Finally, in this list of the benefits and needs for international cooperation is the need to deal with financial malfeasance and tax shelters. As we saw in the section on tax avoidance and evasion in the US, huge amounts of money are secreted in “tax havens” that also serve to park and hide dirty money of all sorts. The sums are enormous, many trillions of dollars. Work has been done on this by groups of countries to share data and impose minimum corporate tax rates, and that effort needs to continue and be expanded.

The Last Word

I’ve tried to avoid politics until now. But in mid-2024 politics and economics are even more impossible to separate than usual. I am an inveterate political door to door canvasser, and I tend to listen as much as talk. My impression is that there is a strong element of class warfare in the current political polarization in the US. And it’s not just in the US, the populist right has been rising in Europe (again) and elsewhere. While there are of course cultural and other factors at play, I’d like to try to make the economic case for anyone whose door I knocked on in 2016 who told me they’d vote for Bernie, but if Hillary was the candidate, they’d vote for Trump.

In this book we’ve looked at some of the major issues of globalization, in particular trade and migration, and tried to put these into an overall context. That context includes increasing income and wealth inequality despite rising labor productivity in the rich nations. At the same time, jobs have shifted away from agricultural and manufacturing into a huge and amorphous “services” sector. The data and studies we looked at show that in both agriculture and manufacturing, the main cause of job losses was continued mechanization and automation, in short more and smarter capital. The “trade shocks” that accompanied opening to trade had the effect of displacing workers in some industries while increasing trade related employment in others, and at the same time lowering the costs of imported items such as clothing for everyone. Overall, in trade the winners, being all of us since we all benefitted from lower prices, could have compensated those who lost jobs and income, and there would have been a net positive. That

is, in the absence of a trade deficit such as the huge one we have in the US. Immigration too creates winners and losers. While immigrants eventually become just part of the general population, new immigrants without professional education compete with natives and other recent immigrants in some occupations. Which can put downwards pressure on wages and upward pressure on housing prices and local budgets.

Anyone who has worked for a large corporation has probably heard the trope about how we're all one big team at the same time that the CEO is making a hundred million dollars. The US really is, or should be, one big team, but inequality has grown to the point where many people don't feel like they're sharing in the wealth.

The net domestic product of the US which is GDP minus depreciation was $23.54 trillion in 2023. That is our sustainable national income. There are about 255 million adults in the US, so our national income is around $90,000 per adult or $146,000 per worker. Median income for wage and salary workers is currently around $60,000. Figure 95 shows median wages/salaries versus net domestic income per worker in 2023 dollars.

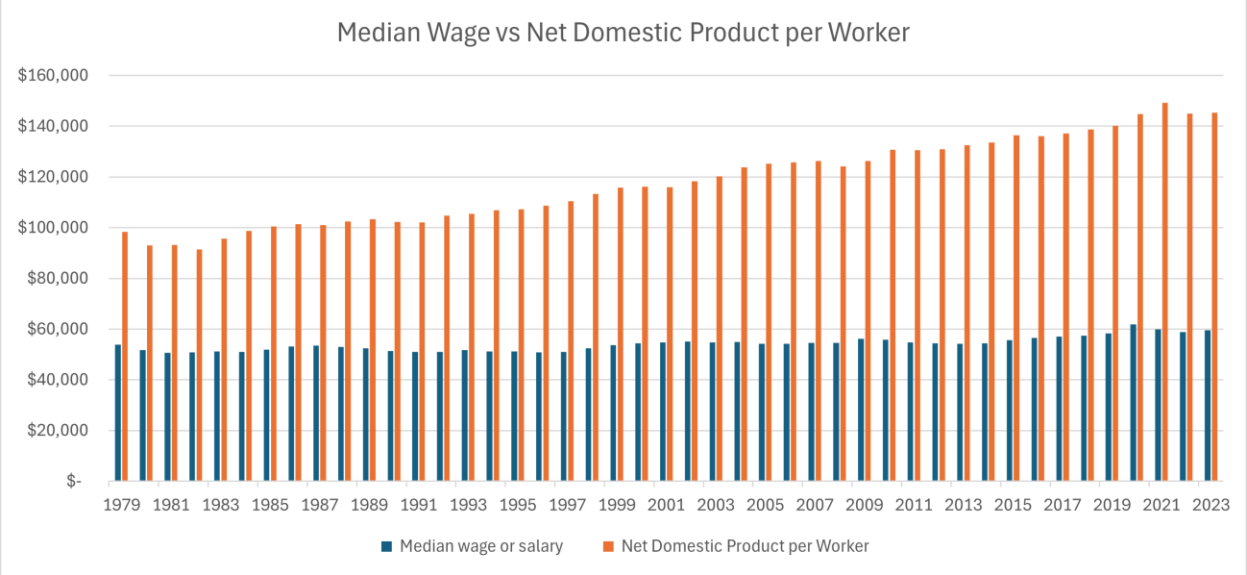

Figure 95 Median Wage vs Net Domestic Product in inflation adjusted 2023 Dollars. Sources: BLS and BEA via FRED[426]

It is obvious that national income per worker, i.e. labor productivity, has risen considerably since 1979 but that median wages and salaries have not risen in inflation adjusted terms. No wonder so many people are worried about inflation!

[426] Inflation adjusted by CPI. Other inflation indexes such as the PCI might show higher growth but the ration between the two lines would stay the same.

The unequal distribution of gains since 1980 or so can also be seen in the chart below. As we've seen, the higher you go in the income curve, the more incomes have grown in percentage terms over the last 40 years. That is the reverse of the pattern for 40 years following WWII when incomes grew faster for those at the lower end of the distribution

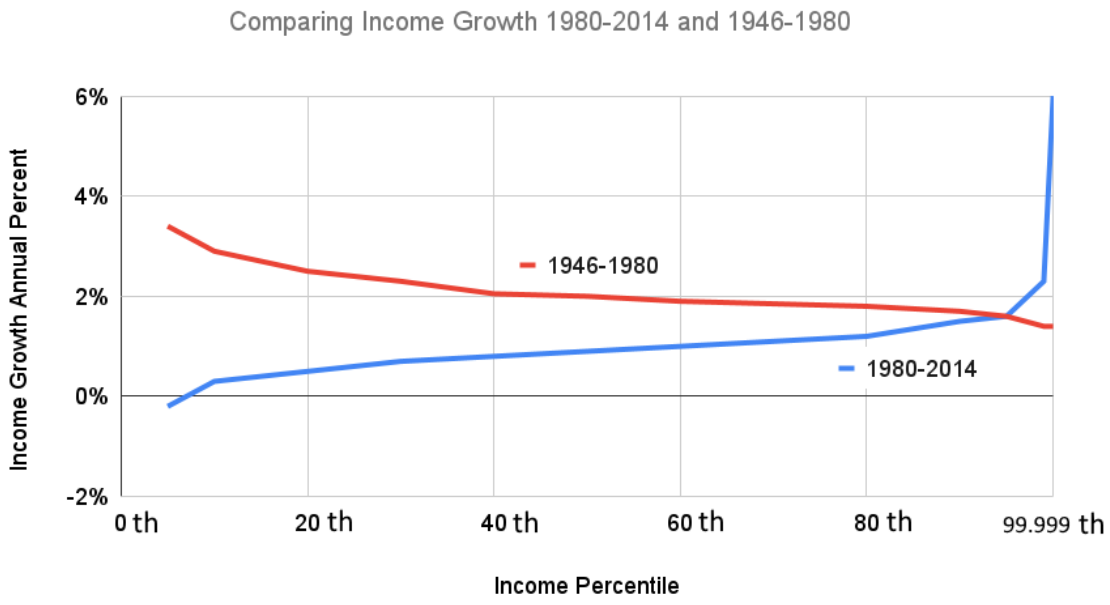

Figure 96: Annual Income Growth over 34 Years. This chart shows that incomes grew fastest for the middle class and poor in the period 1946-1980, and fastest for those at the upper end of the income scale from 1980-2014. Income is inflation adjusted and includes taxes, transfers, and non-cash benefits. Source: The data for this chart was taken from a chart appearing in the NY Times in an opinion piece by David Leonhardt, which in turn was based on data provided by the inequality researchers Thomas Piketty, Emmanuel Saez and Gabriel Zucman.[427]

Who is to "blame" for this situation of growing inequality and not everyone sharing in what I call the "productivity dividend"? Obviously, the market is the primary candidate, but markets do what they do and railing against them is pointless. Once we accept that capitalist markets, including trade, are great but unequal drivers of productivity and economic growth, we have to look elsewhere for fixes if we're going to more broadly share in the fruits of our labor. In the first half of the twentieth century inequality was also a major issue. Labor unions were part of the solution at that time. By teaming up, labor gained heft in negotiating wages, a market-based solution. But that wasn't sufficient to address the concentration of wealth and income, so marginal income tax rates were increased. In 1917 for example, the marginal Federal income tax for

[427] https://www.nytimes.com/interactive/2017/08/07/opinion/leonhardt-income-inequality.html?_

enormous incomes was 67% with 20 lower brackets. In 1960 as we've noted, the highest marginal rate was 91%. It is 37% now on that part of income over $578,00, 35% on anything over $231,000 and 22% on anything over $44,726[428]. Table 24 shows the taxes due on taxable income using 1960- and 2023-income tax rates.

Table 24: Income Tax Using 1960 and 2023 Filing Single Rates. Data Source: Tax Foundation, author's calculation WW138

Income 2023$	Tax using 1960 rates	Tax using 2023 rates	Reduction
$24,000.00	$4,953.60	$3,959.88	4%
$50,000.00	$11,140.80	$6,412.86	9%
$100,000.00	$26,422.40	$17,769.78	9%
$150,000.00	$45,627.20	$33,769.78	8%
$200,000.00	$68,204.80	$43,368.75	12%
$300,000.00	$128,964.80	$78,269.23	17%
$400,000.00	$194,313.60	$115,269.23	20%
$800,000.00	$493,190.40	$256,331.73	30%
$2,000,000.00	$1,555,430.40	$700,331.73	43%
$20,000,000.00	$17,930,070.40	$7,360,331.73	53%
$100,000,000.00	$90,730,070.40	$36,960,331.73	54%

Clearly taxes have come down most for stratospheric incomes. Remember also that capital gains are taxed at much lower rates, unrealized capital gains aren't taxed at all, and the social security tax is capped for those making more than about $160,000.

When we looked at spending (page 270), we found that even including entitlements and the runup in healthcare costs, Federal spending hasn't gone up much as a share of GDP. With declining revenues and constant spending, of course the deficit has grown.

Politically, one party has made tax cuts their mantra. Reaganomics followed an economic theory that postulated that cutting taxes for the wealthy and corporations would "trickle down" to the less fortunate of us through economic growth. The theory of "supply side economics" is a counter-intuitive alternative to Keynesian economics (page 45) which holds that instead of demand being the main driver of economic activity, as in traditional economics, somehow throwing money at rich folk and companies will increase supply which will then drive economic expansion[429]. Such a theory might make a bit of sense if capital was in limited supply, but in the US that isn't an issue. In any case, the Reagan tax cuts, deregulation, and union busting in the 1980's were followed by the decades of wage stagnation and growing inequality we saw above. Under Reagan's cuts, in 1989 there were only two income tax brackets: a rate of 15% applied to income below $29,750 and 28% above that compared to the 73% highest marginal rate when he took office in 1981. Since Reagan, a few more brackets have been returned but the highest marginal rate hasn't exceeded 39.6%. As a result, tax revenues have declined as a fraction of

[428] Filing single, the brackets are higher for filing married.
[429] "Trickle down" economics actually has a long history, see the Wikipedia entry. Supply side theory was a way to repackage it.

GDP and shifted more towards the middle class, while spending has not declined. We're living on borrowed money, much of it from foreigners. Increasing the deficit increases interest costs, already on par with defense spending and growing. We will eventually have to reduce the deficit. To do so either we reform taxes, including spending through the tax code, or we cut spending. As we saw, the large items in the Federal budget are defense, interest payments, and entitlements such as Social Security, Medicare, Medicaid, and the Earned Income Credit. Cutting these entitlements would make income and wealth inequality even worse. Hence my suggestions for tax reform (page 283).

If you're trying to decide which party to support in the 2024 election based on economic considerations, two recent tax law changes, the Tax Cuts and Jobs Act (TCJA), passed in 2017 without a single Democratic vote, and the Inflation Reduction Act of 2022 passed without a single Republican one, provide a contrast. Like most tax legislation, the TCJA is complex. It includes some changes to business taxes and some related to personal taxes. While the business-related tax changes are permanent, the individual tax changes expire in 2025 unless Congress renews them. The key business tax changes include lowering the maximum corporate income tax rate from 35% to 21%, a change which many economists across the spectrum have advocated, as discussed above. The personal tax changes included increasing the standard deduction, doubling the exemption on the estate tax, and lowering the top marginal income tax rate. The personal tax changes were made temporary because they worsen the deficit. The Tax Foundation's models indicate that making the individual tax cuts permanent would increase the deficit by $3.7 trillion over 10 years when all factors are included[430]. Overall, the TCJA was about corporate tax reform with some temporary income tax reductions included that make the deficit much worse. As in any cross the board tax cut, the wealthiest benefit most in terms of reduced tax payments. The "jobs" mentioned in the bill's title are projected to come from trickle down.

By comparison the Inflation Reduction Act of 2022 (IRA) was very ambitious and addressed far more than taxes. According to McKinsey,

The IRA is one of three major investment bills passed since November 2021; together, the IRA, the Bipartisan Infrastructure Law (BIL), and the CHIPS and Science Act (CHIPS) are projected to inject more than $2 trillion into the US economy[431].

These three pieces of legislation are designed to restore degrading infrastructure such as highway bridges, modernize railways and airports, expand broadband coverage ($65 billion largely for rural communities), improve power infrastructure, subsidize chip manufacturing in the US, and provide tax credits to spur climate change investment and manufacturing here.

The IRA, which is focused on climate change, was projected to cost $500 billion over 10 years, but it includes measures to offset costs:

[430] https://taxfoundation.org/research/all/federal/making-2017-tax-reform-permanent
[431] https://www.mckinsey.com/industries/public-sector/our-insights/the-inflation-reduction-act-heres-whats-in-it

- Corporate minimum tax of 15% on profits, projected to raise $222 billion
- Prescription drug price reform, projected to save $281 billion
- Stock buyback excise tax, projected to raise $74 billion
- Additional funding for the IRS to counter tax evasion, projected to raise $100 billion
- Other measures projected to raise $60 billion

Overall, these revenue-raising and cost-savings measures are projected to bring in $747 billion over ten years, more than offsetting the $500 billion cost of the IRA, thus reducing the deficit [432].

We should note that all of these bills are doing something to improve the country, create jobs, and address climate change. The IRA in addition brings in new revenue and savings which have a positive effect on income distribution.

A relative of mine refers to the Democrats as the party of "tax and spend" and the Republicans as the party of "borrow and spend". As we've discussed a lot of federal spending, unlike state spending, is actually transferring money to people for them to spend, be it through Social Security or Medicare payments. We've been borrowing that money, though, instead of really transferring it, thanks to very generous tax cuts for the wealthiest. And for that we can clearly thank the Republican party. With interest payments on the national debt now the size of the defense budget and growing, and with income and wealth inequality approaching all time highs, and with the obvious failure of "trickle down" to benefit the vast majority of Americans, it is high time to raise taxes on the rich. There is only one party and assorted Independents willing to take that on.

So much for economics. Now, in mid-2024, anyone who loves America as the world's longest running experiment in democracy, has an obligation to speak out. A portion of the electorate would be quite happy to turn our country into a theocracy where "Christian values" determine laws much as Muslim sharia law is state law in Afghanistan. Another part of the electorate, overlapping in many cases, would be happy to turn us into a fascist state. A MAGA candidate in Florida says, to applause, "When President Trump gets back in office, I will put forth legislation on his first day back in office to suspend the writ of habeas corpus. This will give President Trump the authority to arrest and imprison the treasonous officials and subversives who now occupy positions across our government."[433] The writ of habeas corpus requires that a court review the legality of a person's imprisonment, so that people cannot be thrown in jail at the whim of a powerful person. It is a foundational principle of justice and goes back to times even before the British Magna Carta of 1215.

The United States and indeed the entire world are at a crossroads. As always. To move forward towards a more perfect union and better world has always been a struggle. We do so now under the immense threat of climate change and humanity outgrowing the capacity of our planet. But

[432] Recent estimates for the costs are about $1 trillion due to the speed of uptake of the incentives and their open-ended nature. On the other hand some major economic benefits of the bills such as reduced CO2 emissions are not included in the calculation.
[433] https://x.com/jamespjudge/status/1802124409114673357

every challenge is an opportunity. With goodwill and a can-do attitude, we can set the course for the next millennium.