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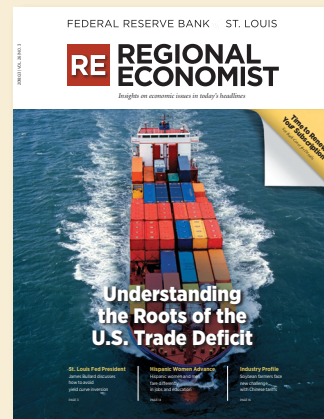
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Read more at www.stlouisfed.org/re.

The Risk of Yield Curve Inversion —and How to Avoid It

The possibility of nominal yield curve inversion—which occurs when the nominal interest rates on shorter-term government debt are higher than those on longer-term government debt—has drawn more attention from policymakers and financial markets in recent months.¹ I see this potential inversion as a key issue in U.S. monetary policy in the near term.

A Flattening Yield Curve

While the spread between longer-term Treasury yields and shorter-term Treasury yields currently remains positive, it has narrowed in recent years—leading to a so-called flattening yield curve. For instance, the spread between 10-year and one-year Treasury yields was close to 300 basis points (or 3 percentage points) at the beginning of 2014 but declined to less than 40 basis points (or 0.4 percentage points) in late August 2018. Subsequently, the spread has increased slightly.²

What has driven the flattening of the yield curve? The Federal Open Market Committee (FOMC) has been raising the policy rate (i.e., the federal funds target rate) since December 2015, and thus shorter-term interest rates have been rising. At the same time, however, longer-term interest rates have not risen as rapidly as shorter-term rates.

Risk of Yield Curve Inversion

In my view, there is a material risk that the yield curve will invert if the FOMC continues on its current projected path for the policy rate. Let's suppose that longer-term yields remain near current levels and that the FOMC remains on track to raise the policy rate at the pace suggested in the FOMC's September 2018 Summary of Economic Projections (SEP). Under this scenario, and based on projections for one-year Treasury yields,³ the U.S. nominal yield curve would invert in late 2018 or early 2019.

Historically, an inversion of the yield curve has been a bearish signal for the U.S. economy and has helped predict recessions. Furthermore, such an inversion would suggest that the Fed and the financial markets have different outlooks for the

U.S. economy. This is because the 10-year Treasury yield is a bellwether rate determined mostly by market forces, and the one-year yield is closely related to the Fed's policy rate.

Avoiding an Inversion

Yield curve inversion could be avoided in two ways—if longer-term nominal interest rates begin to rise in tandem with the policy rate or if the FOMC does not raise the policy rate as aggressively as suggested by the SEP.

Longer-term nominal interest rates (without inflation adjustment) could begin rising more rapidly if longer-term real interest rates (with inflation adjustment) begin to rise, which may happen if investors perceive greater growth prospects for the U.S. economy going forward—say, over a 10-year horizon. I see little prospect of this at the moment though, as the 10-year real interest rate has been roughly constant since 2014. Another way that longer-term nominal yields could begin increasing is if longer-term expected inflation begins to rise, which may occur if investors perceive greater risk of higher inflation in the U.S. economy going forward. But this doesn't seem to be happening either, as longer-term inflation expectations remain relatively low. Consequently, it seems unlikely that longer-term nominal interest rates will begin to rise in tandem with the Fed's policy rate.

The best way to avoid yield curve inversion in the near term is for policymakers to be cautious in raising the policy rate. Since U.S. inflation expectations are currently tame, it is unnecessary to push monetary policy adjustment to such an extent that the yield curve inverts. The FOMC could move to a slower pace of rate increases than what is currently projected—or no planned rate increases—and see how the data evolve. If longer-term yields start to rise or inflation pressure starts to build, then the FOMC could continue with rate increases.

According to recent data, the U.S. economy is doing well and the yield curve continues to have an upward slope. So, why debate this issue now? In addition to looking at the current macroeconomic situation,



it is important to look at how it is likely to evolve over the next two or three years.

Some argue that this time is different when it comes to the yield curve.⁴ I recall similar comments relative to the yield curve inversions in the early 2000s and the mid-2000s—both of which were followed by recessions. To be sure, yield curve inversion could be driven by factors that are unrelated to future macroeconomic performance. Nevertheless, the empirical evidence that an inverted yield curve is a good predictor of recessions is relatively strong. The FOMC does not have to be aggressive with policy rate hikes until warranted by inflation or other economic data. **RE**

A handwritten signature in black ink, appearing to read 'J. Bullard'.

James Bullard, President and CEO
Federal Reserve Bank of St. Louis

ENDNOTES

¹ For more on this topic, see my presentation on July 20, 2018, "Assessing the Risk of Yield Curve Inversion: An Update," in Glasgow, Ky.

² For a FRED graph showing this spread from 2012 to the present, go to <https://fred.stlouisfed.org/graph/?g=lqqB>.

³ I calculated projections for the one-year Treasury yields as the SEP median fed funds rate plus the current spread between the one-year Treasury rate and the fed funds rate.

⁴ For example, see Johansson, Peter; and Meldrum, Andrew. "Predicting Recession Probabilities Using the Slope of the Yield Curve," FEDS Notes, March 1, 2018; and Engstrom, Eric; and Sharpe, Steven. "(Don't Fear) The Yield Curve," FEDS Notes, June 28, 2018. These models, which include additional or alternative variables to the typical yield spread, indicate increased recession probabilities before past recessions but a relatively low probability currently.

Understanding the Roots of the U.S. Trade Deficit

By Brian Reinbold and Yi Wen



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KEY TAKEAWAYS

- Profound economic changes lie at the root of both the U.S. trade deficit and declining manufacturing employment.
- The role of the U.S. dollar as an international reserve currency has helped finance domestic consumption of imported goods.
- Labor productivity and a shifting of comparative advantage to developing nations explain the loss in manufacturing jobs.

Organization (WTO) and to negotiate the North American Free Trade Agreement (NAFTA). But America's enthusiasm for free trade has recently waned: It pulled out of the Trans-Pacific Partnership (TPP), called for a renegotiation of NAFTA, and imposed trade tariffs on China and other nations.

Much of the concern over trade deficits stems from a fear that these deficits lead to declining manufacturing employment. In this article, we will explore why the U.S. runs a trade deficit, why manufacturing employment is declining, and how these two are related. Then we will look specifically at the case of China.

Introduction

Running a trade deficit is nothing new for the United States. It has been running trade deficits since the 1970s. (See Figure 1.) However, trade deficits have recently become hotly scrutinized.

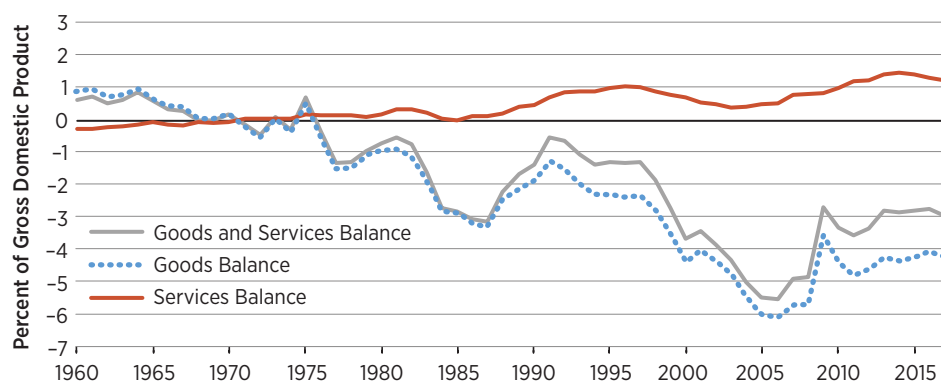
Since World War II, the U.S. has promoted free trade and globalization; its commitment was best exemplified by its push to create the World Trade

The Collapse of the Bretton Woods System

After World War II, a new international monetary system called Bretton Woods was created that would draw lessons from the previous gold standards abandoned after World War I and the experiences of the Great Depression. Bretton Woods established (1) the U.S. dollar was to be an international reserve currency, (2) the U.S. dollar would be backed by gold at a price

Figure 1

The U.S. Trade Deficit



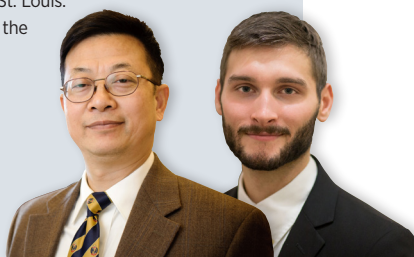
NOTE: Though having a long-running trade deficit in goods, the U.S. has posted a growing surplus in services, such as in travel and finance. This has tempered the size of the overall trade deficit.

SOURCES: Bureau of Economic Analysis, Haver Analytics and authors' calculations.

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Yi Wen is an economist and assistant vice president at the Federal Reserve Bank of St. Louis. His research interests include macroeconomics and the Chinese economy. He joined the St. Louis Fed in 2005. Read more on the author and his research at <https://research.stlouisfed.org/econ/wen>.

Brian Reinbold is a research associate at the Federal Reserve Bank of St. Louis.



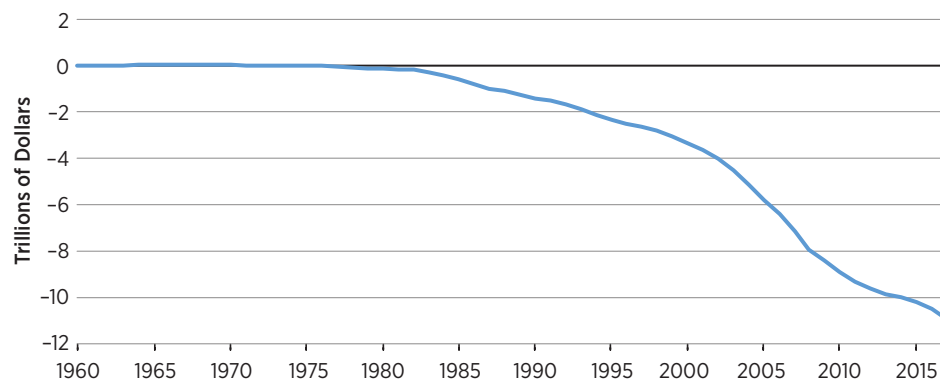
The U.S. decision to end dollar convertibility to gold and the subsequent collapse of the Bretton Woods system in the early 1970s meant that the world economy entered a new era: The U.S. dollar became the global currency, and U.S. government securities became the most-demanded foreign reserve in the world.



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Figure 2

Cumulative Saving Gap (Saving-Investment)



SOURCES: Bureau of Economic Analysis, Haver Analytics and authors' calculations.

of \$35 per ounce, and (3) any country could exchange dollars for gold. This new system facilitated and stabilized global trade, especially trade among the industrialized nations.

However, after years of expansionary growth in U.S. aggregate demand in the 1960s, countries running trade surpluses with the U.S. sought to exchange their dollars for gold, which rapidly shrunk U.S. gold reserves. The U.S. then ran the risk of failing to meet its obligation to redeem dollars for gold at the official price. Thus, President Richard Nixon effectively ended the Bretton Woods system in 1971.¹

The U.S. decision to end dollar convertibility to gold and the subsequent collapse of the Bretton Woods system in the early 1970s meant that the world economy entered a new era: The U.S. dollar became the global currency, and U.S. government securities became the most-demanded foreign reserve in the world. This outcome resulted from the historical strength of the U.S. currency. Consequently, the dollar became as good as gold (despite the fact that it is a fiat currency), which fuels demand for U.S. currency and securities to be used both as an international medium of exchange and store of value.

When the U.S. can purchase goods from the world market simply by printing money or issuing debt, it is destined to run persistent trade deficits. Indeed, just a few years after the end of the Bretton Woods system, the U.S. trade balance started to show persistent and growing deficits, which continue today. (See Figure 1.)

Foreign holdings of U.S. Treasury securities also started to increase in the early 1970s immediately following the end of the Bretton Woods system. More than 40 years later, by 2014, foreign holdings of U.S. Treasury securities reached more than \$6 trillion. Similarly, we see the rising share of foreign holding of U.S. debt from as low as 3 percent in 1970 to as high as 34 percent in 2015. Also, foreign holdings of U.S. dollar reserves have reached \$6 trillion, making the total amount of foreign holdings of U.S.-issued IOUs around \$12 trillion.

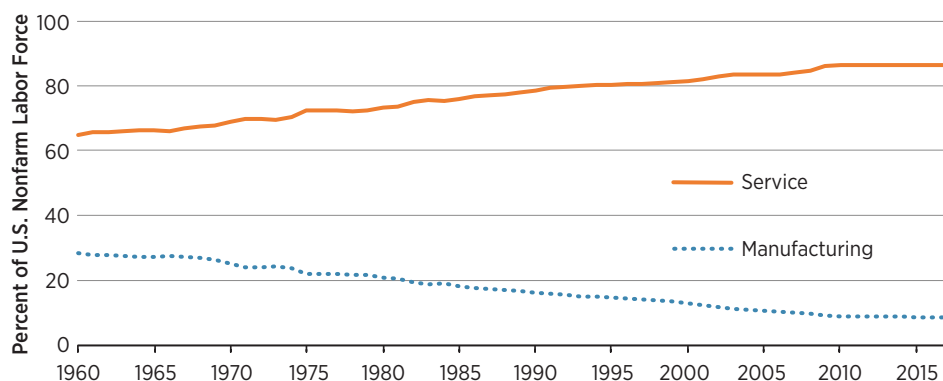
Simple Accounting Helps Explain the Trade Deficit

In macroeconomic theory, net exports—the country's trade balance—equal national savings minus investment; i.e., $NX = S - I$.² Thus, imbalanced trade implies insufficient national savings (private savings plus government savings) to finance national investment. Hence, as saving and investment became mismatched, the saving gap ($S - I$) started to grow more and more negative around the early 1970s, suggesting rapidly accumulating private debt and public debt in the U.S. Figure 2 shows that the cumulative saving-investment gap started to grow in the middle 1970s and ballooned to \$11 trillion in recent years, suggesting roughly an equal amount of foreign holdings of U.S. currency and government bonds.

Therefore, the current international monetary system—based on the U.S. dollar as the dominant world reserve currency and U.S. government securities as

Figure 3

Shifting U.S. Jobs



SOURCES: BLS, Haver Analytics and authors' calculations.

NOTE: The construction, mining and logging sectors are excluded.

the most-sought-after store of value—is the root cause of persistent trade deficits in the U.S.

Had the Bretton Woods system been kept in place, the U.S. ability to issue an astronomical amount of U.S. dollars and Treasuries as a substitute for gold in the global market would have been severely constrained, and U.S. trade would have been far more balanced.

Deficits and Manufacturing

Do trade deficits lead to declining manufacturing? Not necessarily. Of course, if a nation relies heavily on imported manufactured goods and exports only raw materials, then persistent trade deficits may lead to declining employment in manufacturing. This often occurs in developing countries with low productivity growth in manufacturing.

The more likely causes of declining U.S. manufacturing employment are rapid technology growth and improved labor productivity. This is similar to what happened in the U.S. agricultural sector—agricultural employment used to absorb 80 percent of the labor force in the 19th century, but it now requires less than 2 percent of the labor force, thanks to rapid improvement in the productivity of agricultural production.

Therefore, the declining manufacturing employment in the U.S. may have little to do with U.S. trade deficits. In fact, data show the downward trend of manufacturing employment in the

U.S. started in the 1960s (see Figure 3) as labor productivity continuously rose in the manufacturing sector; it has increased sevenfold in the U.S. since 1960.

Indeed, using a calibrated dynamic stochastic general equilibrium model, economists Timothy Kehoe, Kim Ruhl and Joseph Steinberg showed that 85 percent of the employment reduction in the goods manufacturing sector from 1992 to 2012 was due to the rapidly rising labor productivity in that sector, and only the remaining 15 percent was due to rising U.S. trade deficits with the rest of the world.³

When workers get pushed out of agriculture and goods-producing sectors, they enter the service sector. This phenomenon of structural change (caused by technology growth) is observed across all successfully industrialized nations. Accompanying this structural change is the phenomenon of outsourcing: Firms with obsolete or older technologies at home that hire domestic workers at low wages will either go out of business or find it profitable to move to developing countries.

The Shifting of Comparative Advantage

Labor-intensive mass production technology used to be profitable in the U.S., but technological improvements and rising labor productivity (and hence real wages) induce firms to adopt capital-intensive production technologies to save on labor costs.

However, instead of going out of business, firms with labor-intensive

The more likely causes of declining U.S. manufacturing employment are rapid technology growth and improved labor productivity. This is similar to what happened in the U.S. agricultural sector—agricultural employment used to absorb 80 percent of the labor force in the 19th century, but it now requires less than 2 percent of the labor force.



Today, China is at the cusp of entering the capital-intensive production stage as its labor costs rapidly rise. So we see labor-intensive production firms reallocating away from China and moving into other Asian countries (such as Vietnam and India) and Africa.

technologies can move abroad where labor is still cheap, such as China and India. Behind this trend of firm migration from advanced nations to developing nations is the shifting of comparative advantage.

Historically, industrialization has three phases: (1) the first industrial revolution features labor-intensive mass production, (2) the second industrial revolution features capital-intensive mass production, and (3) the welfare revolution features a service-oriented welfare state.⁴

The first phase of industrialization results in labor shifting away from agriculture to labor-intensive goods production such as textiles. As labor costs rise, a nation then enters the second phase because rising labor costs make labor-intensive production unprofitable; its original comparative advantage now shifts toward labor-saving technology or capital-intensive technology. This shift causes labor-intensive firms or labor-intensive technologies to move abroad.

As labor costs further increase and capital becomes even cheaper—thanks to continuously improving technologies and rising labor productivity—a nation experiences deindustrialization and enters a service-oriented welfare state with new jobs and technologies, such as vibrant health and financial industries that employ advanced information technologies.

In this stage, as the service sector becomes the dominant sector, and the agriculture and manufacturing sectors shrink due to their high labor productivity, nations can afford to run big welfare programs, such as unemployment insurance, social security and free medical care. The manufacturing sector also starts to be reallocated to other nations with

comparative advantages in labor and land costs.

Thus, as the U.K., for example, finished its first industrial revolution (labor-intensive mass production) and entered the second industrial revolution (capital-intensive mass production) in the middle 19th century, the rest of Europe and the U.S. became the main adopters of labor-intensive technology and the main exporters of labor-intensive goods.

After the U.S. entered its own second industrial revolution in the late 19th and early 20th centuries, nations such as Japan were the main adopters of labor-intensive technology and became the main exporters of labor-intensive goods in the early 20th century. Meanwhile, the U.K. entered the welfare state, while the U.S. became the powerhouse of capital-intensive manufacturing before WWII.

After WWII, especially in the 1960s, the U.S. started to enter the welfare state, while its manufacturing sector began to be reallocated abroad. In the 1980s, when Japan entered the welfare state, the so-called Asian Tigers became the main producers and exporters of labor-intensive goods. By the 1990s, when the Asian Tigers adopted capital-intensive technology due to rising labor costs, China became the main producer and exporter of labor-intensive goods.

Today, China is at the cusp of entering the capital-intensive production stage as its labor costs rapidly rise. So we see labor-intensive production firms reallocating away from China and moving into other Asian countries (such as Vietnam and India) and Africa.

Is China to Blame?

Manufacturing employment in the U.S. declined nearly 20 percent from 2000 to 2007, even before the Great Recession. This sharp decline correlates with a worsening U.S. trade balance and a growing trade deficit with China. Based on this coincidental evidence, it is easy to point the finger at China. But is China to blame for the declining U.S. manufacturing jobs?

China entered the world stage as a manufacturing powerhouse in the past decades, thanks to the global shifting of comparative advantage. As mentioned earlier, since WWII, the global comparative advantage in manufacturing shifted

from the U.S. to the postwar recovering countries such as Germany and Japan. It then gradually shifted to the emerging Asian Tigers in the 1970s and 1980s, and then to China after that. Indeed, of the total U.S. goods trade deficit, the East Asian and Pacific region (including China) alone accounted for more than 80 percent in 1991.

However, although the total U.S. goods trade deficit with Asia (including China) has been increasing, the Asian share (including China) of the U.S. goods trade deficit as a whole has been steadily declining since 1991, now standing at around 65 percent, despite China's rise as the largest supplier of goods to the U.S.—and by extension, the biggest creditor to the U.S.

In other words, the rise of China since the late 1980s—especially after joining the WTO in 2001—has not increased the total share of Asia's contribution to the U.S. trade imbalance; China simply substituted out other Asian economies by taking their positions. That is, even though China's share in total U.S. trade deficits has been increasing rapidly from around 15 percent in 1991 to 45 percent around 2016, it has not increased the total share of Asia's trade position with the U.S.

Conclusion

The long-running U.S. trade deficits and the emergence of China as a major creditor nation to the U.S. seem to be the result of two major economic forces: (1) the breakdown of the Bretton Woods system, which caused the U.S. currency and U.S. government debts to become the world currency and a global form of liquidity and store of value; and (2) the shifting of comparative advantage in goods production, which caused the reallocation of labor-intensive manufacturing from the U.S. to nations with cheaper labor.

Given this perspective, a trade war with China may not necessarily solve the U.S. trade imbalance problem. There are three likely outcomes from an extended trade conflict with China: (1) Chinese imports will become more expensive; (2) U.S. trade deficits will shift to other countries with similar comparative advantages in producing labor-intensive goods; and (3) U.S. exports to China will become more expensive as a result of China's retaliation. None of the above is likely to increase U.S. exports and reduce its trade deficits.

Most important, a trade war with China cannot stop declining American manufacturing employment if it is driven mainly by rapid technology progress, such as automation, robots and artificial intelligence. Instead, it may significantly reduce American consumers' welfare and cause the U.S. to lose its leadership in free trade and globalization.

The U.S. has a long, successful history of promoting public education that has allowed workers to remain skilled and adaptable to a changing world. Therefore, the U.S. may need to more effectively promote education and job training programs that will allow Americans to better compete in a rapidly changing global environment. This policy will not necessarily increase manufacturing employment per se but would train workers for highly skilled manufacturing and services, which are the future of the economy. **RE**

(This article was published online Oct. 9.)

ENDNOTES

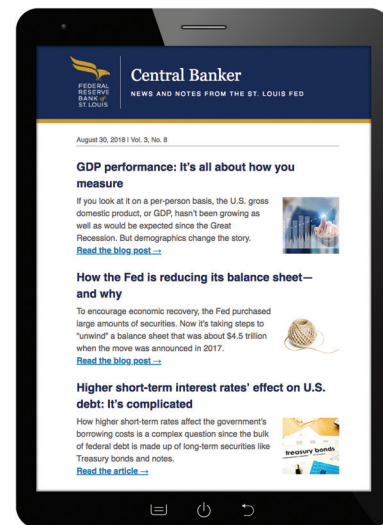
- ¹ See Ghizoni.
- ² This idea follows from the national account identity that gross domestic product (GDP) is the sum of consumption, investment, government spending and net exports ($Y = C + I + G + NX$). Gross savings are defined as GDP minus consumption and government spending ($S = Y - C - G$). Then by rearranging the national accounting identity with the definition of gross savings, we obtain the relationship that net exports are equal to national savings minus investment ($NX = S - I$). Therefore, a nation runs a trade deficit when savings are less than investment ($S < I$) and runs a trade surplus when savings are greater than investment ($S > I$).
- ³ See Kehoe et al.
- ⁴ See Wen.

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Taking a Closer Look at U.S. Exports to China

By Subhayu Bandyopadhyay, Asha Bharadwaj and Suryadipta Roy



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KEY TAKEAWAYS

- U.S. tariffs on Chinese goods will affect American exporters as China retaliates, imported inputs become more expensive and protected U.S. industries draw more resources.
- Aircraft, soybeans, motor vehicles and microchips are top U.S. exports to China. Since 2001, the share of these exports going to China has increased sharply.
- Soybeans and motor vehicles are targets of recent Chinese tariffs. Production of these two exports is geographically concentrated.

Debate on Sino-American trade relations has focused on China's hefty share of the U.S. merchandise trade deficit—46 percent of the \$800 billion deficit last year was with China alone—and the national impact of tariffs recently imposed by both countries. Among other parties, U.S. exporters to China are facing the prospect of losing revenue, with the largest effects likely to be felt by states where production of these goods is concentrated.

In this article, we discuss how trade policy may affect overall U.S. exports, look at the top U.S.-China merchandise export categories and then identify the top producing states for these goods. We conclude with a brief discussion of the status of the current U.S.-China trade war and its impact on U.S. exports to China.

Effects of Trade Policy on Exports

International trade allows nations to specialize along the lines of comparative advantage. The U.S. enjoys comparative advantage in products ranging from civilian aircraft to agricultural commodities like soybeans. Producers of these goods seek markets abroad through the reduction of trade barriers. On the other hand,

sectors where the U.S. does not have a comparative advantage (e.g., iron and steel) benefit from greater trade barriers because of reduced foreign competition.

Unfortunately, protecting industries that do not have comparative advantage (i.e., import-competing industries) is not costless for exporting industries. There are several channels through which a nation's import protection can affect its exports—we discuss three important ones next.

First, as a nation devotes more resources to import-competing industries, it has fewer resources left to use in its export industries. In the long run, production in exporting industries must fall, and this, in turn, will reduce exports. In other words, import protection has the unfortunate effect of export reduction.¹

A second, more direct channel is retaliatory tariffs imposed by foreign nations. For example, when U.S. imposes tariffs on Chinese steel imports and China retaliates by imposing tariffs on U.S. soybeans, U.S. soybean exports are hurt.

Third, tariffs raise the prices of imported inputs that U.S. exporting firms need to make export goods, which renders U.S. exports less competitive.

While imports have led to job losses in the U.S. manufacturing sector, exports have boosted other sectors. The sectors that export the most to China, however, stand to suffer directly from the escalating Sino-American trade tensions. In addition, higher tariffs will escalate the cost of Chinese intermediate inputs that U.S. firms use in their global supply chains, which can also hurt U.S. exports to other nations.

Next, we look at the top four merchandise-exporting sectors to China (in terms of

2017 exports in dollars) between 1991 and 2017. Last year is the most recent year for available data, while 1991 precedes China's entry into the World Trade Organization (WTO) exactly by a decade. Therefore, our start date provides a useful benchmark to follow U.S.-China exports before its entry into the WTO and since that time.

Top U.S. Exports to China

In 2017, the top export category to China was civilian aircraft, at around \$16.26 billion, followed by soybeans, at around \$12.25 billion. The third-highest export was motor vehicles, at \$10.3 billion, and fourth was electronic integrated circuits, at around \$5.29 billion.

We pose three questions vis-a-vis these exports. First, how have these exports evolved since 1991? Second, how important is China in terms of the global market for these exports? Third, how important are these exports in terms of aggregate U.S. production of these goods?

Figure 1 charts the top four merchandise-export categories as a share of global U.S. exports in these same goods starting from 1991. China's share of these four export categories has gone up significantly in the years following that country's entry into the WTO. For example, the value of soybean exports to China climbed from around 19 percent of global U.S. soybean exports in 2001 to around 57 percent in 2017, while motor vehicle exports to China jumped from a negligible level of 0.08 percent in 2001 to around 19 percent of global U.S. motor vehicle exports in 2017. Civilian aircraft exports also climbed sharply from negligible levels to around 13 percent of global U.S. exports in this category.

ABOUT THE AUTHORS

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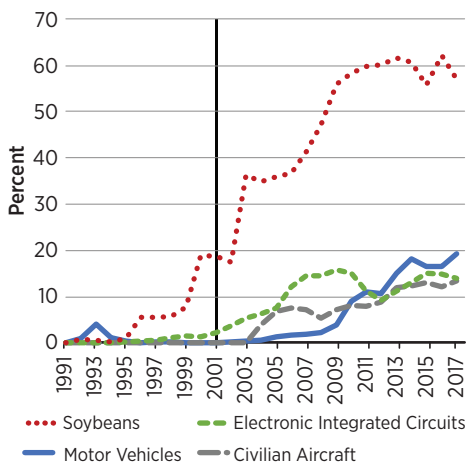
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Figure 1

Top U.S. Exports to China as a Share of Total U.S. Exports of Each Good



SOURCES: U.N. Comtrade database, U.S. Department of Commerce and authors' calculations.

NOTES: Data for civilian aircraft are available only from 2002 onward. The black vertical line depicts China's entry into the World Trade Organization.

The rise in electronic integrated circuit exports (from 2 percent in 2001 to 13 percent in 2017) is probably the result of global supply chain linkages, in which products exported by the U.S. may be used to make other products that are imported into the U.S. For example, Intel computer chips are used as an intermediate input in imported computers. Regardless, exports in this category, even if due to global supply chain linkages, lead to specialization and increased productivity, potentially benefiting all parties.²

One metric relevant to our third question is the ratio of exports to China to total U.S. output of the relevant industry. If this ratio is small, disruptions in exports to China are unlikely to cause major losses for producers and workers in these sectors.

To compute this ratio, we used the data on industry-level gross domestic output published by the Bureau of Economic Analysis (BEA) for the year 2016. The ratio of soybean exports to China to U.S. farm output in 2016 was around 10 percent, while the ratio of civilian aircraft exports to U.S. durable manufacturing output was 1.2 percent. Motor vehicle exports to China as a share of total U.S. durable manufacturing were 0.7 percent, while the

analogous ratio for electronic integrated circuits was 0.4 percent.

Electronic integrated circuits are intermediate inputs that can potentially find markets elsewhere; they also have a relatively low export-to-production share. For those reasons, we focused our state-level analysis on soybeans, aircraft and motor vehicles.

Disruptions to trade in these three categories are likely to be most starkly felt by states where the production of these goods is concentrated. Accordingly, we identified the top producing states of these goods to get a sense of the likely dispersion of export damage across states.

Top Producing States

While civilian aircraft are the top U.S. export to China, they are not yet subject to major retaliatory tariffs. For motor vehicles, the U.S. is not as dependent on exports to the Chinese market because of its own large domestic market and other export destinations. Given these facts and space considerations, we have presented a chart (Figure 2) of only the regional dispersion of soybean production; civilian aircraft and motor vehicle charts are available from the authors on request.

Figure 2 identifies the top 10 soybean-producing states, which together account for around 79 percent of U.S. soybean production. Illinois tops the list, at around 14 percent, while Iowa is second, at around 13 percent. Clearly, the impact of the trade war and its consequences (e.g., declining soybean prices) will be most directly felt by farmers and farmworkers in these top producing states.

Aerospace manufacturing is concentrated in the states of Washington (around 25 percent) and California (around 11 percent). Motor vehicle production is also concentrated, with Michigan (around 24 percent) and Indiana (around 12 percent) accounting for more than a third of U.S. output.

Current Status of the Trade War

Earlier this year, the U.S. announced plans to impose tariffs on \$50 billion worth of Chinese goods, which led China to threaten to impose its own tariffs on American goods. The first round of U.S. tariffs on Chinese imports worth about \$34 billion went into effect on July 6; that same day, China imposed tariffs on a similar amount of U.S. products. On Aug. 23, the remaining U.S. tariffs on \$16 billion

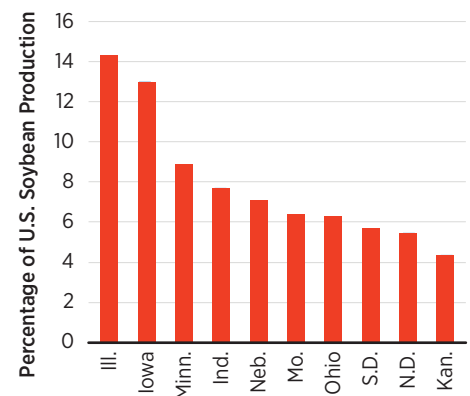
worth of imports were implemented; that same day, Chinese tariffs on \$16 billion of U.S. goods took effect.

Major U.S. exports targeted by the Chinese tariffs include soybeans and vehicles, parts and accessories. Thus, two of the top four export categories to China are caught in this trade war. Commercial jets, airplane engines and other aviation equipment were not included in the most recent Chinese tariffs, but that could change if trade tensions mount. The U.S. already proposed tariffs on approximately \$200 billion of Chinese goods, though they haven't yet been imposed; China has vowed to counter those measures. Still, both sides held trade talks in late August, and it is possible that an agreement will eventually be reached that alleviates these trade tensions. RE

(This article was published online Sept. 12.)

Figure 2

Top 10 Soybean-Producing States in 2016



SOURCES: U.S. Department of Agriculture and authors' calculations.

ENDNOTES

- ¹ International trade economists refer to this concept as the "Lerner Symmetry Theorem," which says that an import tariff has effects that are equivalent to an export tax.
- ² For example, Princeton economists Gene Grossman and Esteban Rossi-Hansberg show that offshoring of some production tasks can raise domestic wages through a productivity effect in spite of greater competition from cheaper foreign labor.

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Rising Rates Impact Borrowing Costs for the U.S. Government, Too

By Miguel Faria e Castro and Asha Bharadwaj



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KEY TAKEAWAYS

- As the Fed raises short-term interest rates, the cost of borrowing increases for everyone, including the U.S. government.
- A hike in the Fed's policy rate will directly impact rates on short-term Treasuries, but the effect on long-term Treasuries is less predictable.
- Interest rates on longer-term Treasuries are also shaped by macroeconomic expectations and other factors.

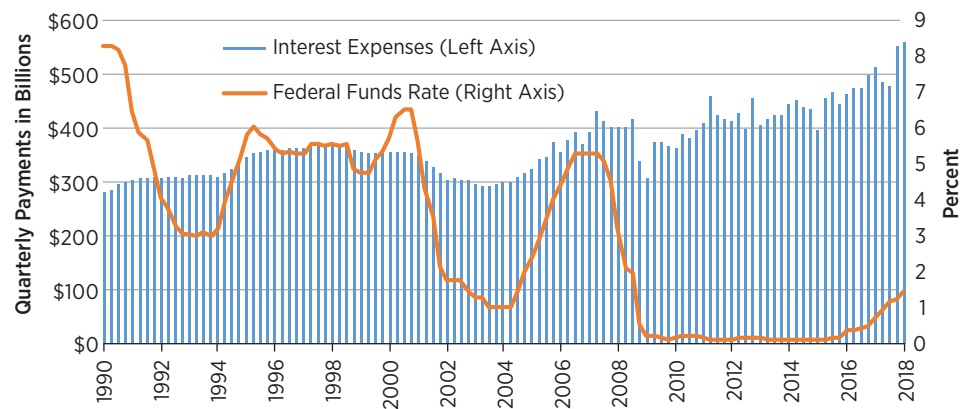
As the U.S. economy continues to grow, the Federal Reserve remains on its path to normalize monetary policy. An important part of this normalization process is the gradual increase of the policy rate—that is, the federal funds rate target.¹ As the policy rate rises, so do other interest rates in the economy, and thus the cost of borrowing rises for everyone, including the federal government.

This article explores the relationship between the federal funds rate and the U.S. government's cost of borrowing. The two are related, but not in a trivial way. While the Federal Reserve's policy rate directly affects short-term interest rates, the government borrows at many different maturities, ranging from one month to 30 years. The Treasury pays a different interest rate at each maturity, and these rates are not equal to (but are influenced by) the federal funds rate.

The government's cost of borrowing is likely to become an increasingly important issue. The federal debt stands at its highest level since the 1940s, having exceeded 103 percent of annual gross domestic product (GDP) at the end of 2017.²

Figure 1

Federal Interest Payments Don't Move in Lockstep with Short-Term Rates



SOURCE: FRED (Federal Reserve Economic Data).

NOTE: Quarterly data for payments and the federal funds rate are from the first quarter of 1990 through the first quarter of 2018.

What Determines the Government's Borrowing Cost?

One can think of interest expenses for the federal government as the product of both the interest rate and the total stock of federal debt. All else constant, these expenses tend to increase when the stock of federal debt is higher or when the Federal Reserve raises interest rates.

Figure 1 shows quarterly interest payments by the federal government and the path of the federal funds rate since 1990. The effects of movements in the interest rate are visible during periods of rapid rate increases or decreases: In 2004, for example, the Federal Reserve started raising interest rates, and this led to a noticeable increase in interest payments.

The relationship is, however, nonlinear. First, as mentioned, the total stock of debt also matters. That is why interest payments

rose after 2009, even though interest rates were roughly constant. Debt was rising during this period due to increased government spending on extraordinary stimulus programs (such as the American Recovery and Reinvestment Act) and interventions in the financial sector (such as the Troubled Asset Relief Program).

Additionally, as mentioned in the introduction, the Federal Reserve's policy rate affects primarily short-term interest rates, but the Treasury borrows at many different maturities, paying a wide range of interest rates. Understanding the maturity structure of government debt is therefore important to understanding the behavior of government borrowing costs. These longer-term interest rates are influenced by the federal funds rate but are also affected by many other factors, as we will discuss next.

ABOUT THE AUTHORS

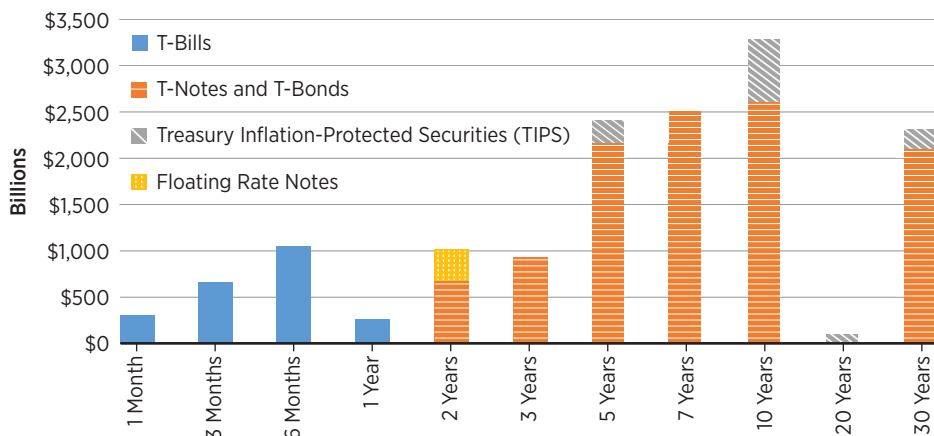
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Figure 2

Maturity Structure of Marketable Federal Debt

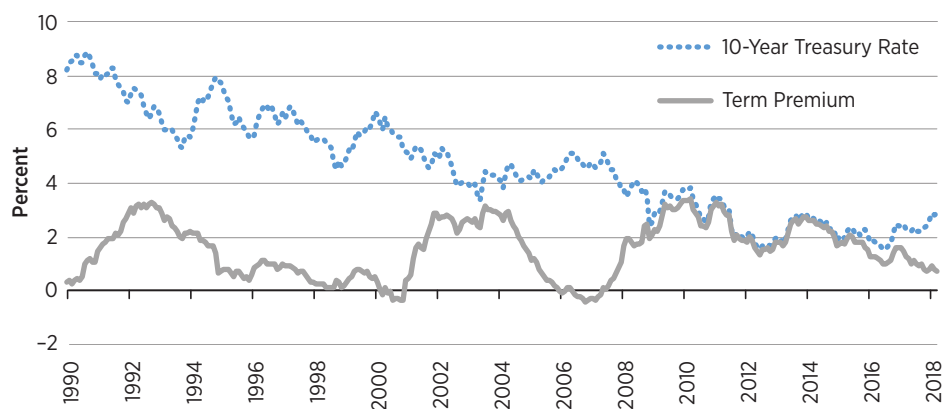


SOURCES: U.S. Department of the Treasury and authors' calculations.

NOTE: Data as of March 2018.

Figure 3

The Term Premium and the 10-Year Rate



SOURCE: FRED (Federal Reserve Economic Data).

NOTES: The term premium is the difference between the 10-year and one-year rates. Monthly data are from January 1990 through April 2018.

Short and Long Maturities

Figure 2 presents the maturity structure of marketable federal debt as of March 2018. Each bar corresponds to the value of outstanding debt issued at the given maturity.³

Figure 2 also decomposes this federal debt by the type of security. Each of these securities has different characteristics, such as a particular maturity schedule or a formula for its interest payments.

The bulk of this federal debt is financed using three main types of securities: Treasury bills, Treasury notes and Treasury bonds. These three types of securities account for almost 90 percent of all

marketable federal debt outstanding as of March 2018.⁴

Treasury bills are typically issued at maturities of one month, three months, six months and one year. (The Treasury plans to offer two-month T-bills in October.) These securities do not pay any interest or coupon (they are known as zero-coupon bonds), and we can therefore measure their implied interest rate from the price at which the Treasury sells them: If the government sells at \$99.50 a Treasury bill that promises a \$100 payment in three months, we can think of this security as paying a fixed interest rate of close to 2 percent a year. Since these bonds have very short

maturities, the implied interest rates will typically be close to the policy rate set by the Federal Reserve, less so as the maturity increases.

Treasury notes are issued at two-, three-, five-, seven- and 10-year maturities. These notes pay a fixed coupon twice a year, which is fixed at issuance.⁵

Treasury bonds are identical to Treasury notes, but issued with a maturity of 30 years. When deciding to invest in these securities, as opposed to ones with shorter maturities, investors take into account the fact that they are locking their funds into an asset that pays a fixed interest rate for a long time horizon.

An alternative investment strategy could be to invest in short-term securities and continually roll over funds into new securities with the same maturity. In this case, if the Fed raises short-term rates, then the investor stands to earn a greater return. For this reason, among others, investors will typically demand a higher interest rate on these longer-term Treasury securities.

The Term Premium

This extra compensation that investors demand for holding long-term treasuries is known as the Treasury term premium, and it may not respond to movements in the policy rate in a predictable manner. The term premium can depend on expectations of future macroeconomic indicators—such as GDP growth, inflation and financial conditions—and even on other factors, such as demographics.

While long-term rates tend to move along with short-term rates, movements in the term premium are crucial to ascertain whether they will move *by more or less*. Figure 3 shows the behavior of the 10-year rate and of a common measure of the term premium—the difference between the 10- and one-year rates. The term premium fluctuates over the business cycle and is generally positive for the reasons explained above. From December 2008 to December 2015, the term premium coincided with the 10-year rate since short-term rates were at essentially zero.

Besides serving as a potential indicator of recessions,⁶ the term premium also serves as an indicator of the relative cost of borrowing for the government across maturities. When the Treasury issues a

(continued on Page 22)

In the U.S. Hispanic Labor Force, Women Surpass Men in Multiple Ways

By Alexander Monge-Naranjo and Juan Ignacio Vizcaino



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KEY TAKEAWAYS

- In terms of education, female Hispanic workers have advanced at a faster pace than their male counterparts.
- In terms of jobs, female Hispanic workers have a stronger presence in higher-paying occupations than do male Hispanic workers.
- The advantage of female Hispanic workers is particularly high in professional occupations, where their presence almost doubles that of their male counterparts.

An examination of Hispanics in the U.S. labor force shows that women have an advantage over their male counterparts in educational attainment and in their presence in professional occupations. Albeit in line with the gender differences for the overall U.S. labor force,¹ some of the gender differences within the Hispanic workforce are quite remarkable. In particular, Hispanic women with college education substantially outnumber their male counterparts. Much more dramatic, the share of Hispanic female workers in professional occupations almost doubles that of their male counterparts.

For this article, we used individual-level data on the gender, educational level and current occupation of self-declared Hispanic workers from the IPUMS USA data set.² As reported in our article in the last issue of the *Regional Economist*, the percentage of U.S. residents who identify themselves as Hispanic or Latino has grown dramatically—more than eight times—within the past seven decades. Hispanic workers represented almost 13.4 percent (1 in 7.5) of all the workers in 2016 from just 1.6 percent (1 in 62.5) in 1950. How this growing presence is split between the two genders is the focus of this article.

Differences in Education

The IPUMS USA database can be used to classify workers according to 11 educational attainment categories. For tractability, we grouped these categories into five broader groups: primary school or less (i.e., nursery school through eighth grade), secondary incomplete (i.e., ninth to 11th grade), secondary complete (i.e., 12th grade), college incomplete (i.e., one to three years of college), and college complete or more (i.e., four or more years of higher education).

Figure 1 summarizes the changes in the educational attainment of Hispanic workers, both male and female from 1960 to 2016. Noticeably, when we look at individuals with primary complete or less and secondary incomplete (our two lower education groups), female and male workers have behaved similarly, as both genders have reduced their presence by similar fractions.

A very interesting difference is evident in the behavior for the higher levels of education. Looking at workers with incomplete college, we observe that Hispanic male workers moved from 4 percent in 1960 to 15 percent in 2016, almost four times higher. This improvement is nonetheless dwarfed by the advancement of Hispanic female workers, who experienced a sixfold increase, from 3 percent to 18 percent. Female Hispanic workers exhibited the same advancement in terms of the share with complete college or more: 2 percent in 1960 to 12 percent in 2016. This growth is twice as high as the growth exhibited for male Hispanic workers, from 3 percent to 9 percent during the same

period. One simple way to summarize the difference as of 2016 is to say that the women-to-men ratio of Hispanic workers with university degrees is 4-to-3.

Differences in Occupations

The IPUMS data set also allows us to group workers according to broad occupational groups. Specifically, IPUMS USA uses the 1950 Census Bureau occupational classification, aggregating three-digit occupations into the following nine broad groups, ordered by their skill intensity:³ professional and technical workers; managers, officials and proprietors; sales workers; clerical and kindred; craftsmen; service workers; operatives; farmers and farm laborers; and unskilled laborers.⁴

Figure 2 shows the share of female and male Hispanic workers across these occupations, comparing the years 1960, 1980 and 2016. First of all, notice that there are important differences between the genders that are sustained over time. Some occupations, such as laborers and craftsmen, are traditionally dominated by males, while other occupations, such as clerical and service workers, are traditionally held by female workers. The differences observed for Hispanic workers are in line with those observed for the overall population of workers in the U.S. We can also observe a clear, decreasing trend in lower-skill occupations such as farmers and laborers, except that for laborers, the male participation rebounded between 1980 and 2016.

Of more interest, we observe very clear and strong trends in the two occupation categories that are higher paid:

ABOUT THE AUTHORS

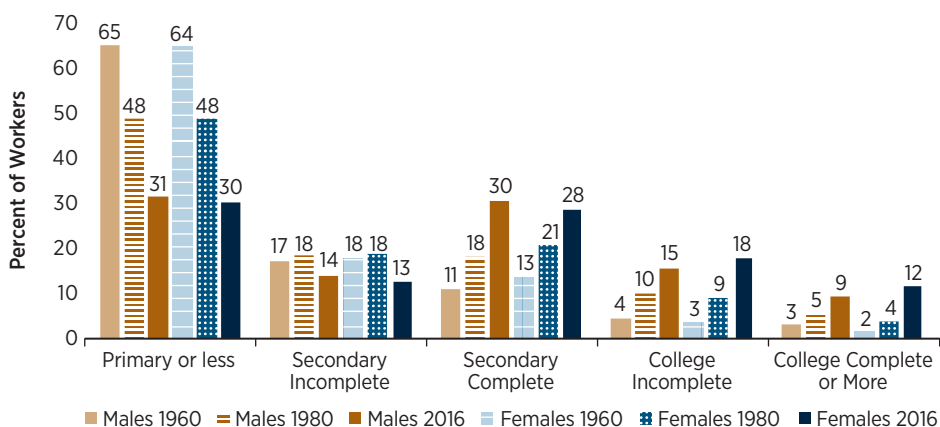
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Figure 1

Educational Attainment of Employed Hispanics

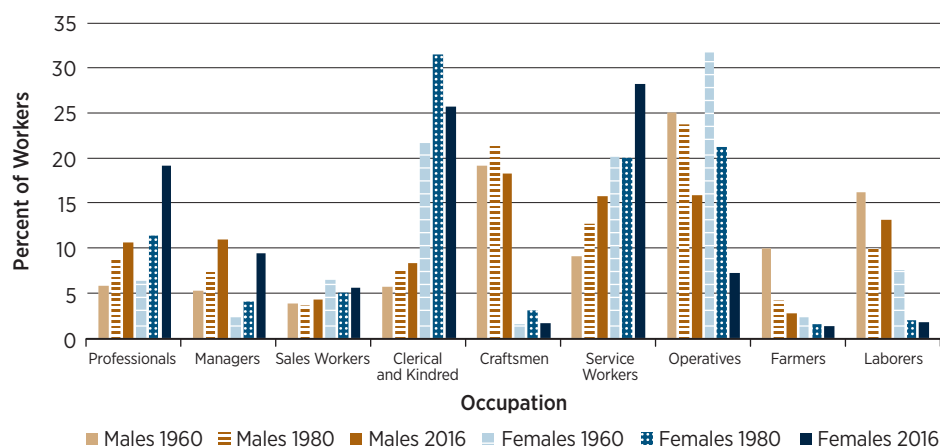


SOURCES: IPUMS USA and author's calculations.

NOTE: Educational attainment is defined by the following groups: primary school or less (nursery school through eighth grade), secondary incomplete (ninth to 11th grade), secondary complete (12th grade), college incomplete (one to three years of college), and college complete or more (four or more years of higher education).

Figure 2

Evolution of Hispanics' Occupations



SOURCES: IPUMS USA and author's calculations.

professionals and managers. The share of male and female Hispanic workers in those occupations has increased. For managerial occupations, women are closing the gap relative to their male counterparts: In 1960, about 5.25 percent of all the Hispanic male workers were managers, and that percentage doubled to 10.65 percent in 2016. For Hispanic female workers, the equivalent percentage more than doubled, from just 2.27 percent to 9.44 percent, almost a fourfold increase.

While the gender gap in managerial positions has almost closed, the most remarkable difference is with respect to professional positions, in which women

have clearly dominated men. As of 2016, 19.1 percent of all Hispanic female workers were in professional occupations, which is almost twice as high as the equivalent percentage for men, only 10.6 percent.

All in all, women are the ones pushing forward the advancement of Hispanic workers in the education and occupation ladders in the U.S. marketplace. ^{RE}

Research assistance was provided by Qiuhan Sun, a research associate at the St. Louis Fed.

(This article was published online Aug. 23.)

ENDNOTES

- ¹ See Monge-Naranjo and Vizcaino.
- ² See IPUMS USA, University of Minnesota, www.ipums.org. We discarded individuals whose employment status is unknown and those who are unemployed or not in the labor force, as classified by the variable EMPSTAT codes 0, 2 and 3.
- ³ Skill intensity is measured by the percentage of workers in an occupation with the highest year of school degree completed in 1950 being college or more. Thus, the higher the percentage of workers in an occupation with at least a college degree in 1950, the more skill-intensive an occupation is. The order of the top four occupations is preserved if we use 2016 instead of 1950 to measure skill intensity.
- ⁴ Observations of individuals with unclassified, missing or unknown occupations are discarded.

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Soybeans, the Eighth District's No. 1 Crop, Caught in Trade Tussle

By Camilla Adams, Jonas Crews and Charles Gascon



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KEY TAKEAWAYS

- Soybeans are an important agricultural crop in the U.S. and the Eighth Federal Reserve District. The commodity is mainly produced in the U.S. and Brazil.
- U.S. and regional farmers face uncertainty after China, the world's biggest importer of soybeans, imposed a tariff on U.S. soybean imports.
- While the result of the tariff is difficult to predict, economic models indicate a negative impact for both the U.S. and China, with significantly reduced U.S. soybean production.

Tofu, animal feed and crayons: It sounds like the beginning of a bad joke, but the commonality found in this strange combination of everyday products is anything but trivial. Each item relies on the same crop, potentially from the same farmer or even the same plant. With astonishing diversity of uses, soybeans have exploded in popularity.

Soybean processing primarily yields high protein soybean meal and soybean oil, as soybeans are composed of 38 percent protein and 18 percent oil.¹ Livestock, such as hogs and cattle, almost exclusively consume the world's production of soybean meal. Humans primarily use soybean oil for cooking. Edamame, simply pre-ripened soybeans, is a growing, yet globally popular, way to enjoy the crop.

And now this key crop is being targeted in global trade negotiations. In July, China imposed a 25 percent tariff on U.S. soybean imports and other products after the U.S. imposed tariffs on Chinese goods. In this article, we examine the role of soybeans in both the U.S. and the Eighth Federal Reserve District² as well as their role in global trade.

U.S. and Brazil Are World's Largest Producers

In the 2016-17 crop year,³ 297 million acres of land grew 350 million metric tons of soybeans worldwide. Only wheat, rice and corn superseded the total acreage of soybeans. The U.S. and Brazil produced 66 percent of all soybeans worldwide, 33 percent each.

In the U.S., soybeans are grown mostly in the Mississippi River watershed, with 26 of the 31 soybean-producing states in 2017 having a portion of their territories fall within the watershed. Those 26 states accounted for 99 percent of 2017 domestic production. Combined, Illinois and Iowa produced 27 percent of the 2017 soybean crop.

Figure 1 shows soybean production by county; it highlights the role of the Mississippi River Basin, with most high-production counties lying along the river, or sandwiched between the Mississippi and one of its major tributaries.⁴

The Eighth District is outlined on the map. Soybeans were the most planted crop in the District, with almost twice as many acres as corn and 15 times as many acres as wheat. The District produced 19 percent of U.S. soybeans in 2017. Its pattern of production was consistent with that of the rest of the U.S.: The top 10 soybean-producing counties in the District lie along the Mississippi River or are separated from the Mississippi River by one county.

The District's involvement in the soybean industry goes beyond growing

the crop. It is home to multiple soybean processing plants and the headquarters of agribusiness Bunge North America. The District is also home to Bayer's Crop Science Division, the subsidiary that absorbed Monsanto Co. after Bayer completed its acquisition of the U.S. seed giant; the division provides conventional and genetically modified soybean seeds, as well as pesticides and herbicides, to farmers across the world.

Consumption and Trade

As seen in Figure 2, the U.S. and Brazil combined accounted for 83 percent of global soybean exports in the 2016-17 crop year. China was far and away the largest global importer, buying 65 percent of global exports. China also dominated global consumption, accounting for 31 percent of the global total; the U.S. was a distant No. 2, at 17 percent.⁵

Focusing on the U.S., soybean exports equaled 46 percent of domestic soybean production in 2017. Figure 3 provides a breakdown of export destinations. China and Mexico were the two largest importers, accounting for 58 percent and 7 percent of U.S. soybean exports, respectively.

Among all U.S. goods exports in 2017, soybeans accounted for 1.6 percent of total value;⁶ this was the greatest share of any single food, beverage or feed product exported.

Exported soybeans are shipped through either the Pacific Northwest or the Gulf Coast. In 2013, exporters shipped 60 percent of soybeans through the Gulf

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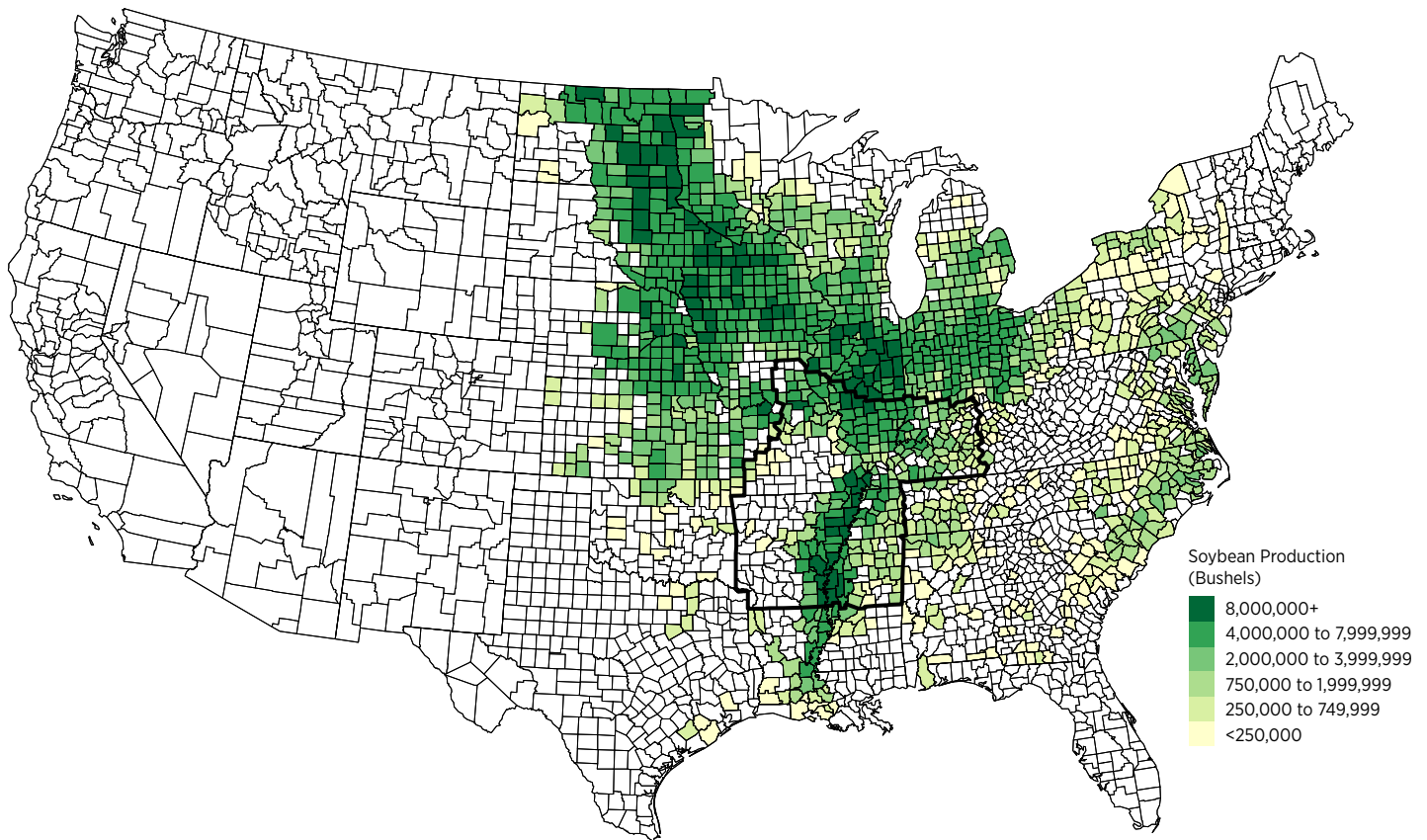


At the time this was written, **Camilla Adams** was a research intern at the Federal Reserve Bank of St. Louis.

At the time this was written, **Jonas Crews** was a senior research associate at the Federal Reserve Bank of St. Louis. He is currently a research associate at the Walton Family Foundation.

Figure 1

Soybean Production by County for Selected States, 2017



SOURCE: U.S. Department of Agriculture.

NOTE: Uncolored areas represent counties where no estimates were reported.

Coast using inland barges as the preferred method. However, relative transportation costs do sometimes fluctuate, and this can lead to more soybeans being shipped via the Pacific Northwest.⁷

The Impact of Tariffs

Recent fluctuations in soybean prices demonstrate the traditional economic theory of supply and demand. From 2011 to 2014, higher soybean prices enticed farmers to produce more soybeans. In addition to more crops being planted, farming techniques improved with better technologies and resources. Both factors contributed to a surge in supply.⁸

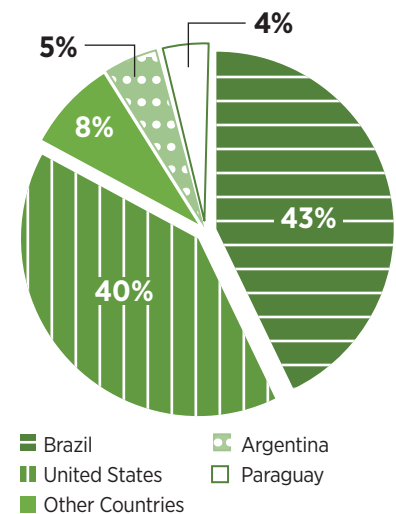
Initially, the increased supply faced growing demand from a larger global population with ever greater incomes.⁹ From just 2011 to 2014, China, the largest importer of U.S. soybeans, saw a 36 percent increase in gross domestic product (GDP) per capita, which increased the demand for soybean meal-consuming pigs.¹⁰

Starting in 2015, farmers' willingness to increase production waned because of lower prices due to slower population and income growth in China, combined with a greater global supply of soybeans.¹¹ With lower prices of soybeans and other grains, many U.S. farmers have struggled to break even in recent years. While there haven't been any indications of major reductions in farming activity up to this point, there have been several reports of farmers' equity shrinking significantly. Thus, farm consolidation and outright closing are expected if prices remain low.

Prospective soybean tariffs, the most discussed downside risk to U.S. soybeans in recent months, have already affected soybean prices. U.S. future prices declined about \$2 a bushel in the spring after the Chinese announcement of a potential 25 percent tariff on U.S. soybeans. China imports 90 percent of the soybeans it consumes, with 30 percent originating in the U.S. Furthermore, reports from earlier

Figure 2

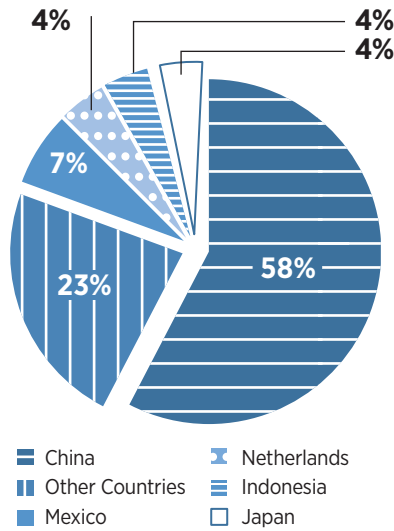
Top Exporters of Soybeans, 2016-17 Crop Year



SOURCE: U.S. Department of Agriculture.

Figure 3

Countries Importing U.S. Soybeans by Volume, 2017



SOURCE: U.S. Department of Agriculture.

NOTE: The Dutch port of Rotterdam is the largest port in the European Union. Soybeans are then exported to other EU countries.

this year indicated that Chinese buyers were canceling orders for U.S. soybeans, in part due to fears that the tariff increase would be enacted before purchases entered China. Those fears were fulfilled when China imposed tariffs in July.

Estimating the impact of an economic shock like a tariff is challenging because these shocks trigger a sequence of events that ripple through the economy. Economists design models to capture as many of these events as possible. Data can be used to estimate many of these relationships; however, one is always forced to impose certain assumptions.

In this case, a critical assumption is needed about how Chinese consumers will respond to the tariff. On the one

hand, the demand for soybeans may be relatively inelastic because the price of beans is relatively low; it is just one input into the cost of raising pigs. On the other hand, there are substitutes for U.S. beans—primarily beans from other countries—that would increase the elasticity of demand.

Economists Farzad Taheripour and Wallace E. Tyner at Purdue University used an economic model to estimate the impact of the Chinese tariffs.¹² The magnitude of the economic impact is very sensitive to their assumption of trade elasticities, but some main findings hold. First, global economic welfare declines: Welfare declines more in the U.S. than in China, while welfare increases in Brazil. Second, over time, China produces slightly more soybeans, while the U.S. produces far less, as farmers plant other crops; increased production in Brazil further offsets the decline in U.S. production. Third, the U.S. increases its exports to the European Union, as Brazil shifts exports to China.

Even with assumptions and estimates, economic models often fail to incorporate critical variables necessary for accurate projections. In this case, principle factors like exchange rate movements due to external forces could lead to price changes, and weather conditions play a key role in determining crop yields and overall production levels.

Conclusion

Soybeans are one of the most produced and used agricultural products in the world, the U.S. and the Eighth District. In recent months, strained U.S.-China trade relations have also made the crop one of the most widely discussed commodities.

Concerns regarding China's tariff on U.S. soybeans are met with multiple mitigating factors. First, proposed aid for farmers potentially offsets the drastic effects of lower prices, albeit not completely neutralizing the negative effects. Additionally, Chinese consumers' growing reliance on U.S. soybeans demonstrates an increasingly inelastic demand pattern for soybeans.

In the end, projections indicate these tariffs will place considerable costs on both the U.S. and China. A world with higher tariffs may be business as usual for the American farmer, but, as always, much remains to be determined by the weather. **RE**

ENDNOTES

- ¹ See North Carolina Soybean Producers Association.
- ² Headquartered in St. Louis, the Eighth Federal Reserve District includes all of Arkansas and parts of Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee.
- ³ The 2016-2017 crop year roughly covers the beginning of the Northern Hemisphere planting season in 2016 through the end of the Southern Hemisphere harvest and marketing season in 2017. We use this period for our global analysis because, at the time of writing, only preliminary estimates were available for the Southern Hemisphere from the 2017-2018 crop year.
- ⁴ See USDA, 2017.
- ⁵ Data on acres and production are from the USDA, 2018a. Data on consumption, imports and exports are from the USDA, 2018b.
- ⁶ See National Oilseed Processors Association.
- ⁷ See Denicoff et al.
- ⁸ In addition to production decisions, the other important yet least predictable determinants of price are weather and disease.
- ⁹ See USDA, 2016b.
- ¹⁰ See World Bank.
- ¹¹ See USDA, 2016a.
- ¹² See Taheripour and Tyner.

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(This article was published online Sept. 10.)



60% of District's Jobs Could Face Automation in Next 20 Years

By Sungki Hong and Hannah G. Shell



The Eighth Federal Reserve District is composed of four zones, each of which is centered around one of the four main cities: Little Rock, Louisville, Memphis and St. Louis.

KEY TAKEAWAYS

- Automation is replacing jobs in the service and manufacturing sectors in the U.S. economy.
- Jobs in the St. Louis Fed's District are more at risk of being automated than are jobs nationwide.
- Automation will have the greatest impact on smaller MSAs in the District due to a high concentration of employment in sales and production occupations.

Advances in technology are almost always considered positive because they increase productivity and ease frustration of completing simple, menial tasks. However, technological improvement does not come without cost; some tech advancements can result in the automation of jobs that used to be performed by humans.

This phenomenon is not new to the U.S. Several decades ago, labor was mostly concentrated in production and agriculture; however, as automation increased the productive capacity of manufacturers and farmers, labor was freed up to pursue other types of employment.

Currently, automation is occurring more in service and manufacturing positions. It is one factor that contributes to labor market polarization, or the disappearance of middle-income, routine task type jobs in the U.S.¹ Despite a strong labor market, fear of job loss from automation is common. Some parents with young children already worry that robots will take all potential jobs for their children in the near future.²

Automation in the U.S.

Automation can impact the labor market in several ways. One way is through job loss. Automation means fewer jobs for laborers in the short term, which could increase the unemployment rate. In the long term, laborers will either exit the labor force or seek new skills to work in a different occupation.

The short-term impact of automation is not directly observable, but two economists at the University of Oxford, Carl Benedikt Frey and Michael A. Osborne, attempted to quantify jobs that are at risk in a 2013 article about automation.³ The researchers used a machine-learning algorithm to estimate the probability that an occupation will become automated in the next few decades. The probability is calculated based on three major factors of the occupation: perception and manipulation, creative intelligence, and social intelligence. The result can be interpreted as the likelihood that engineers will be able to produce machinery that performs tasks required in each occupation.

The economists found that 47 percent of jobs in the U.S. are at risk of becoming automated. Jobs that are repetitive or routine-intensive have the highest probability of this happening. The economists predicted that the transportation and logistics occupations, as well as the office and administrative support occupations, will lose the most jobs to automation over the next decade or so.

Not all jobs are at risk for automation. Occupations that require technical procedures, persuasion, social intelligence and creative intelligence are less likely to become automated. Community and social services occupations, along with science, engineering, mathematical and

artistic occupations, are least likely to become automated in the immediate future, although they are not entirely immune to automation.

The Oxford economists predicted that automation will occur in waves, first replacing routine tasks, then slowing as engineers reach a technological plateau. A good example, provided by Frey and Osborne, is that paralegals and legal assistants (which are considered relatively low-skill, routine-based occupations) are seeing their jobs quickly becoming automated; however, it will be a long time before computers are advanced enough to replace lawyers (whose jobs are considered high-skill, nonroutine).

Impact on the Eighth District

Occupational employment is not evenly distributed over regions, so certain metropolitan statistical areas (MSAs) and regions of the country will experience more impact from automation depending on the occupational mix. To examine the impact that automation may have on the St. Louis Fed's District,⁴ we've merged the Frey and Osborne probabilities of automation with the Census Bureau's 2017 Occupational Employment Statistics data set, using employment data on the MSA level.

Compared with Frey and Osborne's results, our employment data yield a slightly higher estimate of the number of jobs at risk for automation. We found that 57 percent of jobs could be automated on the national level, while 60 percent of jobs in the District have potential to be automated in the next two decades.⁵

ABOUT THE AUTHORS

Sungki Hong has been an economist at the Federal Reserve Bank of St. Louis since 2017. His research interests include macroeconomics and industrial organization. Read more about the author and his research at <https://research.stlouisfed.org/econ/hong>.

Hannah G. Shell is a senior research associate at the Bank, where she has worked since 2014.

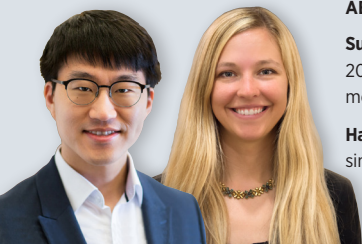
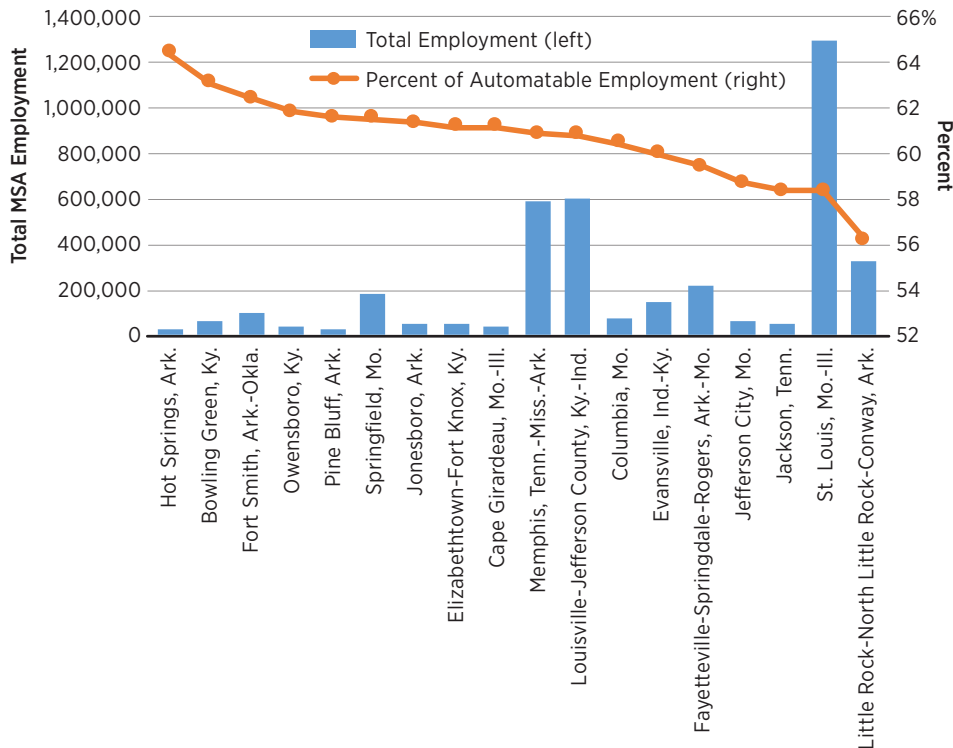


Figure 1

Automation and Employment in District MSAs



SOURCES: Census Bureau's Occupational Employment Statistics, Frey and Osborne, authors' calculations.

NOTE: The figure shows total employment (bars) and percentage of automatable employment (line) for each MSA in the Eighth District. There is an inverse relationship between MSA size in terms of employment and percentage of automatable employment.

Figure 1 shows the proportion of jobs in each District MSA that is at risk of automation. The figure gives us an idea of which MSAs will be most impacted across the District. The proportion of employment in automatable occupations is inversely correlated to the size of the labor market in District MSAs.

The MSA with the highest proportion is Hot Springs, Ark. (64 percent of 28,330 employees), while the MSA with the lowest is Little Rock-North Little Rock-Conway, Ark. (56 percent of 326,240 employees). The smaller MSAs tend to have more employment concentrated in sales, production and food preparation occupations, which all have a high probability of automation. From this figure, we can see that smaller MSAs in the District may feel the impact of automation more in the next few decades.

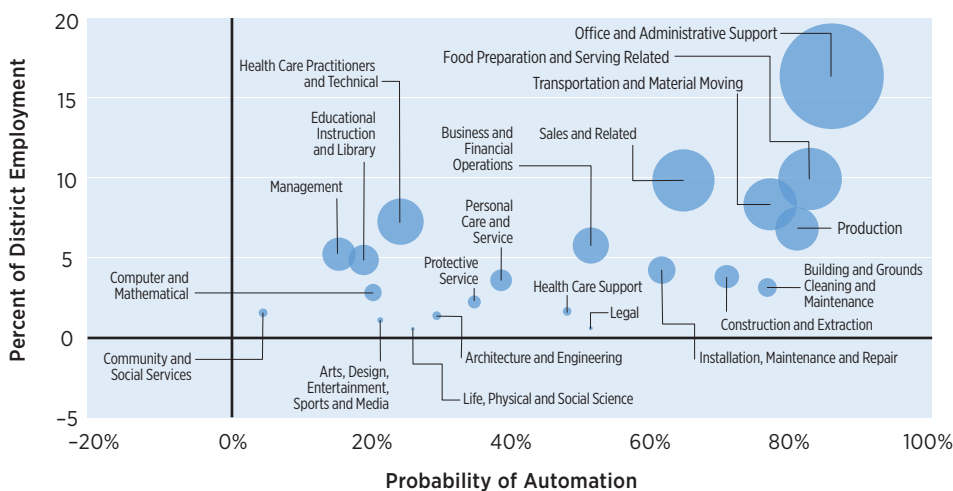
In the District overall, the occupation that is most likely to be impacted by automation is office and administrative support. Figure 2 shows which other occupations in the District will be heavily impacted by automation. The horizontal axis displays an occupation's probability of automation as estimated by the Oxford economists, and the vertical axis represents the occupation's employment as a percentage of District total employment. The bubbles are sized according to an occupation's total employment in the District.

The graph shows a positive correlation, meaning many of the highest-employment occupations in the District also have a high probability of automation. Office and administrative support, food preparation and serving, sales, and transportation occupations are all big sources of employment in the District. Because many of these occupations involve routine tasks, they are likely to be automated over the next few years.

The occupations in the District with high employment and low probability of automation are in health care, business and financial operations, education, and management occupations. These jobs all require some degree of greater human intelligence and social interaction or else they involve nonroutine tasks that computers are unlikely to be able to perform.

Figure 2

Which Jobs Are Most at Risk of Being Automated?



SOURCES: Census Bureau's Occupational Employment Statistics, Frey and Osborne, authors' calculations.

NOTE: The figure shows a positive correlation between probability of automation and percentage of employment for occupations in the Eighth District. Probability of automation is on the horizontal axis, while percentage of employment is on the vertical axis. The size of the bubbles represents the number of jobs in each occupation.

(continued on Page 22)

Forecasters See Solid U.S. GDP Growth during Rest of 2018

By Kevin L. Kliesen



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KEY TAKEAWAYS

- Strong corporate profits, healthy financial market conditions, and accommodative monetary and fiscal policies fueled brisk U.S. economic growth in the second quarter.
- Forecasters expect U.S. real economic growth to average close to 3 percent in the second half of 2018.
- The St. Louis Fed's inflation forecasting model predicts that increases in the personal consumption expenditures (PCE) price index will slow over the next 12 months.

The U.S. economy roared ahead in the second quarter of 2018 after increasing at a modest rate in the first quarter. Economic conditions have been fueled by strong corporate profits, healthy financial market conditions, and accommodative monetary and fiscal policies. If these trends persist, buoyant economic and labor market conditions are likely over the second half of the year. By contrast, headline inflation moderated in the second quarter, though the year-over-year gain remained slightly above the 2 percent target rate of the Federal Open Market Committee (FOMC). In response to strengthening economic conditions and rising price pressures, the FOMC indicated that further gradual increases in its policy rate are likely. However, policymakers and economists are carefully monitoring recent international developments.

Strong Economic Conditions

After increasing at a 2.2 percent annual rate in the first quarter, real gross domestic

Current Forecasts from the Survey of Professional Forecasters

	Actual 2018:H1	Forecast 2018:H2
National Income and Product Account Components		
Percent, SAAR		
Real Gross Domestic Product	3.2	2.9
Real Personal Consumption Expenditures (PCE)	2.3	2.6
Nonresidential Fixed Investment	9.4	5.3
Real Residential Fixed Investment	-2.3	1.9
Government Spending	1.8	1.8
Billions of 2012 dollars, SAAR		
Change in Net Exports	24.7	-19.0
Change in Private Inventories	-22.0	28.5

Inflation

Percent, SAAR		
PCE Price Index	2.2	2.1

SOURCES: Federal Reserve Bank of Philadelphia and Haver Analytics.

NOTES: Actuals and forecasts are two-quarter averages. SAAR is seasonally adjusted annual rate.

product (GDP) increased at a brisk 4.1 percent annual rate in the second quarter. The second-quarter increase was modestly stronger than both the consensus of Blue Chip forecasters (3.9 percent) and the St. Louis Fed's Economic News Index (3.4 percent).

The near doubling of real GDP growth from the first to the second quarter reflected solid gains in consumption by households, capital spending by firms, and sales of goods and services to the rest of the world (exports). Government expenditures also advanced at a modestly faster rate in the second quarter compared with the previous quarter. By contrast, residential fixed investment declined for the fourth quarter in the past five. Still, if

not for a decline in inventory investment in the second quarter, real GDP growth would have been much stronger at 5.1 percent. In the statement issued after the Aug. 1 meeting, the FOMC said that "economic activity has been rising at a strong rate."

The strength in product markets (production and sales of goods and services) has bolstered labor markets. In July, non-farm payroll employment rose by 157,000. Although this gain was well below its average over the previous three months (about 230,000), the average gain per month thus far in 2018 is running about 30,000 more than the first seven months of 2017.

With the unemployment rate falling below 4 percent, many firms continue to report that they are having a difficult time filling open positions despite faster labor force growth. In fact, the Bureau of Labor Statistics reported that in the second quarter of 2018, unfilled job openings



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exceeded the number of those unemployed and actively seeking a job for the first time on record. (Job openings data only go back to late 2000.)

Strong demand for labor has fueled a modest acceleration in labor compensation. The year-to-year growth in the employment cost index, a broad measure of compensation that includes wages and salaries and benefits, has increased from 1.8 percent in the first quarter of 2016 to 2.9 percent in the second quarter of 2018—a 10-year high.

Has Inflation Peaked?

Spurred by a sharp slowing in the growth of energy prices, headline inflation moderated in the second quarter. After increasing at a 2.5 percent annual rate in the first quarter, the all-items personal consumption expenditures price index (PCEPI) rose at a 1.8 percent rate in the second quarter. However, input price pressures remain intense

in some industries, such as construction and transportation. At the same time, nonenergy commodity price pressures moderated in June and July. In this vein, the U.S. Energy Information Administration projects that crude oil prices will fall slightly over the second half of 2018 and into the first half of 2019.

The St. Louis Fed's inflation forecasting model employs a broad array of prices, both domestic and foreign, to predict headline PCEPI inflation over the next 12 months. The latest forecast projects that inflation will slow from 2.2 percent in July 2018 to about 1.75 percent in July 2019. This forecast is consistent with recent developments: a strengthening U.S. dollar, some softening in the global economy, weaker oil and commodity prices, and stable inflation expectations. The model continues to indicate a small probability that headline inflation will accelerate past 2.5 percent over the next 12 months.

The Near-term Outlook Looks Bright

As seen in the accompanying table, the consensus of professional forecasters is that U.S. real GDP growth will average close to 3 percent over the second half of 2018. Forecasters expect continued solid gains in consumption and business fixed investment, a modest rebound in residential fixed investment, and some inventory rebuilding, offset to some extent by weaker growth of net exports (i.e., a larger trade deficit in goods and services). Forecasters also predict that inflation will remain near the Fed's target rate. Solid growth and low inflation will help maintain healthy labor market conditions, though with perhaps some modest upward pressure on interest rates. **RE**

Brian Levine, a senior research associate at the Bank, provided research assistance.

(This article was published online Aug. 17.)

Rising Rates

(continued from Page 13)

long-term security, such as a Treasury note or bond, it fixes the coupon payment on that security and therefore protects itself against future increases in short-term interest rates by the Fed. The term premium is the cost of that insurance.⁷

Conclusion

While rising interest rates are associated with higher borrowing costs for the federal government, the relationship is not linear. It depends not only on the current stock of debt but also on its composition, in particular the maturity structure.

While the cost of issuing short-term debt securities, such as Treasury bills, closely tracks the policy rate, this is not necessarily true for longer-term securities, such as notes or bonds, whose cost also depends on the term premium. This is especially relevant because longer-term securities (with a term over five years) represent over 70 percent of marketable federal debt outstanding. **RE**

(This article was published online Aug. 6.)

ENDNOTES

- ¹ The Federal Open Market Committee, the Fed's primary monetary policymaking body, sets a range for the federal funds rate, the interest rate at which depository institutions lend balances at the Federal Reserve to other depository institutions overnight. On June 14, the policy rate was set at 1.75 to 2.00 percent.
- ² See <https://fred.stlouisfed.org/series/GFDEGDQ188S>.
- ³ The plot corresponds to contractual maturities, i.e., the maturities at which each debt security was issued. Another important concept is residual maturity, which is the difference between the contractual maturity and the current date.
- ⁴ The composition of federal debt outstanding can be found in the Monthly Statement of the Public Debt of the United States, issued monthly by the Department of the Treasury. Other types of marketable debt securities are Treasury inflation-protected securities (TIPS) and floating rate notes. Marketable debt securities account for over 73 percent of total federal debt outstanding. The remainder, nonmarketable debt, is mostly accounted for by intragovernmental holdings and is ignored for the purposes of this article.
- ⁵ This coupon is roughly equal to the interest rate that ensures that the bond will be sold at par; that is, the Treasury sells the bond to an investor for the same amount of dollars that the bond pays at maturity.
- ⁶ See, for example, the Dec. 1, 2017, speech by St. Louis Fed President James Bullard at www.stlouisfed.org/from-the-president/speeches-and-presentations/2017/assessing-yield-curve.
- ⁷ This, obviously, also means that the Treasury will "miss out" on lower borrowing costs should the Federal Reserve lower its policy rate.

Automation

(continued from Page 20)

Conclusion

In this article, we have looked at how automation would impact jobs in the Eighth District. We found that the jobs in the District are more exposed to risk of computerization than the nation-wide average. By examining data on the MSA level, we saw that smaller MSAs have higher probabilities of automation. Also, high employment occupations—such as office and administrative support, food preparation and serving—face a higher probability of automation.

These results should be interpreted carefully. The probability of automation does not equal the probability of job loss. There are many additional factors that we would need to account for to measure job loss. For example, these estimates do not include the equilibrium effect of how easy or hard it will be for a displaced worker to find a new job in other industries when replaced by a machine. Also, we do not consider whether the cost of research and development investment for computerization is lower than the cost of labor.

The full impacts of automation remain hard to quantify. Job loss is one potential outcome, but automation could also result in job polarization and lead to increased income inequality. **RE**

(This article was published online Aug. 9.)

ENDNOTES

- 1 See Dvorkin and Shell for a discussion of labor market polarization and its impact on the District.
- 2 See Samuel.
- 3 See Frey and Osborne.
- 4 Headquartered in St. Louis, the Eighth Federal Reserve District includes all of Arkansas and parts of Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee.
- 5 Risk of automation does not mean these jobs are going to disappear in the next two decades. Rather, risk of automation measures how likely that an occupation will be impacted by automation.

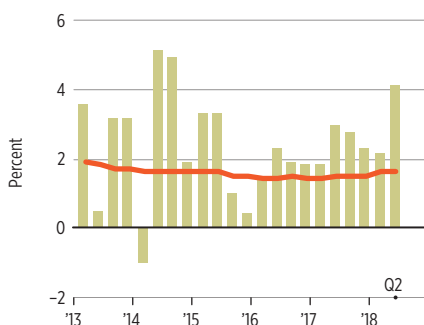
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ECONOMY AT A GLANCE

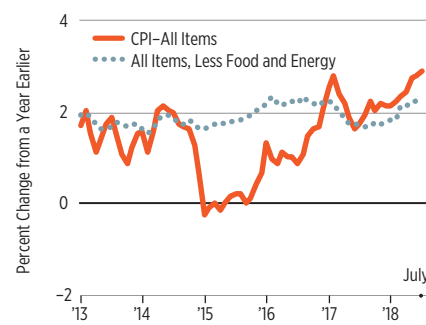
All data as of Aug. 10, 2018

Real GDP Growth

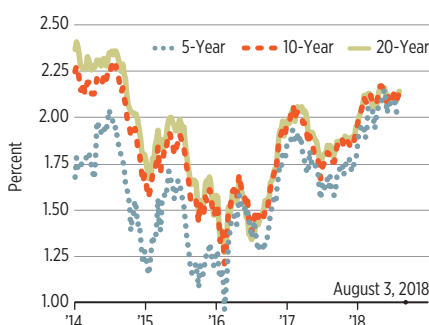


NOTE: Each bar is a one-quarter growth rate (annualized); the red line is the 10-year growth rate.

Consumer Price Index (CPI)

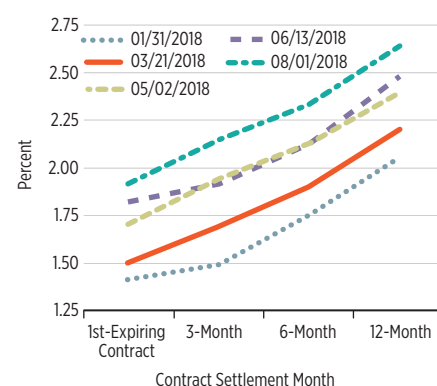


Inflation-Indexed Treasury Yield Spreads

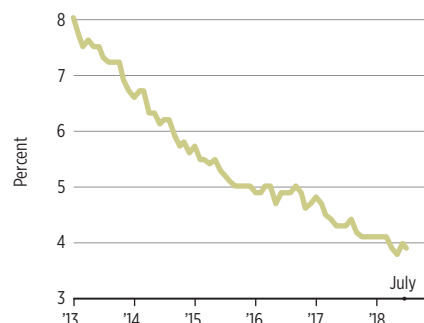


NOTE: Weekly data.

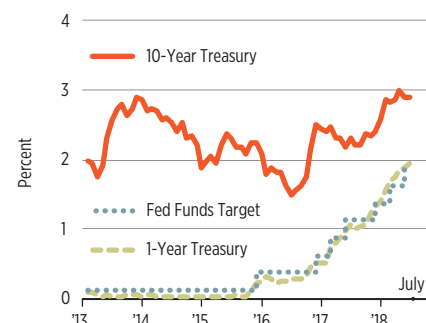
Rates on Federal Funds Futures on Selected Dates



Civilian Unemployment Rate

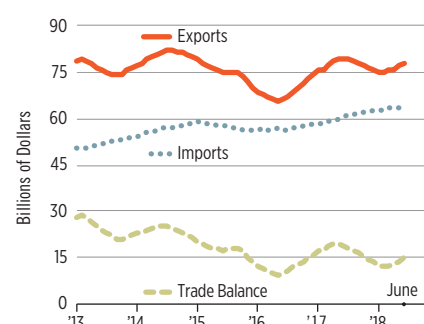


Interest Rates



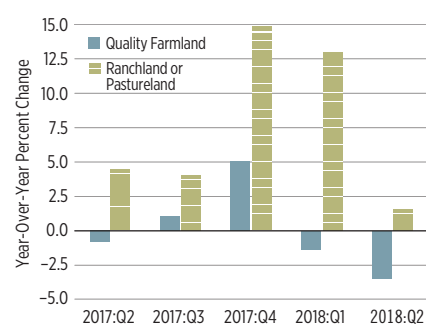
NOTE: On Dec. 16, 2015, the FOMC set a target range for the federal funds rate of 0.25 to 0.5 percent. The observations plotted since then are the midpoint of the range.

U.S. Agricultural Trade



NOTE: Data are aggregated over the past 12 months.

Average Land Values Across the Eighth District



SOURCE: Agricultural Finance Monitor.

On the web version of this issue, 11 more charts are available, with much of those charts' data specific to the Eighth District. Among the areas they cover are agriculture, commercial banking, housing permits, income and jobs. To see those charts, go to www.stlouisfed.org/economyataglance.



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