

# THE REGIONAL ECONOMIST

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THE FEDERAL RESERVE BANK OF ST. LOUIS  
CENTRAL TO AMERICA'S ECONOMY®

President Bullard  
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# 6 China's Economic Data: An Accurate Reflection, or Just Smoke and Mirrors?

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Accurate reporting by China on its GDP and other indicators is important because of the country's huge influence on other economies. Doubts about the accuracy—warranted or not—have led others to do their own measuring, sometimes using proxies like energy consumption and even the “night lights” seen from space.



## THE REGIONAL ECONOMIST

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## A Case for Shrinking the Fed's Balance Sheet

As a consequence of the financial crisis, Great Recession of 2007-09 and sluggish economy that persisted for several years beyond that, the Federal Open Market Committee (FOMC) took extraordinary actions to stimulate the economy and promote the recovery. By December 2008, for instance, the FOMC had reduced the federal funds rate target (i.e., the policy rate) to near zero—exhausting its conventional monetary policy tool. With the economy still weak and to guard against deflation, the FOMC turned to unconventional monetary policy, including three rounds of large-scale asset purchases from late 2008 to late 2014. The purchases were primarily of longer-term Treasuries and mortgage-backed securities. This policy, better known as quantitative easing (QE), led to an expansion of the Fed's balance sheet.

Fast forward to today. The Fed's goals for employment and inflation have essentially now been met. The FOMC's focus has shifted to monetary policy normalization, including increasing the policy rate, which it has done three times since December 2015. With this return to more conventional monetary policy now underway, the question of how and when to begin normalizing the Fed's balance sheet is timely.

As a result of the three QE programs, the Fed's balance sheet increased from about \$800 billion in 2006 to about \$4.5 trillion today.<sup>1</sup> The FOMC's reinvestment policy, which includes replacing maturing securities with new securities, is keeping the balance sheet at its current size. If the FOMC wanted to begin shrinking the balance sheet, the most natural step would be to end the reinvestment policy. Ending reinvestments would lead to a gradual reduction in the size of the balance sheet over several years.

In recent months, I have been an advocate of ending reinvestments for two main reasons. One is that current monetary policy is distorting the yield curve. While actual and projected increases in the policy rate are putting upward pressure on short-term interest rates, maintaining a large balance sheet is

putting downward pressure on medium- and long-term interest rates. Of course, interest rates are volatile and are affected by many factors, but raising the policy rate would normally tend to raise interest rates all along the yield curve. Therefore, a more natural way to normalize interest rates would be to allow all of them to increase together.

My second argument for ending reinvestments is to allow for more balance-sheet "policy space" in the future. In other words, the FOMC should begin reducing the balance sheet now in case it needs to add to the balance sheet during a future recession. If, at that time, the policy rate is once again reduced to zero, the FOMC may want to consider using QE again. By having a smaller balance sheet in that situation, the FOMC would have more "policy space" to buy assets, if necessary.

Although I am in favor of ending reinvestments, some may argue that the "taper tantrum" of the summer of 2013 calls for caution in doing so. The FOMC's QE3 program was ongoing at that time, and the taper tantrum was related to communications about the pace of asset purchases. In May of that year, then-Chairman Ben Bernanke commented to a congressional committee that he thought the pace of asset purchases might be slowed at future meetings. That message was reinforced by the results of the June meeting, when the FOMC authorized Bernanke to announce a road map for a possible decision to begin tapering later in the year. Financial markets viewed this announcement as relatively hawkish and reacted accordingly. (For example, longer-term U.S. interest rates increased.) At the September meeting, the FOMC postponed the decision, which financial markets viewed as relatively dovish. When the FOMC finally decided in December to begin tapering the pace of asset purchases, global financial markets did not react very much.

In my view, the taper tantrum was a communications issue—not an issue about actual changes in the size of the balance sheet.



Similarly, communication will be important in the current situation. If the FOMC properly communicates the end of the reinvestment policy, I would expect the experience to be similar to December 2013, when there was no appreciable impact on global financial markets because they had already anticipated the changes in the Fed's policy.

Some have suggested waiting to end the reinvestment policy until the FOMC has decided on the final size of the balance sheet. But few would argue that today's \$4.5 trillion is appropriate in the long run.<sup>2</sup> Given that balance sheet normalization will take years, the FOMC could continue to debate the final size after reinvestment ends. In my view, it would be prudent to begin shrinking the balance sheet and making progress toward the eventual goal. The balance sheet policy was designed to cope with a near-zero policy rate, but now that the policy rate has increased, having such a large balance sheet is less critical. 

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

### ENDNOTES

<sup>1</sup> For a FRED graph showing the amount of U.S. Treasury securities, mortgage-backed securities and other assets on the Fed's balance sheet, see <https://fred.stlouisfed.org/graph/?g=dIAD>.

<sup>2</sup> Before the crisis, the liability side of the balance sheet was almost all currency with some reserves. To give an idea of how far the balance sheet is now from where it may need to be, accounting for currency today and allowing for a sufficient level of reserves would result in a balance sheet in the \$2 trillion range.

# Does More Financial Development Lead to More or Less Volatility?

By Maria A. Arias and Yi Wen



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For a long time in the history of economic thought, financial development has been viewed as a pivotal force for fostering economic growth.<sup>1</sup> Lately, though, some people have suggested that too much financial development can lead to excessive economic volatility.

Financial development is a broad concept that describes the degree to which an economy's financial sector is developed. The concept includes the strength and stability of financial institutions and their effectiveness in easing transaction costs to enable smoother trade of goods and services.

Moreover, financial development encompasses the depth and extent of access to credit and other financial services, as well as access to resources and information. So, along with legal and regulatory institutions, financial development promotes enforceable contracts and effective transactions.

In general, by furthering access to credit, financial development enables firms and individuals to smooth their investment and consumption over time. It does this by allowing them to finance projects (such as production, purchases, and research and development activities) or to save when they need to, thus optimizing the allocation of resources now and in the future.

Along these lines, financial development may also provide firms and individuals with a better buffer against aggregate shocks, thus promoting economic stability. Since economic volatility is negatively correlated with economic growth,<sup>2</sup> this buffer is an additional channel through which financial development can promote long-run growth.

Considering the wide-reaching consequences of the financial crisis of 2008, however, many economists and policymakers

may think that excessive financial development can instead lead to systemic risks and generate excess aggregate volatility.

In this article, we explore the relationship between financial development and overall economic volatility. We show that the more pessimistic perception of financial development is not supported by the data.

## The Relationship to Volatility

With data from more than 100 countries, Figure 1 shows that financial development is strongly negatively correlated with economic volatility, as measured by changes in real economic activity. In other words, countries with better financial development and deeper financial markets tend to have less volatility in gross domestic product (GDP).<sup>3</sup>

In addition, Figure 1 shows that this negative relationship is highly nonlinear: When financial development is low, an increase in the level of financial development will lead to a higher reduction in aggregate volatility than if financial development is already high.

More specifically, Figure 1 shows an L-shaped negative relationship between financial development and aggregate volatility. This pattern holds true across developed and developing economies. For example, countries that belong to the Organization for Economic Cooperation and Development (OECD)—countries that are generally more financially developed and less volatile—cluster around the bottom right of the chart. Emerging and newly industrialized economies are farther spread out in the chart, showing higher levels of aggregate volatility and in most cases less financial development than OECD countries do. Finally, the “other” group of less-developed economies clusters around the bend and shows even

higher levels of volatility and less financial development.

Figure 1 excludes 1998 data for the emerging Asian economies of Singapore, South Korea, Thailand, Malaysia and Hong Kong to avoid the volatility that emerged from that year's Asian financial crisis. Including these data in Figure 2, we can see that the L-shaped relationship remains strong even though aggregate volatility in these five Asian economies is higher.

Economists Pengfei Wang, Yi Wen and Zhiwei Xu studied this relationship further by looking at alternative measures of financial development and even using investment volatility instead of GDP to measure the relationship.<sup>4</sup> They found that the relationship holds even when you study each country group independently and that the nonlinear relationship is even sharper with aggregate investment volatility: The decline in investment volatility is much larger than the decline in GDP volatility when financial development increases, especially for those economies with less-developed financial markets.

In addition, the authors found that the L-shaped relationship is robust even when controlling for other factors, such as interest rates, trade volume, international capital flows, money supply, government spending, per capita GDP level and inflation.

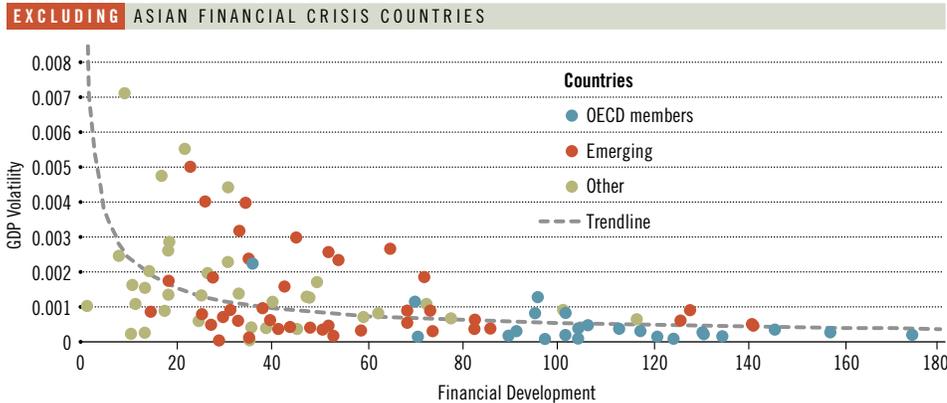
## More than a Coincidence

Having found a strong correlation does not quite explain the relationship between financial development and aggregate volatility. Is the relationship merely a coincidental one, or is it a causal one? If the latter, in what direction does the causation go?

Perhaps financial development reduces aggregate volatility. If it does, how does it do

FIGURE 1

**More Financial Development=Less Volatility**

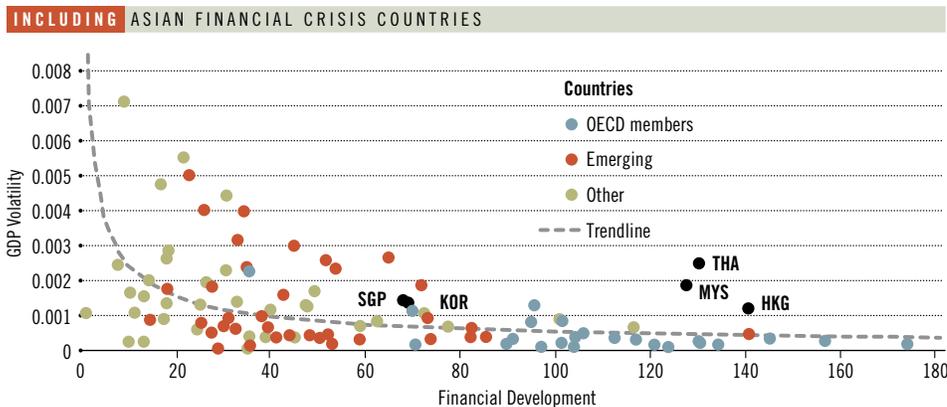


SOURCES: World Bank, authors' calculations.

NOTE: GDP volatility is measured as the variance in GDP growth over the sample, and the measure of financial development is the ratio of total domestic credit to GDP multiplied by 100 (measures above 100 show that the total domestic credit is larger than GDP). GDP volatility calculations exclude 1998 GDP data for countries deeply affected by the Asian financial crisis (Singapore, South Korea, Thailand, Malaysia and Hong Kong). The figure shows how countries with higher financial development have less volatility in GDP.

FIGURE 2

**More Financial Development=Less Volatility**



SOURCES: World Bank, authors' calculations.

NOTE: GDP volatility is measured as the variance in GDP growth over the sample, and the measure of financial development is the ratio of total domestic credit to GDP multiplied by 100 (measures above 100 show that the total domestic credit is larger than GDP). Including 1998 GDP volatility data for countries deeply affected by the Asian financial crisis (Singapore, South Korea, Thailand, Malaysia and Hong Kong) does not affect the L-shaped relationship between financial development and GDP volatility: In general, higher levels of financial development are associated with lower volatility in GDP.

it? Investigating this question further can not only improve our understanding of the business cycle but also can shed new light on the longstanding Schumpeterian question of why financial development promotes long-run growth itself.<sup>5</sup>

A well-known empirical study by economists Garey Ramey and Valerie Ramey tackled this question and showed that faster economic growth leads to lower aggregate volatility.<sup>6</sup> But further research is needed to identify the sources of economic growth and if there are other ways in which financial

development reduces aggregate volatility.

Economists Wang, Wen and Xu took a different approach when trying to answer this question, by studying it from the point of view of firms with different borrowing constraints. To do so, they built a general equilibrium model in which firms have access to credit markets and have the ability to accumulate savings and invest in assets.

They showed that by relaxing firms' borrowing constraints in the model, firms are

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ENDNOTES

- <sup>1</sup> See Levine for a literature review.
- <sup>2</sup> See Ramey and Ramey.
- <sup>3</sup> We measured financial development by the size of the credit market relative to GDP using total domestic credit, and we measured overall volatility in each country as the variance of GDP growth, obtained from the World Bank's World Development Indicators. We used data between 1989 and 2006 to avoid the period during the global financial crisis. See Wang, Wen and Xu for further analysis on financial versus nonfinancial shocks and for an analysis of the negative relationship between financial development and aggregate volatility even when including data of the financial crisis period.
- <sup>4</sup> See Wang, Wen and Xu.
- <sup>5</sup> See Schumpeter.
- <sup>6</sup> See Ramey and Ramey.

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Wang, Pengfei; Wen, Yi; and Xu, Zhiwei. Financial Development and Long-Run Volatility Trends. Federal Reserve Bank of St. Louis Working Paper No. 2013-003B, Sept. 21, 2016.



# China's Economic Data

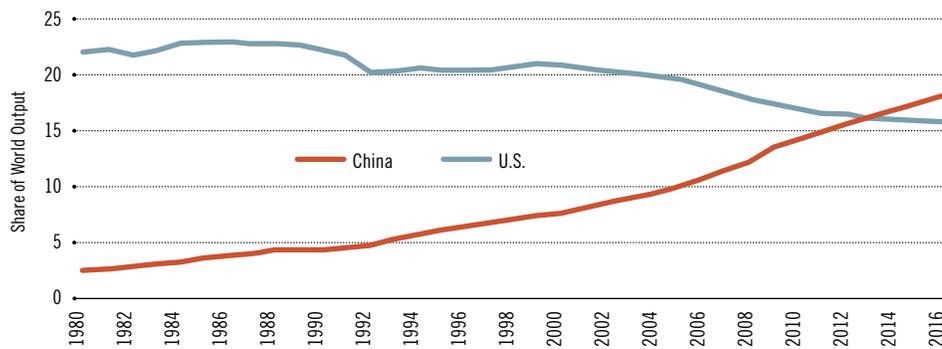
## An Accurate Reflection, or Just Smoke and Mirrors?

*By Michael T. Owyang and Hannah G. Shell*

Since China became more open in 1978, its gross domestic product (GDP) is reported to have risen from 2.3 percent of the world's economy to nearly 18 percent.<sup>1</sup> (See Figure 1.) Because of this rising share, the Chinese economy influences a myriad of economic outcomes, including, for example, global prices of oil and food, as well as U.S. imports and exports. But are these data on China's economy accurate? Some people remain skeptical about the official statistics released by the Chinese government.

FIGURE 1

**China vs. U.S. Share of World Economic Output**

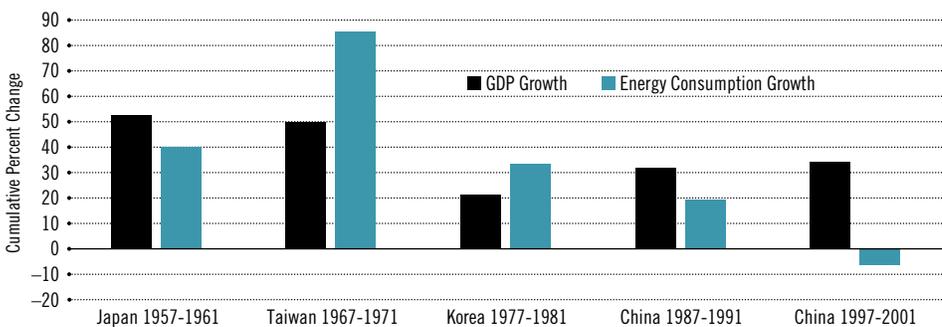


SOURCE: International Monetary Fund World Economic Outlook database. See references.

NOTE: GDP share is based on purchasing power parity.

FIGURE 2

**Did China's Energy Use Contradict Its GDP Growth from 1997 to 2001?**



SOURCE: Rawski. See references.

NOTE: This chart compares official gross domestic product (GDP) growth with growth in energy consumption for China and other countries during different growth periods.

Reliable economic statistics are important for analysts who look at the performance of the Chinese economy to assess, for example, the demand for oil and other commodities. Thus, we explored some of the challenges to the Chinese data gathering/reporting process and put China's data quality within the context of other developing nations'. We found that the Chinese National Bureau of Statistics has improved its source data and its collection practices, making its final official statistics higher quality than those of many counterparts in the developing world. However, due to the country's complex economy and challenges posed by the transition from a command economy to a market economy, China's economic statistics remain unreliable.

These issues with official Chinese government statistics have fostered attempts to obtain better estimates of Chinese GDP,

using methods that vary widely. Some methods are simply corrections to the official Chinese GDP numbers, while others use alternative variables like energy imports that are correlated with output. Alternative data series are particularly useful if they are not compiled by the Chinese government.

**From Command Economy to Market Economy**

China's National Bureau of Statistics (NBS) was created to track agriculture and production in the state-owned enterprises. In a command economy, the statistics bureau's primary purpose is tracking physical output to ensure that economic activity meets preset production goals; this allows the state to allocate raw materials. Consequently, rather than tracking the output contribution of each sector, the NBS focused more narrowly on final physical production.<sup>2</sup> Because the means of production are owned and operated by the state, tracking exact economic activity—such as physical inputs, outputs and technology levels—is more straightforward in a command economy.

In a market economy, the statistics bureau tracks economic activity more broadly—focusing on the concept of variables like GDP, employment and unemployment—to obtain an economy-wide measure of macro growth.

In the late 1970s, China began a major economic transformation. The country allowed individuals to own companies and opened four coastal cities to foreign investment in special economic zones. These steps resulted in a new private service sector, which grew faster than the NBS was prepared for. According to economist Carsten A. Holz, many of these private service-sector businesses created a major measurement challenge because they did not report directly to the NBS until the 1990s.<sup>3</sup>

In 1993, the country transitioned to the United Nations' System of National Accounts, which uses the more conventional value-added approach to GDP. China retroactively published GDP data applying these methods. Still, concepts like value-added were relatively new to the individual statisticians and government bureaucrats behind the national numbers: Understanding and adopting these new concepts takes time.

Measurement errors are inevitable in an economy as large and complex as China's.

The additional challenge of overhauling the country's statistical system to measure market economy variables makes accurately measuring growth during the transition period unlikely.

### **Cooking the Books?**

Some critics of official Chinese data cite falsification at the provincial and individual levels as the biggest source of unreliable GDP statistics. Holz explained that data falsification is thought to occur in rural areas, where leaders tend to only want good news because they are evaluated by the economic performance of their locality. After fabricating one report, leaders struggle to go back to accurate numbers because they would have to report lower than actual growth to rebalance the level of output. Hence, GDP statistics at the provincial level remain inflated.

However, the NBS is aware of the tendency for provincial officials to overstate GDP, and the bureau makes corrections for this behavior. In 1994, the country introduced census surveys to bypass lower-tier statistical departments and check the quality of the data collection. Four years later, the NBS took action against data falsification by issuing a reform that allowed for statistical breaks in provincial numbers to relieve past exaggeration. In 2015, the NBS reported national GDP of \$10.4 trillion, which was about 7 percent less than the sum of the provincial numbers.

Former Fed Chairman Ben S. Bernanke and research analyst Peter Olson have argued that the Chinese NBS' lack of transparency may be more of a factor in the unreliability of the statistics than its lack of political independence.<sup>4</sup> For example, the NBS produces data series that are less volatile than those from other countries, making China's time series statistics seem unreliable or manipulated. Bernanke and Olson have pointed out that this smoothness is more likely a result of technical issues rather than political manipulation.

### **Better Data than Others?**

The degree of unreliability of China's official statistics may be less egregious if the country is compared with other developing countries. The World Bank, which classifies China as a middle-income country, ranks low- and middle-income countries



An industrial zone in China.

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with populations greater than 1 million by a statistical capacity score, reflecting the country's ability to produce and disseminate high-quality aggregate data. The statistical capacity score aggregates 25 individual variables that measure aspects of a country's statistical methodology, source data, periodicity and timeliness.

In the past, China's score has been at or below the median (38th percentile of low- and middle-income countries scored in 2004 and 52nd percentile in 2015). However, in the 2016 rankings, China earned a score of 83.3 out of 100, putting it in the 83rd percentile.

This score means China is actually on the upper end of the distribution for statistical capacity compared with similar countries. China's score improvement comes mostly from better methodology, improving timeliness and periodicity of data releases, and joining the International Monetary Fund's Special Data Dissemination Standard, a voluntary program that evaluates a country on criteria important for international capital markets.

### **Alternative Methods to Track GDP**

#### **Energy Consumption**

Without more transparency from the NBS, the academic community has been forced to rely on alternative measures to track Chinese GDP growth. One alternative measure is the change in energy

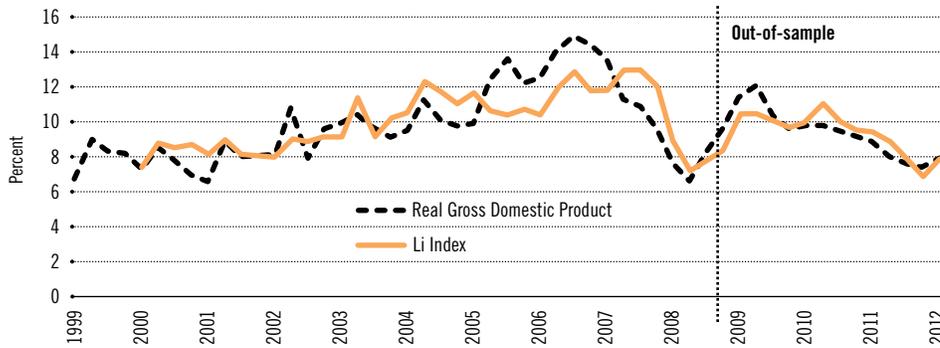
consumption. As an emerging economy with a large manufacturing sector, China consumes a lot of energy. Changes in energy consumption may be a good proxy for changes in output because energy usage typically correlates with output and can be verified by data sources outside the Chinese government; as an input to manufacturing, energy also is a variable that China's command economy statisticians were well-equipped to measure.

Economist Thomas Rawski studies Chinese GDP through the lens of energy use. He points out that between 1997 and 2000, official figures reported that Chinese real GDP grew 24.7 percent, yet energy consumption decreased 12.8 percent.<sup>5</sup> The difference implies a 30 percent reduction in energy use during those years, which seems unlikely for an industrializing economy. Rawski bolsters this argument by comparing energy use in other Asian countries during their respective episodes of growth. Figure 2 highlights his results. In each case, even that of China during an earlier growth period, a double-digit increase in GDP is related with a double-digit increase in energy consumption. But for the 1997-2001 period, Chinese energy consumption declined despite GDP growing at a faster pace than in the 1987-91 period.

Rawski argues this result is evidence of overestimation of Chinese GDP growth during that period. He suggests cumulative

FIGURE 3

**Li Index vs. Official Growth Rate**



SOURCE: Fernald, Malkin and Spiegel. See references.

NOTE: The Li index estimates GDP growth based on Chinese electricity production, rail cargo shipments and loan disbursements. In the out-of-sample area, this portion of the Li series represents predicted growth during 2009:Q4-2012:Q4; the predicted value is based on the relationship between these three variables during 2000:Q1-2009:Q3. As the chart suggests, the relationship between the Li index and real GDP held during 2009 to 2012.

Perhaps the most popular index for Chinese GDP is the one suggested by and named after Li Keqiang, then China’s vice premier and now premier.

growth was more likely somewhere between 0.4 and 11.4 percent during those five years.

Energy consumption, however, is an imperfect proxy of economic growth. A country’s energy consumption could be impacted by several factors external to economic output. Increased efficiency, a shift from an industrial to a service economy or, similarly, a shift from a production to a consumption economy could all result in lower energy consumption. For this reason, several individuals have come up with broader GDP proxies that include more variables.

**Indexed GDP Proxies**

Several private-sector research firms have developed their own measures of Chinese GDP growth based on a wide array of indicators, including freight volume, passenger travel, electricity output, construction indicators, purchasing managers indexes, financial indicators like money supply and the stock market, alternative GDP deflation measures, and alternative measures of production.<sup>6</sup>

These indexes focus on measuring the quarter-to-quarter growth rather than the level of output, but all of them suggest that there has been overstating of growth during downturns and in recent years. Consistent overestimation of quarterly growth could lead to an exaggerated GDP level, an issue we address below.

All the indexes suggest China’s GDP growth is lower than the official estimates. Lombard Street Research’s measure, based on searching for a more accurate way to

deflate nominal GDP, estimated a 2.9 percent growth rate in the third quarter of 2015, while Bloomberg’s model—which includes more data on industrial output and retail sales—estimated growth of 6.6 percent in the same period; the official estimate was 6.9 percent for the third quarter of 2015. The problem with these measures is that a lot of them are black boxes, leaving one to wonder if they give adequate weight to the many complex facets of the Chinese economy.<sup>7</sup>

Perhaps the most popular index for Chinese GDP is the one suggested by and named after Li Keqiang, then China’s vice premier and now premier. In 2007, Li was quoted in a U.S. diplomatic cable later released by WikiLeaks as saying GDP figures are “man-made” and therefore unreliable. He went on to say that instead of looking at official figures, he uses electricity production, rail cargo shipments and loan disbursements.

This index is easily constructed by anyone with access to these three data series. Researchers John Fernald, Israel Malkin and Mark Spiegel designed an index based on the three variables and made the data and methodology available in an online appendix.<sup>8</sup> The researchers fitted a regression of the index on real GDP growth from 2000 to 2009 and then used the fitted values to predict real GDP growth from 2009 through 2012 (referred to as out-of-sample in the accompanying graph).

Their results indicate that the relationship between GDP and the Li index during the 2000-2009 period continued to hold in the 2009-2012 period. In other words, the changes in official GDP statistics during the 2009-2012 slowdown were consistent with Li’s index. This analysis offers some validation that the quarter-to-quarter percent changes in Chinese official statistics are not overstated.

These methodologies, however, would not detect whether the level of Chinese GDP has been consistently overestimated for a long period of time. Moreover, many of the GDP proxies do not include any measure of China’s growing service sector or agricultural production. By some estimates, services now make up about 49 percent of Chinese output, compared with physical production, which makes up 42 percent.<sup>9</sup>

**Luminosity**

Another alternative method uses satellite data that measures the intensity of

man-made night lights (luminosity). Unlike indexes of human-produced economic data, these data are immune to falsification or misreporting. The night-lights data we examine are gathered by Air Force satellites circling the earth 14 times a day since the 1970s. The satellites measure the light intensity emanating from specific geographic pixels, which can be aggregated to subnational, national and supranational levels. In 2012, economists J. Vernon Henderson, Adam Storeygard and David N. Weil created a dataset using information from night-lights satellites and applied it to estimate GDP in countries with low-quality data.<sup>10</sup>

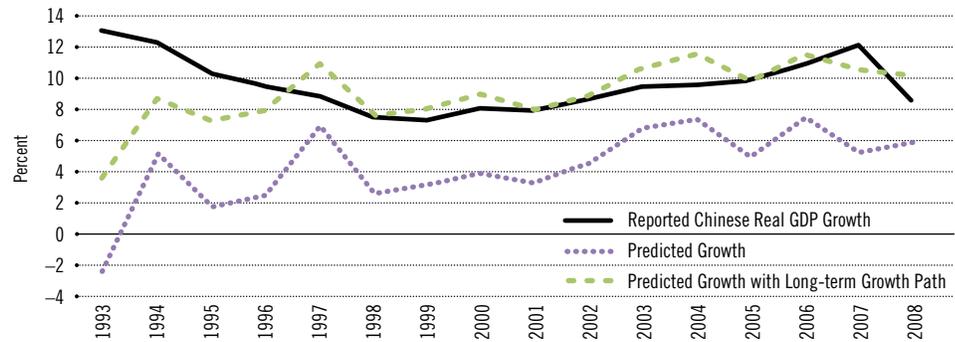
The three researchers identified several reasons why night-lights data are a good proxy for economic activity. First, they argued that night-lights data track GDP because consumption of all goods in the evening requires light. To verify this claim, they confirmed that variation in pixels lit across countries is positively correlated with income (controlling for population density).<sup>11</sup>

Henderson, Storeygard and Weil estimated a 14-year change and annual changes in economic activity for a panel of 188 countries between 1992 and 2008, including many low- and middle-income countries.<sup>12</sup> One way to assess the quality of Chinese economic data is to look at the difference between the growth rate of real GDP reported by the government and the estimated growth from 1992 to 2006 using the night-lights data. Reported real GDP growth in China over this period is about 122 percent, while predicted growth using the night-lights data is only 57 percent.

This sizable gap suggests cumulative Chinese growth over the years could be overstated by as much as 65 percent. Compared with other countries in the sample, the difference between the official and estimated numbers for China is large. In fact, the only country with a larger gap than China is Myanmar. India also has a large gap between actual and estimated, about 39 percent, although this gap is still notably smaller than China's. Other emerging countries, like Brazil and Russia, have significantly smaller gaps between actual and estimated.

Figure 4 shows Henderson, Storeygard and Weil's estimated annual GDP growth using night-lights data. The purple line represents estimated real GDP growth using night-lights

**FIGURE 4**  
**Real GDP Growth Estimates Using Luminosity Data**



SOURCE: Henderson, Storeygard and Weil. See references.

NOTE: The black line represents the official growth rate numbers provided by the Chinese government. The purple line is estimated real GDP growth using data on light intensity at night gathered by U.S. Air Force satellites. The green line is estimated real GDP growth using night-lights data in conjunction with the country's long-term growth path. All are calculated using official data.

data.<sup>13</sup> The green line is estimated real GDP growth using night-lights data in conjunction with the country's long-term growth path, calculated using official data. The inclusion of this trend essentially forces the estimated values to follow the same growth path as the official data so that the night-lights data are only informing annual fluctuations from the trend.

The purple line shows that real GDP growth is consistently overstated, particularly in the years before 1996. The green line (with the included growth trend) shows overstated growth before 1996; it also is much more volatile from year to year, moving more as one would expect real GDP growth to move. After 1996, however, the green line tracks the black line (the official growth rate) closely; this supports the other indexes' conclusions that quarter-to-quarter fluctuations in Chinese real GDP growth are smoothed, but likely move in the correct direction.

## Conclusion

Skepticism for Chinese official economic data is widespread, and it should be. Even if every Chinese economic number were reported truthfully and accurately to the best of an individual's understanding, the official numbers would still fail to fully capture the evolution of an economy growing and changing so quickly.

China's economic data system is a work in progress and a hurdle that statisticians have yet to overcome. The Chinese NBS could improve its system by offering greater

transparency behind the data-gathering process and statistical procedures, allowing data users to better identify weaknesses in the official numbers. But the heavy criticism of Chinese officials and accusations of intentional falsification or manipulation are likely misplaced. The truth is more likely that economic growth in China is too challenging to capture as effectively as growth in developed countries.

Alternative measures of growth can offer useful insight into the accuracy of official statistics. Chinese growth was likely overstated during the transition period from command to market economy, possibly leading to an exaggerated level of output in the recent data. An exaggerated level of output could mean that the Chinese share of world GDP is overstated.

However, while the level of Chinese GDP may remain overstated, both the Li index and estimates from the night-lights data suggest that the recent growth rate numbers for Chinese official data are more reliable. They may be subject to collection error and smoothing, but appear to be moving in the correct direction. 

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## ENDNOTES

- <sup>1</sup> Share of world output data is from the 2016 IMF World Economic Outlook database, reported from 1980 to 2016. See [www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx](http://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx).
- <sup>2</sup> Economist Harry X. Wu describes how these methods resulted in double counting and did not entirely remove inflation growth from nominal GDP, resulting in a higher real GDP growth number. See Wu.
- <sup>3</sup> See Holz.
- <sup>4</sup> See Bernanke and Olson.
- <sup>5</sup> See Rawski.
- <sup>6</sup> See Kawa.
- <sup>7</sup> See LaoHu Economics Blog.
- <sup>8</sup> See Fernald, Malkin and Spiegel.
- <sup>9</sup> See LaoHu Economics Blog.
- <sup>10</sup> See Henderson, Storeygard and Weil.
- <sup>11</sup> While satellite data might still suffer from mismeasurement (for example, faulty calibration), they would not be subject to the types of errors associated with survey measures of national accounts, making correlation in the errors unlikely. Unrelated errors mean that a correlation between the two data series comes from the true portion of the measured series and not the error. In other words, the relationship between GDP and night-lights data is unlikely to be based on measurement errors.
- <sup>12</sup> The estimation is a least squares regression including time and country fixed effects with robust standard errors clustered by country. The long differences are actually formed by averaging the growth rates between 1992/1993 and 2005/2006.
- <sup>13</sup> The regression controlled for country-specific and time-specific effects.

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*continued from Page 5*

able to borrow from the market when they need it most—when their investment demand is high but they don't necessarily have enough savings to cover the investment. In other words, credit is better allocated across firms because when one firm wants to invest but does not have enough saved to cover that investment, it can much more easily borrow through the market from a second firm that wishes to save instead, benefiting both firms.

Since credit is better allocated across firms, each firm can base its investment decisions on its own needs, therefore dampening the effect of aggregate nonfinancial shocks to total firm-level investment and better insulating the overall economy. In addition, the authors

showed that this volatility-reducing effect diminishes with continuing financial development. In other words, increasing the level of financial development will reduce volatility much more when its initial level is smaller than when it is high to begin with.

By providing a causal interpretation to the empirical pattern shown in the figures, Wang, Wen and Xu's work has important policy implications.

One of the main goals for governments and central banks in both developed and developing nations alike is to maintain economic stability. As such, policymakers must work toward maintaining and promoting aggregate stability when looking for optimal fiscal, monetary and exchange-rate policies. That is, their aim should be centered on

insulating the economy from external shocks or responding to such shocks to dampen the aggregate fluctuations in the business cycle without overcorrecting.

Therefore, we believe that a barely regarded yet important factor to consider when trying to reduce aggregate real volatility in the long term is financial development. 

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*Yi Wen is an economist and Maria A. Arias is a senior research associate, both at the Federal Reserve Bank of St. Louis. For more on Wen's work, see <https://research.stlouisfed.org/econ/wen>.*

# Comparing Income, Education and Job Data for Immigrants vs. Those Born in U.S.

By Subhayu Bandyopadhyay and Rodrigo Guerrero



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Immigration continues to be one of the central policy issues confronting the U.S. government. This debate encompasses legal and unauthorized immigration, skilled and unskilled immigration, temporary and permanent immigration, family-based and skill-based immigration, and myriad similar policy choices.

Among the several issues surrounding immigration, one is purely fiscal in nature. If the average immigrant is unskilled and earns a low wage, the tax contribution, either through income or sales taxes, of such an immigrant is likely to be low. Moreover, in states where public services are fairly easily accessible, this immigrant may be able to draw a decent share of public services. This difference between what this immigrant may contribute as tax dollars and what the immigrant may draw in terms of public services is likely to be a net fiscal burden on the government (potentially at both the state and the federal levels). On the other hand, if one considers a highly skilled legal immigrant, who will be earning a high wage and who may be less dependent on public services, there may be a net fiscal gain for the government.<sup>1</sup>

Of course, this fiscal issue alone cannot determine immigration policy, but a greater knowledge about its impact weighed against other factors—like the need of individual industries for workers who may not be available domestically—can inform sensible immigration policy. Knowledge of individual economic characteristics of immigrants, like education levels, unemployment rates, wages, etc., is a first step in shedding more light on how the current immigrant pool compares with the native population and also on how

future immigration may contribute to the U.S. economy.

Accordingly, this article focuses first on a comparison of the native and the foreign-born U.S. population in terms of economic characteristics at the national level. Then, we will present the comparisons at the state level for the top-five and the bottom-five states ranked by their immigrant population.

## The Data

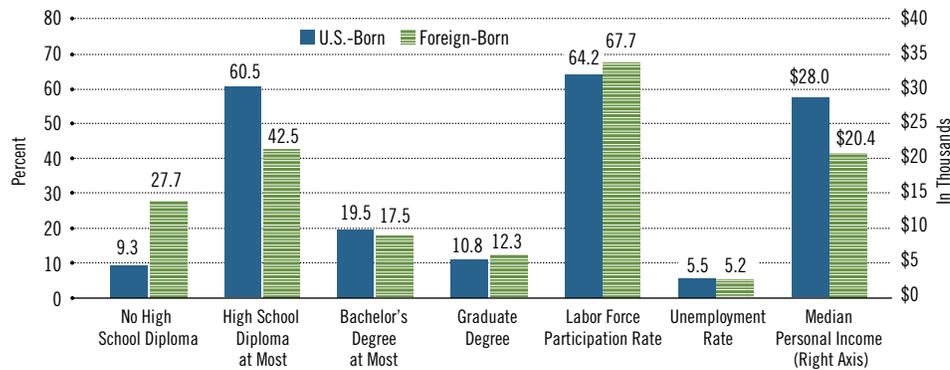
We used data on the foreign-born population living in the U.S. in 2015 as a proxy for current and past immigration flows. These data, which are collected by the American Community Survey, include authorized and unauthorized immigrants; however, it is well-documented that unauthorized immigrants are undercounted in census surveys.<sup>2</sup> Therefore, our calculations may underestimate the extent of unskilled and low-income immigration.

Before beginning our comparison task, we had to account for the fact that immigrant populations in general exhibit an age distribution that is significantly different from that of native populations. In particular, we noted that migration at a young age is relatively uncommon; children rarely migrate by themselves, and newborns cannot be, by definition, foreign-born. The difference in the age distribution is reflected in the data: Whereas over 30 percent of the native population is under 22 years old, only about 10 percent of the foreign-born population is in this age range. Thus, to make these two populations comparable, we restricted the dataset to include only individuals who are 22 years or older in all calculations.<sup>3</sup>

Knowledge of individual economic characteristics of immigrants, like education levels, unemployment rates, wages, etc., is a first step in shedding more light on how the current immigrant pool compares with the native population and also on how future immigration may contribute to the U.S. economy.

FIGURE 1

**U.S.-Born vs. Foreign-Born**



SOURCE: 2015 ACS, accessed via IPUMS USA.

NOTE: Population under 22 years old is excluded. Educational attainment categories are exhaustive and mutually exclusive.

**Comparing the Two Populations**

The U.S. immigrant pool is diverse in terms of both country of origin and skill level.<sup>4</sup> On the one hand, one would expect that a large fraction of the unauthorized immigrants would not have higher academic degrees. On the other hand, casual observation of U.S. Ph.D. programs, especially in the STEM (science-technology-engineering-mathematics) fields, suggests that a large fraction of students in such programs are from abroad. (Although international students reside in the U.S. on a temporary basis, they could potentially

become naturalized citizens. They would still be counted as foreign-born in our data.)

The first four sets of bars in Figure 1 show the diverse educational attainment of immigrants and the native-born. For example, 27.7 percent of foreign-born do not have a high school diploma vs. 9.3 percent for the native population. On the other hand, 12.3 percent of the foreign-born have graduate degrees, as opposed to 10.8 percent of the natives.

It is worth noting that, at 90.8 percent, the natives have a higher high-school graduation rate, far outweighing the foreign-born rate of 72.3 percent. (These rates include

those who have gone on to receive college degrees.) This discrepancy can reflect various factors, including the fact that the U.S. provides an easier access to reasonably priced education in public schools compared with many developing nations, from where lower-skilled immigrants may come. Another factor lies in the self-selection process of immigration. The foreign-born population in the U.S. mainly contains individuals who found it profitable to leave their home country, and one would expect that unskilled individuals have a lower opportunity cost associated with migration.

Among the other variables reported in Figure 1, labor force participation and unemployment rates are not that different between the natives and the foreign-born, reflecting that labor market distress does not seem to be substantially higher for immigrants compared with natives. On the other hand, the median personal incomes of the two groups are starkly different, with a much higher median level of income per person for natives (\$28,000), compared with the foreign-born (\$20,400). This contrast, however, is consistent with the difference in education levels between natives and the foreign-born.

TABLE 1

**Native and Foreign-Born Populations by State**

	Foreign-Born Share	Highest Educational Attainment								Labor Force Participation Rate		Unemployment Rate		Median Income		
		No High School Diploma		High School Diploma		Bachelor's Degree		Graduate Degree		Native	Foreign-Born	Native	Foreign-Born	Native	Foreign-Born	
		Native	Foreign-Born	Native	Foreign-Born	Native	Foreign-Born	Native	Foreign-Born							
<b>United States</b>	<b>17.9</b>	<b>9.3</b>	<b>27.7</b>	<b>60.5</b>	<b>42.5</b>	<b>19.5</b>	<b>17.5</b>	<b>10.8</b>	<b>12.3</b>	<b>64.2</b>	<b>67.7</b>	<b>5.5</b>	<b>5.2</b>	<b>\$28,000</b>	<b>\$20,400</b>	
<b>TOP 5 BY FOREIGN-BORN SHARE</b>																
California	36.8	8.0	33.1	58.3	39.2	21.9	17.3	11.9	10.4	65.8	65.2	6.7	5.5	\$30,000	\$20,000	
New York	29.7	8.8	25.2	54.2	44.1	21.8	17.8	15.2	12.9	65.4	66.6	5.7	5.9	\$30,930	\$21,000	
New Jersey	28.5	7.1	19.3	55.4	43.0	24.4	22.7	13.0	15.0	66.9	70.4	5.9	5.4	\$35,000	\$25,000	
Nevada	26.5	8.8	29.1	66.7	51.3	15.7	13.8	8.8	5.7	63.4	68.7	8.1	6.6	\$27,000	\$21,300	
Florida	25.7	9.2	21.4	62.3	51.7	18.6	17.2	9.9	9.7	58.3	64.0	6.4	5.9	\$25,000	\$18,200	
<b>BOTTOM 5 BY FOREIGN-BORN SHARE</b>																
North Dakota	4.5	6.2	13.7	64.1	55.7	22.8	21.3	6.9	9.3	70.0	81.6	2.8	1.2	\$34,000	\$32,000	
South Dakota	4.1	8.0	35.3	64.1	47.4	20.8	13.0	7.0	4.3	68.2	79.5	4.0	1.6	\$28,000	\$23,000	
Mississippi	3.3	15.5	27.6	64.2	45.2	12.9	17.6	7.4	9.6	59.1	60.0	7.6	6.0	\$20,000	\$15,000	
Montana	3.3	6.8	9.2	64.9	60.5	18.8	16.0	9.5	14.3	63.4	61.4	3.6	3.3	\$25,600	\$20,800	
West Virginia	2.6	13.7	7.8	67.2	48.7	11.9	19.9	7.2	23.5	54.0	62.9	6.0	5.3	\$22,000	\$20,000	

SOURCE: 2015 ACS, accessed via IPUMS USA.

NOTE: Population under 22 years old is excluded. Educational attainment categories are exhaustive and mutually exclusive.



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### Top Five and Bottom Five States

Although the national level comparison is useful, given the wide differences in immigrant concentration across U.S. states, we now focus on the top five and bottom five host states for immigrants in the U.S. to see whether there are any appreciable differences in terms of characteristics of immigrants in these states. The results are reported in Table 1.

California, which has the largest share of foreign-born in its population (at 36.8 percent), shows a rate of 33.1 percent of its foreign-born population without a high school diploma, compared with 8 percent for its native population. At the other end of the educational spectrum, 10.4 percent of the foreign-born living in California hold a graduate degree, whereas 11.9 percent of the U.S.-born California residents do.

The state with the smallest share of foreign-born is West Virginia (at 2.6 percent of its population). The proportion of foreign-born in West Virginia without a high school diploma is 7.8 percent, which is actually lower than the rate for the natives in West Virginia, which is 13.7 percent. Even more striking, 23.5 percent of the foreign-born in West Virginia have graduate degrees, compared with 7.2 percent for the natives.

Among other interesting comparisons, a closer look at the median income levels of the top five host states reveals that native income exceeds foreign-born income by

\$5,700 (Nevada) to \$10,000 (California and New Jersey). For the bottom five states, this difference ranges between \$2,000 (North Dakota and West Virginia) to \$5,000 (South Dakota and Mississippi).

### Conclusion

Our discussion can be summarized into two main points. First, at the national level, the foreign-born present some interesting contrasts with natives, especially in terms of educational attainment at lower and higher levels of the academic spectrum. At the state level, interesting contrasts emerge, where the largest host states of the foreign-born seem to show larger income and educational attainment differences between the foreign-born and the natives.

Although immigration policy is decided at the national (federal) level, sensible policy has to consider potentially disparate effects on states. A look at characteristics of the foreign-born population at the national and the state levels can complement such immigration policy discussions. 

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### ENDNOTES

- <sup>1</sup> In a recent New York Times article, Harvard economist George Borjas discussed the impact of immigration on government budgets. He argued that, on aggregate, immigrants are a fiscal burden, creating an annual fiscal shortfall somewhere in the range of \$43 billion to \$299 billion, depending on different available estimates. See Borjas.
- <sup>2</sup> The estimated undercount of unauthorized immigrants in the American Community Survey is believed to be between 10 and 20 percent.
- <sup>3</sup> We chose 22 years old as a threshold because it is the typical college graduation age in the U.S.
- <sup>4</sup> In an earlier Regional Economist article, we discussed the different countries of origin of the foreign-born population. See Bandyopadhyay and Guerrero.

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- Integrated Public Use Microdata Series (IPUMS)-USA, University of Minnesota. See [www.ipums.org](http://www.ipums.org).

# A Short History of Prices, Inflation since the Founding of the U.S.

By Fernando M. Martin



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Economists generally agree that a central bank that is independent of political pressure is a prerequisite for sound monetary policy.<sup>1</sup> However, in recent years, there have been numerous proposals to subject the conduct of monetary policy of the U.S. central bank—the Federal Reserve—to formal and close congressional oversight beyond what is already taking place.<sup>2</sup> One prime justification for these proposals is the significant increase in the price level since the establishment of the Fed in 1913.

The purpose of this article is not to discuss the merits or shortcomings of the various proposals, but rather to provide some historical context to this rationale by revisiting some basic facts about prices and inflation since the founding of the country.

## Price Levels from the Beginning

Figure 1 displays the yearly average of the price level (measured in logarithms) in the U.S. from 1790 until 2016. Two series measuring the price level are displayed: the gross domestic product (GDP) deflator and the consumer price index (CPI).<sup>3</sup> The former measures average prices of all new, domestically produced final goods and services in the economy, while the latter measures average prices of the typical expenditure basket of an urban consumer.<sup>4</sup> Although there are important and occasionally significant differences between the two series, they both paint a similar overall picture, which can be summarized with three points.

- First, there appear to be at least two different “eras” characterizing the behavior of prices. Their precise boundaries are hard to establish, but the first era seems to have lasted from the founding of the U.S. until around the establishment of the Federal

Reserve or perhaps as late as the entry in World War I. The second era begins around World War II and continues until the present day. The period in between is difficult to assign to either era, as things might have turned out quite differently had the U.S. not entered either world war. Overall, prices seem to move around a stable average during the pre-Fed era, while they have increased steadily since World War II.

- Second, despite the previous observation, high-inflation episodes are sprinkled throughout U.S. history. In fact, there are several temporary and significant increases in the price level in both eras.
- Third, most of the price increase in the postwar period seems to have been concentrated in just two, albeit perhaps prolonged, episodes.

The behavior of prices throughout U.S. history was linked to whether the value of the dollar was fixed in terms of gold and/or silver. The U.S. started under what was effectively a silver standard and subsequently adopted a gold standard in 1834. It remained on it until 1913, except for convertibility suspensions in 1838-1843 and especially during the Civil War and its aftermath, 1861-1878.

The gold standard broke down around the world during World War I and was replaced by the Gold Exchange Standard from 1925 until 1931, when Britain abandoned the system. After World War II, the Bretton Woods System had central banks exchange U.S. dollars for gold at a fixed price. Although the system arguably constrained Fed policy, it did not involve convertibility of dollars to gold for individuals or firms, as was the case with previous metallic standards. The system eventually collapsed in 1971.<sup>5</sup>

## The Basics of a Gold Standard

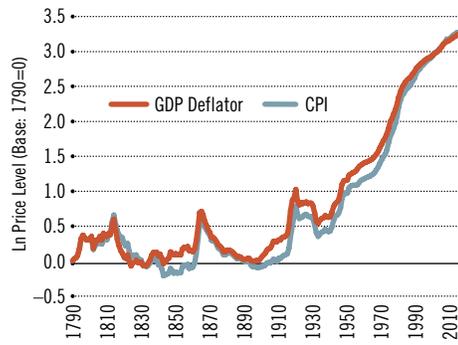
A gold standard is a monetary system in which the price of a country's currency is fixed in terms of a specified amount of gold. In order for the system to work, governments need to be ready and willing to buy and sell gold to anyone at the set price. A similar system can be (and was) implemented using silver or a combination of silver and gold.

Under the Gold Exchange Standard (1925-1931), countries could hold both gold and dollars or pounds as reserves, except for the U.S. and the U.K., which held reserves only in gold. Under the Bretton Woods System (1946-1971), countries settled international balances in dollars and could convert dollars to gold at a fixed price. The U.S. was responsible for keeping the price of gold fixed and, thus, held substantial gold reserves.



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**FIGURE 1**  
**Prices since Founding of U.S.**



SOURCES: Johnston and Williamson (2017); Lindert and Sutch (2006); Bureau of Labor Statistics; Bureau of Economic Analysis; and FRED.

NOTE: Macroeconomic variables that exhibit exponential growth, such as output and prices, are frequently expressed in natural logarithms to transform them into series with a linear trend. The difference between the logged series and its linear trend is approximately equal to the percent deviation of the original series from its trend. The GDP deflator and the consumer price index (CPI) are different measures of the price level. The CPI focuses on consumer expenditures, while the GDP deflator is a broader measure of prices in the economy. Although the two series occasionally diverge, over the long run, they both paint a similar picture.

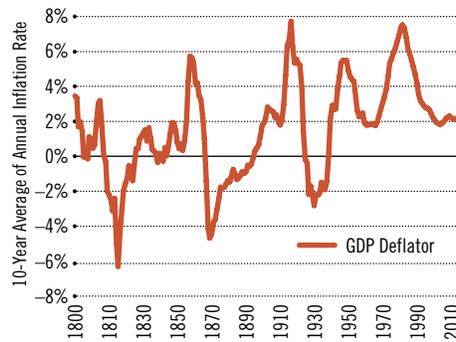
### A Look at Inflation

Let us inspect the data a bit closer by looking at the change of prices instead of their level. Figure 2 shows inflation, measured as the yearly increase in the GDP deflator.<sup>6</sup> Inflation is averaged over 10 years to remove short-term fluctuations and instead focus on long-run trends. Each data point in the chart corresponds to the average annual inflation experienced over the previous 10 years.

Before World War II, episodes of high inflation were followed by periods of deflation, which explains the fact that the price level moved around a stable average. These inflationary episodes correspond to periods during which convertibility of the dollar to gold and/or silver was suspended to meet the demand for additional government revenue, most notably during the Civil War and World War I. Deflationary periods followed as convertibility was reinstated and prices returned to their pre-war levels. Although the price level was stable over the long run, inflation was very volatile during this period.<sup>7</sup>

Starting with World War II, there were two important inflationary episodes, which explain a significant share of the price increase in the postwar period. The first is the war itself, as inflation rose during the

**FIGURE 2**  
**Inflation since Founding of U.S.**



SOURCES: Johnston and Williamson (2017); Bureau of Economic Analysis; and FRED.

NOTE: Episodes of high inflation are recurrent in U.S. history. Prior to the founding of the Fed, high-inflation episodes were followed by prolonged periods of deflation, bringing prices back to their original levels. In the postwar period, inflation instead returned to positive levels, making increases in the price level permanent rather than transitory. Inflation volatility was dramatically higher in the pre-Fed period than during the postwar.

war and then to partly pay for the public debt accumulated to finance it.<sup>8</sup>

The second is the period known as the stagflation of the 1970s, a combination of high inflation and low output growth resulting from various external oil shocks and incorrect or misguided monetary policy. High inflation was effectively defeated during Paul Volcker's tenure as Fed chairman (1979-1987), and inflation has remained low and stable since.

The postwar period exhibits the same recurrence of high inflation episodes as the preceding period, but with the significant difference that the lack of adherence to a metal-backed monetary system made the price level increase permanent rather than transitory. As a result, however, inflation volatility decreased significantly in the postwar period.

### Measuring Volatility

A straightforward way to measure volatility, especially informative when averages differ substantially, is the *coefficient of variation*. This measure is defined as the ratio between the standard deviation and the mean of a given variable. A higher coefficient of variation implies a higher volatility of a variable

*continued on Page 18*

### ENDNOTES

- In fact, the leading cause of high inflation is the willingness of central banks to finance government deficits by printing money.
- Note that the Fed is already held accountable to the public and Congress. For example, see [www.federalreserve.gov/faqs/about\\_12798.htm](http://www.federalreserve.gov/faqs/about_12798.htm).
- Data for the GDP deflator until 1928 are taken from Johnston and Williamson, who used a variety of sources. Data on CPI until 1912 are taken from Lindert and Sutch. All other data come from the Bureau of Economic Analysis and the Bureau of Labor Statistics and are available for free from FRED. See <https://fred.stlouisfed.org/series/A191RD3A086NBEA> and <https://fred.stlouisfed.org/series/CPIAUCNS>.
- The personal consumption expenditures (PCE) price index, which is the Fed's preferred measure of the price level, is available yearly since 1929; over such a long period, it is almost indistinguishable from the GDP deflator.
- For more information on the gold standard, see sidebar, Bordo and Elwell.
- As suggested by Figure 1, using CPI inflation would not change the chart significantly.
- St. Louis Fed economist David Wheelock made a similar observation in a post on The FRED Blog. See <https://fredblog.stlouisfed.org/2015/02/how-did-the-u-s-economy-perform-under-the-pre-fed-gold-standard>.
- Ohanian estimated that postwar inflation (1946-1948) resulted in a repudiation of debt worth about 40 percent of output.

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continued from Page 17

around its mean. For the pre-Fed period (1790-1913), the average annual inflation was 0.4 percent with a coefficient of variation of 13.2. During the period 1941-2016, these figures changed to 3.5 percent and 0.8, respectively. If we look at the post-Volcker era (1988-2016), annual inflation was 2.2 percent on average with a coefficient of variation of 0.4.

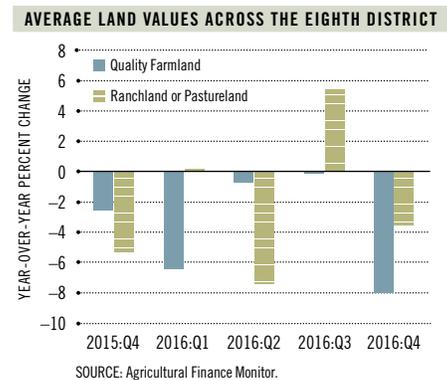
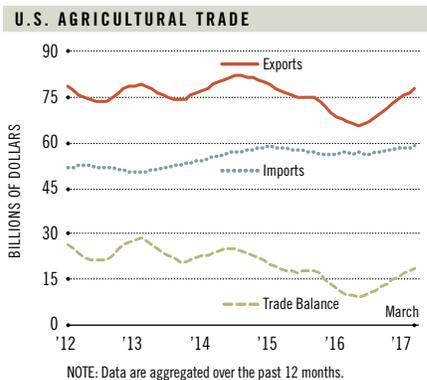
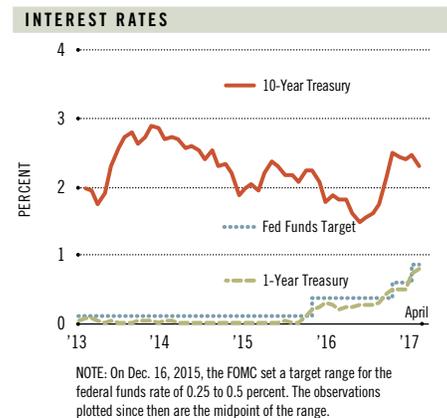
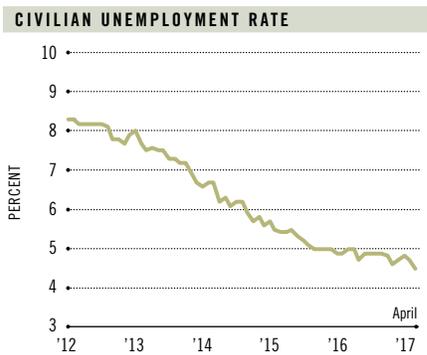
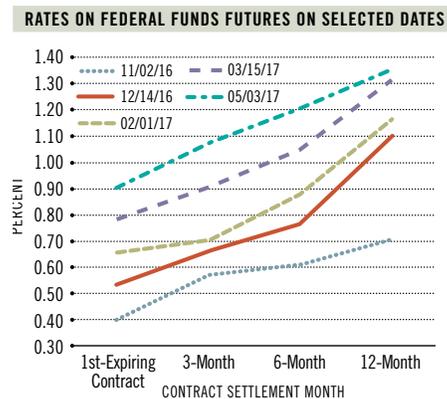
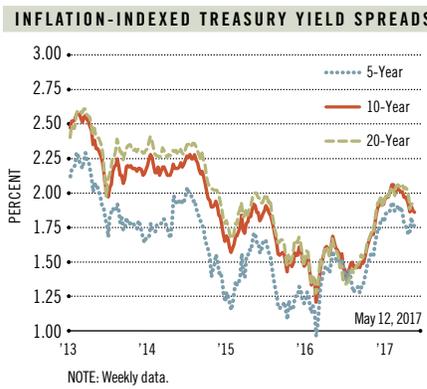
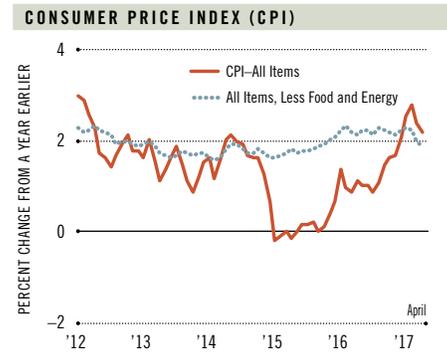
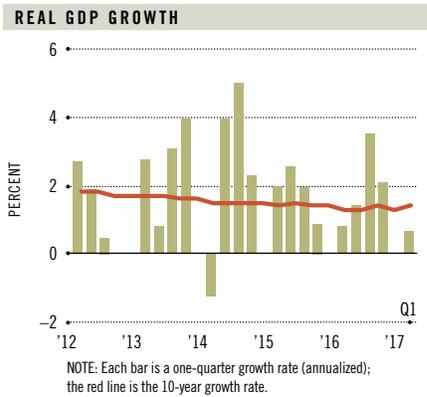
In other words, with the joint creation of the Fed and the abandonment of metal convertibility of the currency, the economy traded off higher inflation for more stable inflation. Higher inflation is generally bad, as it taxes nominal asset holdings and cash transactions. More-stable inflation is generally good, as it makes the future easier to predict, resulting in more-efficient economic decisions, lower costs of long-term (nominal) contracts and increased stability of the financial system.

In addition, eliminating the need for deflation avoids having to endure the potentially costly and gradual process of price and wage reduction. Furthermore, many households get hurt by deflation since the real burden of their debt (e.g., payments on a mortgage with a fixed-interest rate) increases as prices and nominal wages fall.

Although average annual inflation since 1941 is higher, it is not dramatically higher than in the pre-Fed period: 0.4 percent vs. 3.5 percent. In contrast, volatility decreased tremendously: 13.2 vs. 0.8. Arguably, then, the costs were small while the gains large.

Furthermore, episodes of high inflation, which carry high economic costs, are nothing new and instead a recurrent feature in U.S. history. In this regard, the important difference between the pre-Fed and the postwar eras is that these high-inflation episodes were previously followed by prolonged deflation and, in the more recent era, by a return to normal (and positive) inflation rates. **Q**

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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](http://www.stlouisfed.org/economyataglance).

## Handle with Care: Report on GDP for First Quarter

By Kevin L. Kliesen

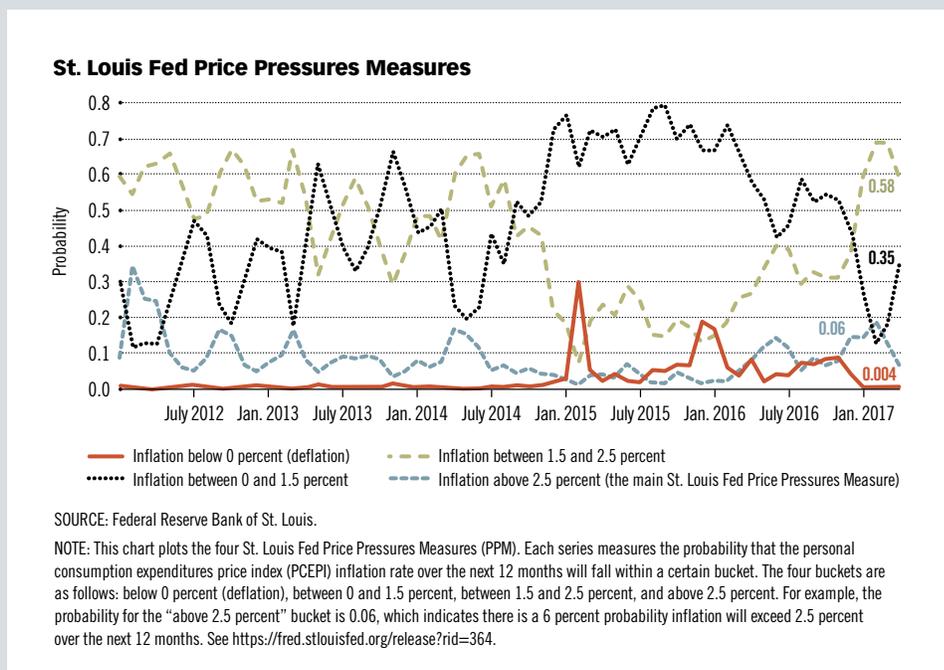
The U.S. economy registered weaker-than-expected growth in real gross domestic product (GDP) in the first quarter of the year, eking out a gain of 0.7 percent at an annual rate. Normally, such a tepid pace of growth would be cause for alarm among the forecasting community. However, few if any forecasters are sounding the recession alarm. Instead, most are pointing to several special factors for why the weak GDP report should be viewed as an aberration. Lost in the hubbub are the continued healthy labor market performance, a potentially worrisome acceleration in inflation over the past six months and the prospect of further increases in the interest rate target of the Federal Open Market Committee (FOMC) in 2017.

### Data Send Mixed Signals

Forecasters have been confronted with a witches' brew of economic data over the past several months. Some of these data have been extremely favorable. Examples pertain to solid job gains, record-high stock prices, a falling unemployment rate, and surveys of households, businesses and homebuilders that reveal an increasingly optimistic outlook for the U.S. economy.

However, other data depict an economy struggling to keep its head above water. First and foremost, an unexpected slowing in the pace of auto sales has been especially concerning—a development that has spurred automotive manufacturers to trim production, which has helped to slow the pace of manufacturing activity. Also pointing to slow growth have been a pullback in expenditures by federal and state governments and a rise in geopolitical tensions, which has elevated economic uncertainty and financial market volatility.

This tension in the data has roiled the forecasting community. Still, as evident by the steady downgrading of first-quarter real GDP forecasts before the official release on April 28, most forecasters were placing more weight on such things as auto sales than on rising levels of consumer confidence. This turned out to be a good choice.



The advance estimate for the first quarter's GDP, published by the Bureau of Economic Analysis (BEA), was appreciably slower than what the Blue Chip Consensus expected at the beginning of the year (2.2 percent). Importantly, growth of real personal consumption expenditures slowed in the first quarter to a near standstill (0.3 percent at an annual rate)—a marked contrast with previous quarters.

Some economists blame the first-quarter GDP weakness on special, temporary factors. These include the warmer-than-usual winter, which lowered consumers' utility expenditures; delayed tax refunds because of new IRS rules; and an inventory correction, which sliced nearly 1 percent from real GDP growth.

Still, others blame the weak first-quarter growth on a quirk in the BEA's seasonal adjustment procedure that may have artificially lowered first-quarter growth—a pattern evident over the past several years. If residual seasonality explains a goodly part of the first-quarter weakness, then the recent pattern suggests that the weak first quarter will be followed up by much faster real GDP growth in the final three quarters of the year. And indeed, that is what the forecast consensus expects: real GDP growth averaging about 2.5 percent over the final three quarters of the year, continued solid job gains and an additional slight drop in the unemployment rate.

Such encouraging news was not absent from the Q1 report. For example, there was healthy growth in real business fixed investment, residential fixed investment and exports.

### The Trend in Inflation

The FOMC's preferred price index (the personal consumption expenditures price index, or PCEPI) rose at a brisk 2.4 percent annual rate in the first quarter. This was the largest increase in nearly six years and brought the current four-quarter percent change to 2 percent, which is equal to the FOMC's inflation target. By contrast, the better-known consumer price index increased at a 3 percent annual rate for the second consecutive quarter. At this point, both forecasters and financial market participants see low probability of much higher inflation (exceeding 3 percent) over the next year. (See chart.)

As is often the case, the direction of crude oil prices could have a significant bearing on the future direction of inflation. U.S. and OPEC crude oil production (supply) is forecast to increase through the end of 2018, according to the latest forecasts from the U.S. Energy Information Administration. These production forecasts are conditioned to some extent on a continued improvement in global economic growth, which increases the demand for oil. But if the projected increase in supply falls short of demand—say, because global economic growth turns out to be stronger than expected—then oil prices will tack higher. [Ω](#)

Kevin L. Kliesen is an economist at the Federal Reserve Bank of St. Louis. Brian Levine, a research associate at the Bank, provided research assistance. See <http://research.stlouisfed.org/econ/kliesen> for more on Kliesen's work.

# “Banking Deserts” Become a Concern as Branches Dry Up

By Drew Dahl and Michelle Franke



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Although changes in technology have made it easy to conduct some banking transactions from almost anywhere, personal and public benefits are still derived from proximity to a bank branch.

In areas without branches—commonly referred to as “banking deserts”—costs and inconveniences of cashing checks, establishing deposit accounts, obtaining loans and maintaining banking relationships are exacerbated.

The closing of thousands of bank branches in the aftermath of the 2007-09 recession has served to intensify societal concerns about access to financial services among low-income and minority populations, groups that are often affected disproportionately in such situations. These sorts of concerns were expressed recently by, among others, researchers Terri Friedline and Mathieu Despard in an article in *The Atlantic*.<sup>1</sup> We explored these concerns from the perspectives of those living in existing banking deserts as well as those who are dependent on isolated branches that, if closed, would create new deserts.

## Existing Deserts

We followed a prominent study by researchers Don Morgan, Maxim Pinkovskiy and Bryan Yang, published in 2016 by the Federal Reserve Bank of New York, in defining deserts as census tracts in which there are no branches within a 10-mile radius from the tracts’ centers.<sup>2</sup> Tracts are classified as “majority minority” if more than 50 percent of their residents are black or Hispanic; they are classified as “lower income” if median household incomes are in the lowest quartile.<sup>3</sup> The maximum for this quartile is \$49,626 in urban areas (inside a metropolitan statistical

area or MSA) and \$46,095 in rural areas (outside an MSA).

We identified 1,132 deserts in existence at the end of 2014, of which 398 were in urban areas and 734 in rural areas. (See Table 1.) The prevalence of deserts in rural tracts is more pronounced when expressed as percentages of overall tracts: 6 percent rural versus 0.6 percent urban.

Of the 3.74 million people living in these deserts, 291,560 were in urban lower-income tracts and 475,156 were in rural lower-income tracts, while 265,323 were in urban majority-minority tracts and 209,011 were in rural majority-minority tracts.<sup>4</sup> Majority-minority populations were relatively evenly distributed across desert and nondesert tracts in rural areas but, perhaps surprisingly, were less common in urban tracts with deserts than in urban tracts outside deserts.

The foregoing can be expressed from a macroeconomic perspective: The people living in lower-income and majority-minority banking deserts represent, respectively, 0.24 percent and 0.15 percent of the nation’s population. The overlap of both is 0.07 percent. More people live in Huntsville, Ala., than in banking deserts with lower-income and predominantly minority populations.

## Potential Deserts

The number of people stranded in areas devoid of bank services would probably expand in the future if branches continue to close. From this perspective, available resources may be better-employed in trying to prevent the creation of more deserts in areas where branches now exist rather than in trying to repopulate existing deserts with new branches.

We isolated branches outside the 10-mile range of any others—that is, branches that

if closed would create new banking deserts. Our analysis is based on demographic and economic data collected for the county subdivision in which each branch is located.

We identified 1,055 potential deserts in 2014, of which 204 were in urban areas and 851 in rural areas. The urban areas had a combined population of 2 million, while the rural areas had a combined population of 1.9 million. (See Table 2.) These potential deserts have relatively low population densities of 26 people per square mile in urban areas and 12 people per square mile in rural areas; comparative densities outside potential deserts are, respectively, 176 and 26 people per square mile. Areas with dispersed populations, in other words, are more at risk of becoming a banking desert.

Median incomes are \$46,717 in potential urban deserts and \$41,259 in potential rural deserts. These levels are lower, respectively, than in existing deserts, as well as in nondeserts (Table 1). This suggests that any desert expansion would affect lower-income people more than higher-income people.

Minorities constitute 9.8 percent of the population in potential urban deserts and 4.0 percent of the population in potential rural deserts. Both percentages are lower than those for existing deserts and nondeserts (Table 1). This suggests that newly created deserts may not disadvantage minorities to a greater extent than existing deserts do.

## The Last Branches

Branches in potential deserts are small, with median deposits of \$23 million in urban areas and \$20 million in rural areas (Table 2). They tend to be operated by small banks, with median total assets of \$776 million in urban areas and \$317 million in rural areas.

**TABLE 1**  
**Populations of Existing Banking Deserts, 2014**

	Urban Desert	Other Urban	Rural Desert	Other Rural
Number of Tracts	398	61,175	734	11,336
Population	1.53 M	271 M	2.21 M	44.1 M
Median Income	\$62,117	\$66,808	\$54,138	\$54,247
Population in Tracts with Lower Incomes	0.292 M	57.8 M	0.475 M	10.6 M
Median Percentage Minority	12.8	21.2	5.9	5.9
Population in Tracts with Majority Minorities	0.265 M	69.7 M	0.209 M	4.2 M

SOURCE: 2010 census data, U.S. Census Bureau; authors' calculations.

NOTE: "M" denotes millions. The data indicate that the number of people in deserts that are characterized by lower-income households and a greater minority presence is relatively modest.

**TABLE 2**  
**Potential Banking Deserts**

	Urban	Rural
Number	204	851
Population	2.04 M	1.92 M
Population Density	26	12
Median Household Income	\$46,717	\$41,259
Median Percentage Minority	9.8	4.0
Median Branch Deposits	\$23.1 M	\$20.1 M
Median Assets of Banks	\$776 M	\$317 M

SOURCE: 2014 branches with deposits data, Competitive Analysis and Structure Source Instrument for Depository Institutions (CASSIDI); 2010 census data, U.S. Census Bureau; authors' calculations.

NOTES: "M" denotes millions. Population density is measured as the number of people per square mile. (For urban areas and rural areas outside potential deserts, the comparable densities are 176 and 20.) The data indicate that lower-income households, but not minority households, are more dependent on a last branch, whose closing would create new deserts.

In comparison, JP Morgan Chase Bank operates 5,413 branches, with average deposits of \$213.4 million and assets valued at more than \$2 trillion.

The small size of these branches and the banks that own them suggest that what stands between a community and its isolation within a new banking desert are not the decisions made by big banks with a national

footprint but, rather, the decisions made by locally oriented community banks. This contrasts with the large numbers of branch closings by big banks that contributed to the creation of existing deserts as described by Tanya Wolfram in a recent report for a community development organization.<sup>5</sup>

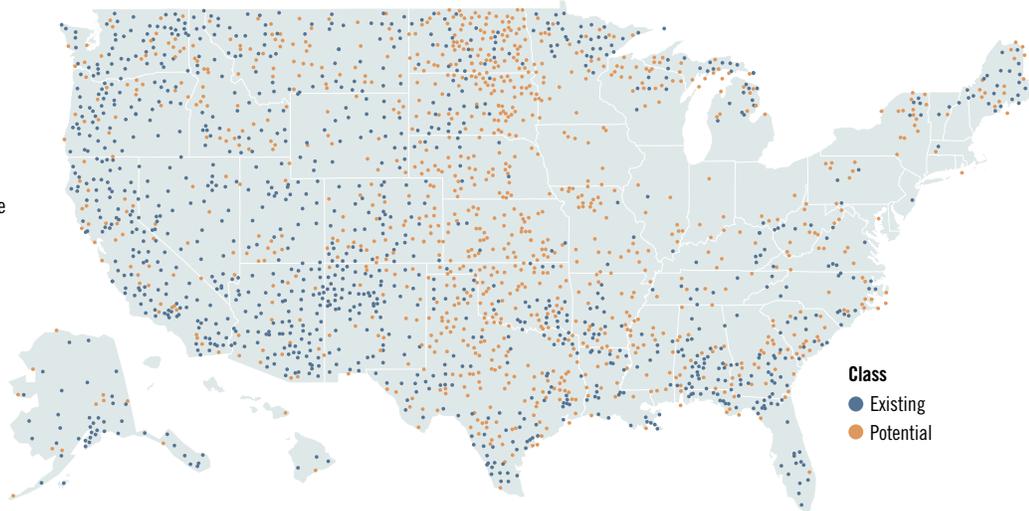
Another difference between existing and potential deserts concerns their geographic distribution. (See map.) Existing deserts tend to be concentrated in Southern and Western states. Potential deserts, on the other hand, are more likely to be located in Midwestern states.

### Conclusions

We found that the number of people in deserts that are characterized by lower household incomes and a greater minority presence is relatively modest. We also found that lower-income households, but not minority households, are more dependent on a last branch whose closing would create new deserts. To the extent that these branches are operated by community banks, which have some operational disadvantages relative to larger banks, the most vulnerable people are dependent on the most vulnerable banks. 

*Drew Dahl is an economist and Michelle Franke is a policy analyst, both in the Supervision Division at the Federal Reserve Bank of St. Louis.*

### The Location of Banking Deserts



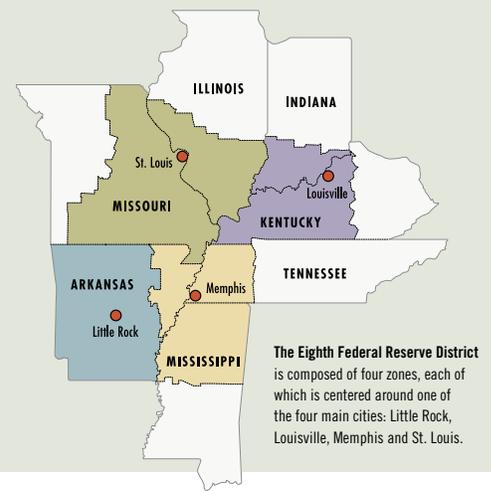
SOURCES: Morgan et al. (see references), CASSIDI and authors' calculations.

### ENDNOTES

- 1 See Friedline and Despard.
- 2 See Morgan et al. We thank these authors for sharing their data. Our only adjustment was to transform their data using census tract delineations from 2010 rather than 2000.
- 3 Household income is the sum of the income of all people 15 years and older living in the household. A household includes related family members and all the unrelated people, if any, such as lodgers, foster children, wards or employees who share the housing unit. A person living alone in a housing unit or a group of unrelated people sharing a housing unit is also counted as a household.
- 4 Identifying the numbers of people living in deserts defined by arbitrary geographic boundaries does not offer definitive evidence on all those who may be impacted by limited access to branch services. In this regard, narrower boundaries would increase the number of people considered to be outside the reach of such services.
- 5 See Wolfram.

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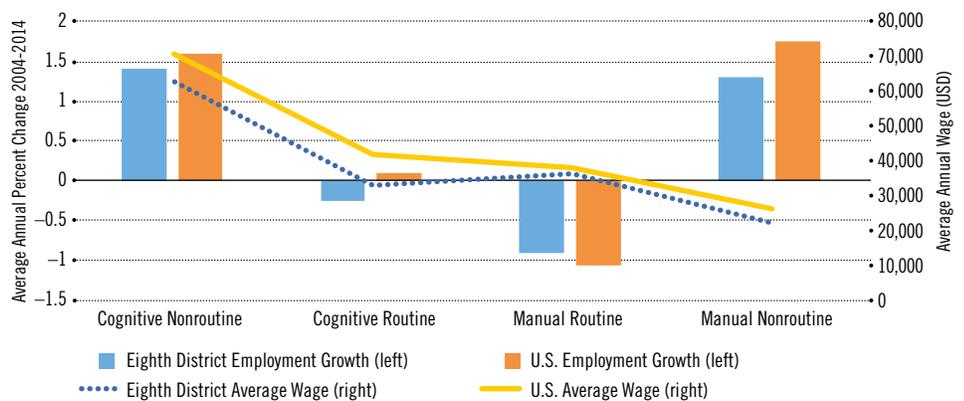
# Labor Market Polarization: How Does the District Compare with the Nation?

By Maximiliano Dvorkin and Hannah G. Shell

Over several decades, the U.S. labor market has been shifting away from jobs with routine tasks (e.g., manufacturing, construction and production) and toward those with nonroutine tasks (e.g., managerial, professional and service). Routine jobs tend to employ middle-skill workers, such as someone with a trade-school degree who might do electrical work. As routine employment declines, jobs are increasingly either low-skill (e.g., personal services or food preparation) or high-skill (management and professional occupations). This transition, called job polarization, is well-documented on the national level.<sup>1</sup> In this essay, we examine the dynamics of occupational employment in the Eighth District since 2004 and compare them with national trends.

To identify the long-term trends in the District and nation, we divided the categories in the U.S. government’s 2010 Standard Occupational Classification into four groups: cognitive routine, cognitive nonroutine, manual routine and manual nonroutine.<sup>2</sup> We assigned each occupation to a group based on the tasks typically performed by a worker in that occupation, similar to the process used in the Standard Occupational Classification.<sup>3</sup> For example, managers and computer scientists would fall into the cognitive nonroutine category because their occupations draw from mental skills and involve adapting to the project at hand. Office and administrative staff fall into the cognitive routine category because their work involves repetitive tasks, although it is not physical. The manual routine group includes more jobs requiring physical labor, like those in manufacturing or construction. Lastly, the manual

**FIGURE 1**  
**Average Employment Growth and Wages 2004-2014**



SOURCES: Occupational Employment Statistics and authors’ calculations.

nonroutine group includes employees such as retail workers and personal-care associates who provide adaptive services based on the required task.

The data we used to track occupational wages and employment in the District and nation are in the Occupational Employment Statistics survey.<sup>4</sup> The Bureau of Labor Statistics sends this survey out to about 200,000 businesses twice a year to gather statistics on employment and wages in very specific occupational categories. The data are available annually on the national and state levels from 1988 to 2014.

We used data from 2004 to 2014 for the nation and for states either entirely or partly covered by the Eighth District.<sup>5</sup> Over that period, employment has increased in both the District and the nation. On average, the District has increased employment by 0.29 percent each year, while the nation has increased employment by 0.58 percent each year.

To identify job polarization trends in the District and the nation, we grouped occupations into the four categories outlined above. Figure 1 shows the average employment growth and wage levels in each category.<sup>6</sup>

In both the District and the nation, employment in nonroutine occupations, either cognitive or manual, grew the fastest. Employment in cognitive routine occupations grew at a very modest pace in the nation and declined in the District; manual routine occupational employment decreased in the nation and the District. This graph confirms that job polarization is as much an issue in the District as it is on the national level.

The lines on Figure 1 represent average real wages in 2014 dollars for each occupational group on the District and national levels. Routine occupations tend to be in the middle of the wage distribution. Cognitive nonroutine occupations have much higher

wages, averaging well above \$60,000 per year on the District and national levels, while manual nonroutine occupations typically have the lowest wages, paying less than \$30,000 per year.

This wage difference highlights the polarization in the labor market, as employment grows the most at the polar opposites of the wage distribution.

Figure 2 breaks down the total employment growth numbers by occupation. Because the nation is growing slightly faster than the District, growth in the nation exceeds District growth in many of the occupational categories. The trends, however, are similar. In the District, occupations in personal services, computers and math, community and social services, and social sciences are experiencing the fastest job growth. The fastest-growing national occupations are more or less the same, with a few small differences. Business and financial occupations are growing faster in the nation than in the District, as are legal, arts and media, and sales occupations, among others. The three occupational groups growing faster in the District than in the nation are community and social service, architecture and engineering, and education, training and library occupations.

The occupations that are shrinking in the District are also shrinking at the national level. Transportation, office and administrative, production, and construction occupations all experienced declines in employment over the 10-year period. Office and administrative and production occupations are shrinking at a faster pace in the District than in the nation.

Figure 2 also shows the average annual real wage growth for these occupation groups. Similar to the employment growth patterns, wage growth in the District mirrors growth in the nation. Wage growth, however, appears to have no correlation with employment growth. The graph shows the occupations in order from fastest to slowest growth in the District. The wage line is mostly flat across the occupations, indicating no noticeable positive or negative relationship.

There are a few reasons why job polarization has occurred over the period studied. First, automation of routine and

repetitive tasks decreases employment in routine occupations. As computers and technology advance, fewer repetitive-task jobs are available. Additionally, the increase in global connections allows some stages of the production process to be performed in foreign countries where labor is cheaper than in the U.S. This outsourcing also decreases employment in routine-task occupations.

Job polarization has been documented prominently on the national level. In this article, we identified that job polarization occurs in the Eighth District in the same way it does in the nation. Employment in routine-based occupations is declining, while employment in nonroutine occupations is increasing. This shift results in a wage gap between the highly paid cognitive nonroutine occupations and the low-paying manual nonroutine jobs. This shift may be an important driver of increasing income inequality in both the District and the nation. <sup>Ω</sup>

*Maximiliano Dvorkin is an economist, and Hannah Shell is a senior research associate, both at the Federal Reserve Bank of St. Louis. For more on Dvorkin's work, see <https://research.stlouisfed.org/econ/dvorkin>.*

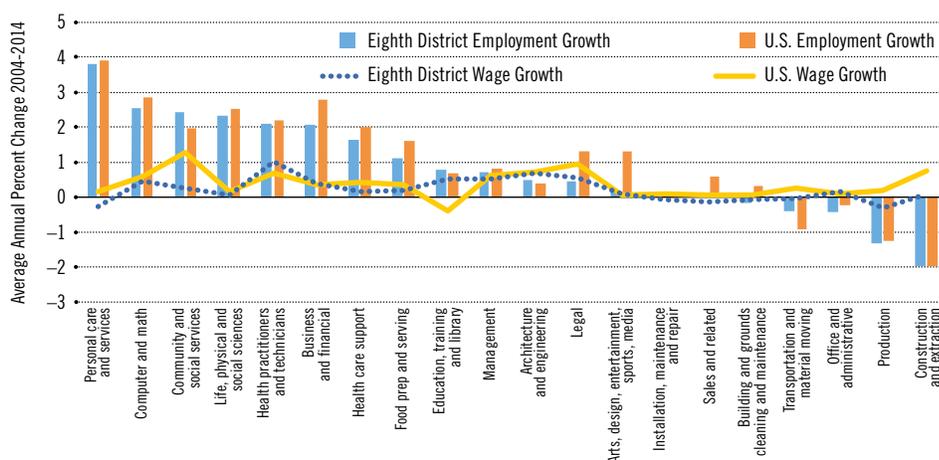
## ENDNOTES

- See, for example, Autor, Katz and Kearney (2006) and Autor and Dorn (2013).
- The Standard Occupational Classification (SOC) system is a coding system designed by the federal government and used to classify workers into occupational groups for data collection and analysis. For more information, see [www.bls.gov/SOC/](http://www.bls.gov/SOC/).
- See Foote and Ryan. We followed their classification of occupations into these large groups.
- While the Occupational Employment Statistics Survey is a firm-level survey, the source data are different than the establishment (aka payrolls) survey. General trends between the two surveys are the same, but growth numbers may be slightly different.
- We used data for the following Eighth District states: Arkansas, Indiana, Kentucky, Mississippi, Missouri and Tennessee. We excluded data from Illinois, a state that is partly in the Eighth District, because Chicago is the main driver of Illinois statistics and Chicago is outside the District.
- Averages are weighted by total employment in 2004.

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**FIGURE 2**  
**Average Employment and Wage Growth 2004-2014**



SOURCES: Occupational Employment Statistics and authors' calculations.

## Growth in Tech Sector Returns to Glory Days of the 1990s

By Charles Gascon and Evan Karson

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Over the past 25 years, the U.S. economy has undergone a profound technological revolution, characterized as a “palpable historic change” by former Federal Reserve Chairman Alan Greenspan.<sup>1</sup>

Innovations in digital computing systems and automation have triggered tectonic shifts in consumer and business behaviors across the economy, and at the core of this disruption has been a small yet rapidly expanding class of firms, entrepreneurs and innovators. In this article, we present a snapshot of the technology sector and its recent dynamics, as well as of its presence in the St. Louis Fed’s District.

The technology sector comprises industries that are primarily focused on developing and producing advanced technology for the rest of the economy. Businesses like Google, IBM and Microsoft are some of the largest businesses in the U.S. tech sector. Although dozens of other companies outside the tech sector make use of modern innovations—and may even have their own research and development departments—most nontech firms use those innovations to provide traditional goods and services. For instance, an auto manufacturer today may use advanced robotics to assemble cars more efficiently, but the manufacturer’s primary output is cars, not the robotic assembly lines.

In our analysis, we define the technology sector as the combination of seven industries as outlined in the North American

Industry Classification System and as laid out by researchers at the Federal Reserve Bank of New York.<sup>2</sup> Table 1 displays these industries, along with the nation’s and the District’s top revenue-generating firms within each.

### The National Scene

The technology sector has a dynamic history of expansion and contraction. Its first high-growth period lasted from 1990 to 2000, a time traditionally thought of as the “dot-com boom” or the “tech bubble.” National employment in technology sector industries shot up by 36 percent over the period. (See Figure 1.) Average weekly wages for technology sector workers doubled, rising by 102 percent over the 10-year period. At its peak in 2000, tech employment accounted for just over 4 percent of total private employment.

After the tech bubble burst in early 2001, technology sector employment declined rapidly, experiencing significant net job losses for four straight years. By the time it bottomed out in 2004, the sector’s workforce had shrunk by 17.8 percent and the tech employment share had declined to 3.4 percent.

From 2004 to 2008, the tech sector experienced modest job growth, in step with the

rest of the private sector. But in 2009, the tech sector suffered a major contraction, which was tied to the financial crisis and subsequent recession.

Since the Great Recession (2007-09) ended, the technology sector has experienced robust expansion in employment and moderate growth in wages. From 2010 to 2015, jobs in the sector expanded by 20.3 percent (see Table 2) compared with just 11.1 percent growth in employment for the private sector. In 2015, U.S. tech sector employment reached 4.6 million, pushing the tech share to 3.9 percent of total employment, effectively matching its level in 2000.

Tech sector wages have also markedly improved, rising roughly 5 percent each year since 2010. Historically, tech-sector wages have exhibited substantial premiums over average private-sector wages. In 1990, the earnings markup in the technology sector was roughly 1.6, meaning that tech-sector workers earned \$1.60 in wages for every \$1 earned by the average private-sector worker. However, this wage gap has widened over the past 25 years. Since 2010, average weekly wages in the tech sector have been at least double the private-sector level; in 2015, the tech-sector wage markup reached a record 2.2.

The distribution of employment across tech-sector industries has been continuously shifting since 1990. Until 1996, the majority of tech employment was in manufacturing, accounting for approximately 60 percent of the high-tech workforce. However, service firms have come to dominate the tech economy. Today, nearly 80 percent of tech workers are in services, with the computer systems design industry accounting for the largest fraction of total tech jobs (41 percent).

In terms of its geographic distribution, tech-sector employment is often more concentrated in metro areas. In 2015, the San Jose metropolitan statistical area (MSA) in California had the largest concentration of tech workers (21 percent). Boulder, Colo., had the second-largest share (18 percent), followed by San Francisco (11 percent). Together, the San Jose and San Francisco MSAs make up the bulk of what is known as Silicon Valley and are home to 9 percent of all technology sector employment in the U.S.

In a sample of the 100 largest U.S. metro areas, technology sector wages in 2015 were highest in the San Jose, San Francisco and Seattle MSAs. In 2015, workers in tech industries averaged earnings of approximately \$4,500 per week in San Jose, \$3,500 per week in San Francisco and \$3,000 per week in Seattle.

### The District's Tech Sector

By comparison, the technology sector has a modest presence in the Eighth Federal Reserve District, home of the St. Louis Fed. In 2015, the tech employment share in the District was an estimated 2.1 percent. Although this figure is below the national average, the District's share has been increasing over the past 25 years.

As Figure 1 shows, employment growth in the District's technology sector has outpaced the District's overall private sector growth since the Great Recession, pushing the District's tech share from 1.7 percent to 1.8 percent between 2005 and 2010 and then up another 0.3 percentage points by 2015. While that change may appear minute, it represents a shift of nearly 41,000 workers into tech industries in just five years. Figure 2 illustrates that in 2015, the industry breakdown within the District's tech sector aligned closely with the nation's.

TABLE 1

### Top Revenue-Producing Firms by Technology Industries (2015)

NAICS Codes	Industry Title	Largest Public Tech Firm in the U.S.	Largest Public Tech Firm in the Eighth District
334	Computer Manufacturing	Apple	Kimball Electronics (Jasper, Ind.)
454111	Electronic Shopping	Amazon	CafePress (Louisville, Ky.)
5112	Software Publishing	Microsoft	Amdocs* (Chesterfield, Mo.)
518	Data Processing, Hosting and Related Services	Xerox	Axiom (Conway, Ark.)
51913	Internet Publishing and Broadcasting and Web Search Portals	Google	Inuvo (Little Rock, Ark.)
5415	Computer Systems Design	IBM	Jack Henry & Associates (Monett, Mo.)
5417	Scientific Research and Development Services	QuintilesIMS	Biomedical Systems* (Maryland Heights, Mo.)

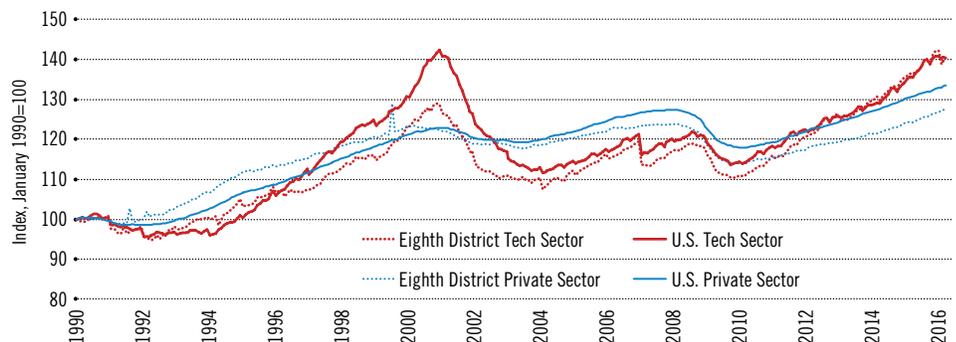
SOURCES: Compustat, Dow Jones.

NOTE: "Largest Public Tech Firm" lists the public company with the largest reported revenue in 2015 for each North American Industry Classification System (NAICS) family of industries.

\*Using Dow Jones' Factiva Companies and Industries Database, these firms were identified as having the most revenue among Eighth District firms in the corresponding family of NAICS codes. No corporations in the Compustat database qualified for this field.

FIGURE 1

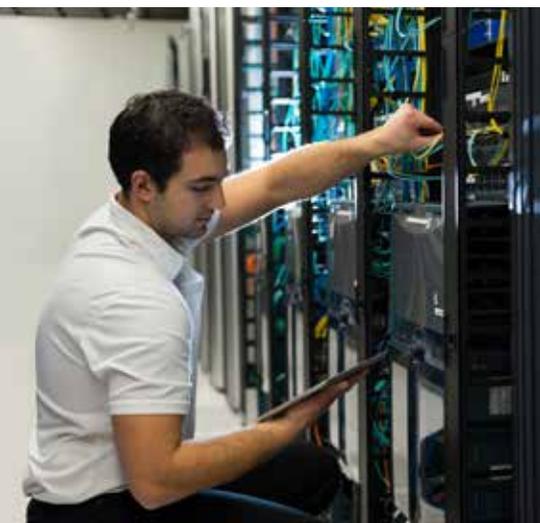
### Job Growth in Tech Sector vs. Private Sector



SOURCE: Bureau of Labor Statistics.

NOTE: Due to nondisclosure at the county level for some industries over time, estimates for the Eighth District technology sector are calculated as the sum of data for the entirety of all District states except Illinois. We excluded Illinois from our calculations since most of Illinois' economic activity stems from the Chicago area, outside the District. The other District states are Arkansas, Indiana, Kentucky, Mississippi, Missouri and Tennessee.

Of the Eighth District's four largest metro areas (see Table 2), the St. Louis MSA had the largest tech sector in terms of gross employment in 2015. St. Louis tech workers also earned the highest wage premium, collecting double the average weekly wage of general private-sector workers in St. Louis. Louisville, Ky., had the fastest-growing technology sector out of the four; employment in these industries has surged by more than 52 percent since 2010, reaching nearly



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12,500 in 2015. Meanwhile, tech-sector wages have been rising most rapidly in Memphis, Tenn. In just five years (2010-15), the average weekly wages of technology sector workers in Memphis jumped from approximately \$1,200 to \$1,500.

Even though Little Rock, Ark., the fourth-largest MSA in the District, had a tech share equal to St. Louis' in 2015, the metro area's tech workforce actually shrank 6 percent from 2010 to 2015. The biggest employment losses were in data-processing services, which accounted for over 60 percent of gross job losses in the area. Wages in high-tech industries in Little Rock were strong in 2015, however, and grew at a healthy tempo of 13.5 percent from 2010 to 2015.

## Conclusion

This article shows that the tech-sector industries have been growing rapidly over the past several years and have the capacity to help bolster economic growth going forward. While the tech sector is small in size, it plays a critical role in driving innovation and productivity growth, and the sector generates disproportionate economic spillovers. The tech workforce is also one of the most highly skilled labor pools in the economy, and high demand for tech workers has been a key driver of wage growth. <sup>Ω</sup>

*Charles Gascon is a regional economist, and Evan Karson is a research associate, both at the Federal Reserve Bank of St. Louis. For more on Gascon's work, see <https://research.stlouisfed.org/econ/gascon>.*

TABLE 2

### Selected Tech Sector Statistics

Region	Total Tech Employment (2015)	Technology Employment Share (2015)	Employment Growth (2010-15)	Wage Premium (2010-15)	Wage Growth (2010-15)
National	4,631,634	3.9%	20.3%	2.2	20.8%
Eighth District*	227,085**	2.1%	26.3%	1.8	10.5%
St. Louis	32,592	<b>2.9%</b>	5.3%	<b>2.0</b>	7.7%
Memphis, Tenn. †	4,542	0.9%	7.8%	1.5	<b>16.3%</b>
Louisville, Ky.	12,485	2.3%	<b>52.4%</b>	1.4	9.2%
Little Rock, Ark. ‡	7,531	<b>2.9%</b>	-6.1%	1.6	13.5%

SOURCE: Bureau of Labor Statistics

NOTE: "Wage Premium" is calculated as the employment-weighted average of the average weekly wages for the seven tech sector industries divided by the average weekly wage for private sectors. The numbers in bold are the highest values among the MSAs for each category.

\* Due to nondisclosure at the county level for some industries over time, estimates for the Eighth District technology sector are calculated as the sum of data for the entirety of all District states except Illinois. We excluded Illinois from our calculations since most of Illinois' economic activity stems from the Chicago area, outside the District. The other District states are Arkansas, Indiana, Kentucky, Mississippi, Missouri and Tennessee. District estimates using county and metro area data range from 1.3 percent to 2.4 percent.

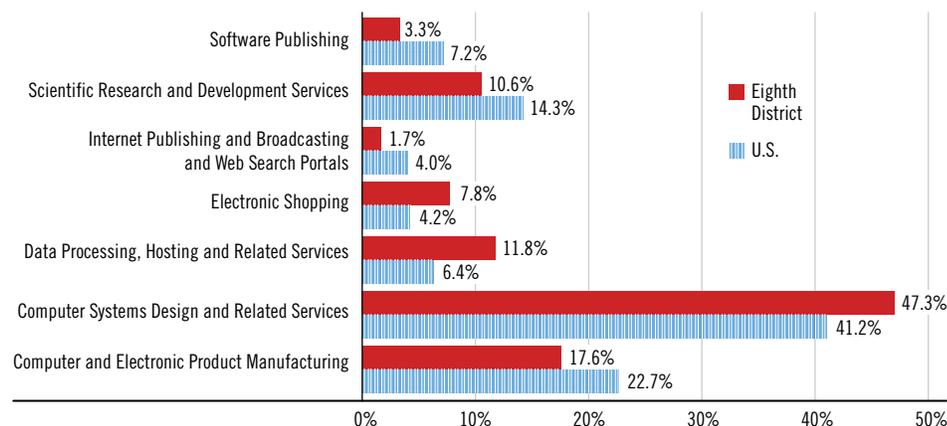
\*\* Total tech employment for the District is calculated as 2.1 percent of total private employment in Eighth District Counties.

† Industry employment shares for Shelby County, Tenn., were used to estimate nondisclosed NAICS industries for the metro area.

‡ Industry employment shares for Pulaski County, Ark., were used to estimate nondisclosed NAICS industries for the metro area.

FIGURE 2

### Industry Shares of Total Tech Employment in 2015



SOURCE: Bureau of Labor Statistics.

NOTE: Due to nondisclosure at the county level for some industries over time, estimates for the Eighth District technology sector are calculated as the sum of data for the entirety of all District states except Illinois. We excluded Illinois from our calculations since most of Illinois' economic activity stems from the Chicago area, outside the District. The other District states are Arkansas, Indiana, Kentucky, Mississippi, Missouri and Tennessee.

## ENDNOTES

<sup>1</sup> See Greenspan.

<sup>2</sup> See Bram and Ploenzke.

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Bram, Jason; and Ploenzke, Matthew. "Will Silicon Alley Be the Next Silicon Valley?" Federal Reserve Bank of New York's Liberty Street Economics, July 6, 2015.

Greenspan, Alan. "Technology and the Economy." Before the Economic Club of New York, Jan. 13, 2000.

ASK AN ECONOMIST



**Paulina Restrepo-Echavarria** is an economist at the Federal Reserve Bank of St. Louis, where she has worked since 2014. Her research focuses on international macroeconomics—in particular, the direction of capital flows and sovereign default—and on search and matching models of the labor and marriage market. Outside of work, she enjoys reading and exercising. For more of her research, see <https://research.stlouisfed.org/econ/restrepo-echavarria>.

**Restrepo-Echavarria and her children.**

**Q: Do oil-producing countries have difficulties repaying their debts?**

**A:** People may think that countries with a lot of oil do not default on their sovereign debt, but that is not the case. Given that big oil-producing countries sometimes hold a significant amount of public debt, this issue is very relevant and is an important one to study. Among the top 25 net oil exporters, for instance, the average public debt from 1979 to 2010 was about 50 percent of GDP.<sup>1</sup> All but eight of those 25 countries defaulted during that period, with the amount of time in default ranging from two years (Kuwait) to 25 years (Sudan).

In a recent paper with Franz Hamann and Enrique G. Mendoza, we examined the effect of having oil on sovereign risk, i.e., investors' perception of the risk in lending to the country.<sup>2</sup> We found that possessing oil can have two different effects on sovereign risk. If a country produces more oil relative to the total size of its economy, then the country is viewed by investors as less risky. This result is very intuitive. Producing more oil means a country has a greater ability to repay its debt and, therefore, has a lower risk of sovereign default.

However, we also found that if a country has more oil underground, then it is viewed by investors as more risky in the long run. This result may seem counterintuitive, but having a large stock of oil may increase a country's ability to withdraw from international financial markets, thereby raising the likelihood of default. At some point, defaulting may become more beneficial to a country than repaying its debt as long as it can still sell oil on international markets. This is the main result of our paper, which is quite surprising for a lot of people.

<sup>1</sup> For figures showing average public debt to GDP and default episodes for these countries, see Arias, Maria A. and Restrepo-Echavarria, Paulina. "Sovereign Default and Economic Performance in Oil-Producing Economies." Economic Synopses, No. 20, 2016.

<sup>2</sup> Hamann, Franz; Mendoza, Enrique G.; and Restrepo-Echavarria, Paulina. "Commodity Prices and Sovereign Default: A New Perspective on the Harberger-Laursen-Metzler Effect." Unpublished manuscript, 2016.

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### NEXT ISSUE

#### Does Quantitative Easing Work?

Following the global financial crisis, some central banks in the world experimented with quantitative easing (QE)—large-scale central bank purchases of long-maturity government debt and private assets. In some cases, central bank asset holdings increased several times over their precrisis levels. When announced, QE seemed to move government bond yields in the direction the central bank intends, but it is hard to find any evidence that QE has the desired effects on inflation and economic activity. This article will explore the theoretical support for QE and the experience with QE in countries where it was carried out.

