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TARIFFS and TRADE DISPUTES

The Impact in the Region

When Inflation Hits Producers

Is Cash Still King?

Interview with Chad Syverson

ECON FOCUS

Trade and Trepidation

"If a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them with some part of the produce of our own industry, employed in a way in which we have some advantage." Since Adam Smith wrote those words in 1776, it has become an enduring consensus among economists that trade makes us all better off by giving consumers and businesses access to more and cheaper goods, and by spurring new efficiencies and innovations.

That doesn't mean there aren't costs. Recent research suggests it can take a decade or more for a local labor market to adjust to the job loss that results from foreign competition. In our district, many communities have been disrupted by the loss of furniture, textile, and steel manufacturing. In the long run, these disruptions may be outweighed by the benefits of trade, but in the short run, figuring out how best to support the people and communities that bear the costs is an important objective for policymakers.

Policymakers sometimes try to curb foreign competition in the first place via trade restrictions such as tariffs or quotas. Regulating trade is far outside the Fed's purview, so it's not our place to weigh in on the pros or cons of any particular policy. But economic theory tells us that restricting trade has a number of potential downsides.

One possible harm is that consumers pay higher prices, either because there isn't a domestic substitute for the foreign good or because the higher price for foreign goods enables domestic producers to raise their prices as well. In addition, U.S. producers import a large share of their intermediate inputs; if those inputs get more expensive, firms might have to raise their prices to recover their costs. We might also see negative economic effects if other countries impose their own trade restrictions to retaliate. That could make U.S. exports less desirable, leading to an oversupply of, and lower prices for, the affected goods. The resulting lower profits for these manufacturers could put jobs at risk.

It's not all downside; for example, firms in the industries being protected may create more jobs, as several metal manufacturers recently have announced they will do. But economic theory suggests those job gains could be offset by job losses in other sectors.

The current trade disputes put several industries in the Fifth District at risk, as Tim Sablik discusses in "Tariffs and Trade Disputes" in this issue. (See page 10.) Car manufacturers in South Carolina, soybean farmers in Virginia, and pork producers and tobacco farmers in North Carolina are all facing new tariffs on their products in China. Maryland and West Virginia are both large importers of steel and aluminum; tariffs could increase costs for manufacturers in these states.

Of course, we don't know precisely what the effects of these tariffs will be. Supply chains have grown increasingly complex, which makes it difficult to predict how changing prices and costs will be dispersed. And if firms expect the tariffs to be temporary, then they might be less likely to significantly alter their prices or production processes.

But one area where I believe we are seeing a clear impact is confidence. For the most part, people feel pretty good about the economy. The University of Michigan's Survey of Consumer Sentiment is back to pre-Great Recession levels, and the Conference Board's measure of consumer confidence is actually higher than it was in the mid-2000s. At the same time, people are increasingly worried about the future with regard to trade. The share of households in the Michigan survey who spontaneously mentioned trade as a concern has more than doubled since May, from 15 percent to 35 percent, and the Conference Board's surveys document a widening gap between people's confidence about the present and their expectations for the future.

Similar results are obtained from surveys of CEOs and business owners. While many firms continue to project high levels of hiring and investment, those projections have fallen in recent months, and 95 percent of CEOs surveyed by the Business Roundtable were concerned about the effects of tariffs on U.S. exports.

It's certainly a concern I've heard from our business contacts throughout the Fifth District. And I'm not alone; in July's Beige Book, a compilation of regional data from each of the 12 Federal Reserve districts, every single Reserve Bank specifically mentioned trade policy as a source of concern or uncertainty for businesses in their district.

Uncertainty is bad for business. So in addition to the effects on sales and prices, the extent to which trade policy affects confidence is something I'll be watching very closely.   EF

TOM BARKIN
PRESIDENT
FEDERAL RESERVE BANK OF RICHMOND

Upfront

Regional News at a Glance

MARYLAND — On Aug. 3, Guinness opened a brewing operation in southwest Baltimore County, the company's first in the United States since the 1950s. The Guinness Open Gate Brewery & Barrel House is touted as a beer destination, with a brewery, restaurant, and taproom. It employs about 200 people, most in the restaurant and taproom but some in packaging. Guinness estimates the brewery will bring 300,000 people to the area in the first year, which could help the county's revitalization efforts for the Route 1 corridor from Elkridge to Laurel.

NORTH CAROLINA — The state's captive insurance program had a $30 million economic impact in 2017, the largest since its inception in 2013, according to a new report from the North Carolina Department of Insurance. Captive insurance is when a business creates its own insurance company to cover its risks, a form of self-insurance; captive insurers set up in the state are regulated by the Department of Insurance. North Carolina's 232 active captive insurers pay premium taxes to the state; the economic impact also comes from revenues to service providers (CPAs, actuaries, investment managers, and the like) and hospitality businesses.

SOUTH CAROLINA — On June 20, Volvo opened its first U.S. plant in Ridgeville. The $1.1 billion plant will have 1,500 workers by the end of 2018 and 4,000 by the end of 2021. Production will begin in the fall with the redesigned S60 sedan, and starting in 2021, the plant will also produce a new XC90 SUV. The plant is expected to make about 150,000 vehicles per year when it is at full capacity.

VIRGINIA — In late June, Virginia announced it is partnering with the Newport News Shipbuilding division of Huntington Ingalls Industries to provide support to the shipyard in hiring and training new employees. Over the next five years, Newport News Shipbuilding plans to hire 7,000 people, including creating 2,000 new positions, to support new and existing contracts. Current employees will also be retrained on new technology. The initiative will be supported by state agencies including the Virginia Economic Development Partnership, the Virginia Community College System, the Virginia Employment Commission, and the Virginia Office of Veterans and Defense Affairs.

WASHINGTON, D.C. — Twenty years ago, D.C.'s finances were overseen by a financial control board due to a ballooning deficit and a "junk" bond rating. That turmoil is now a distant memory: The District was awarded Moody's Investors Service's highest credit rating, AAA, on July 12. That follows Standard and Poor's and Fitch upgrading D.C.'s general obligation bond ratings to AA+. Moody's noted that the ratings bump was due in part to D.C.'s expanding high-wage economy and strong four-year financial plan.

WEST VIRGINIA — After the U.S. Supreme Court struck down a federal law on sports betting in May, the West Virginia Lottery Commission got to work crafting rules for the state's casinos. Earlier in 2018, the state legislature had passed a law allowing sports betting, which the Lottery Commission estimates will have an economic impact of $5.5 million in its first year. On July 9, the commission released the emergency rules for implementation of the law, including requirements for sports betting lounges and specifics on who can use sports wagering apps. These rules will allow casinos to request the necessary licenses immediately and begin securing vendors and equipment.

Computer Models at the Fed

Modeling the U.S. economy on computers has come a long way since the 1950s. It's still a work in progress

BY DAVID A. PRICE

One evening in the fall of 1956, Frank Adelman, a physicist at the Berkeley Radiation Laboratory — now the Lawrence Livermore National Laboratory — came home from work with a question for his wife, Irma, a Berkeley economist. He wanted to try writing a program for the lab's new IBM 650 vacuum-tube computer, but he had found that all of the physics problems he considered interesting were too complex. He asked Irma whether she thought there was an economic model that he could use instead.

"A few days later," she remembered, "I presented him with a copy of the book by Laurie [Lawrence] Klein and Art Goldberger, *An Econometric Model of the United States 1929-1952*."

Frank obtained approval from his boss for one free hour of central processor time, with the stipulation that they would have to reimburse the lab for any additional time at an hourly rate of $600, several times her monthly salary. The couple then set to work together on writing code for Klein and Goldberger's 25-equation model of the U.S. economy. Their new side project was a journey into uncharted territory: Before then, the results of such models had been worked out by human assistants — known as "computers" or "computors" — wielding slide rules or mechanical calculators.

Working in the lab's computer room at night, loading the code and data via punched IBM cards, the Adelmans had an initial version ready to present at an economics conference a little more than a year later. Frank's boss, impressed, allowed them a second free hour, which they used to create a more elaborate version, the results of which appeared in 1959 in the journal *Econometrica*.

From this modest start, the science — and, some would say, the art — of computer modeling of the economy has become indispensable to policymakers and businesses seeking to forecast economic variables such as GDP and employment or to analyze the likely effects of policy changes. The Fed's main computer model since the mid-1990s, known as FRB/US (commonly pronounced "ferbus"), has about 380 equations covering the behavior of households, firms, inflation, relative prices, numerous interest rates, and government taxes and spending (at the federal, state, and local levels), among other phenomena.

Yet even as large-scale macroeconomic models such as FRB/US have attained a role probably undreamed of by Irma and Frank Adelman, their usefulness is debated within economics circles — a reflection of a rift, starting in the 1970s, between many research economists in academia and their counterparts in policymaking institutions and businesses.

The Road to FRB/US

Modern econometric models are descendants of work done by researchers at the Cowles Commission (later the Cowles Foundation) at the University of Chicago from 1939 to 1955. (The organization then moved to Yale University, where it has been since.) The Cowles researchers had the benefit of already-existing theories of the business cycle, efforts by Simon Kuznets and others to collect macroeconomic data, and pioneering attempts by Jan Tinbergen to create models of the economies of the United States and his native Netherlands.

From this starting point, the Cowles group established an approach in which they represented the economy as a set of simultaneous equations — that is, equations that had to be solved together, not one by one. Each equation specified how some economic variable (such as aggregate personal consumption) on the left side of the equals sign depended on some other variables, which reflected what economic theory or the researcher's judgment suggested about the determination of that variable. The model could then be estimated using statistical methods. This "estimated" model could then, in theory, be used to forecast the path of the economy or analyze policy changes.

Lawrence Klein, who joined the Cowles Commission after finishing graduate school at MIT, continued the Cowles approach to model building at the University of Michigan, Oxford University, and the University of Pennsylvania, eventually receiving a Nobel Prize for his work. Writing in 1950, before the computer age had reached econometrics, he noted that an "annoying problem" in such research was "the laboriousness and complexity of computation" — the problem that Irma and Frank Adelman would address on the night shift later in the decade using a model he had co-created.

At the Fed's Board of Governors, work on an econometric model of the U.S. economy began in 1966 as a collaboration between Fed economists and academics. The resulting model, which was used by Fed staff starting in 1970, was known as "MPS" for the institutions involved (MIT, the University of Pennsylvania, and the Social Science Research Council). The staff started

The mid-to-late 1960s would be the high-water mark of joint work between policymakers and academic economists on macroeconomic models.

work on a global model in 1975, which led to MCM, for "multi-country model," coming into use in 1979.

As it turned out, the collaboration on MPS in the mid-to-late 1960s would be the high-water mark of joint work between policymakers and academic economists on macroeconomic models. Interest among academics in such projects declined afterward — the result, in large part, of a single article by Robert Lucas of the University of Chicago that did not initially attract much attention. In the article, published in 1976, Lucas presented what is now universally called the "Lucas critique": In simple terms, he argued that Cowles Commission-style large structural models were all but useless in analyzing the future effects of policy changes because they failed to account for people's and firms' expectations, especially the possibility that their expectations would anticipate possible policy changes. In his view, to the extent that economic actors were able to anticipate policy changes, and thus adapt to them, models that could take into account only the prior behavior of individuals and firms would generate "invalid" results.

FRB/US at the FOMC

In reaction to the Lucas critique, as well as various limitations that the Fed encountered in using the MPS and MCM models, Fed economists began work on successors to them in 1991 and 1993, respectively. The resulting models, FRB/US and its international counterpart, FRB/MCM, replaced the earlier ones in 1996.

FRB/US, which the Fed's Board of Governors released to the public on its website in 2014, added extensive and complex mechanisms for factoring in expectations. When using the model, Fed staff can determine the assumptions they want it to make about how different players in the economy — for example, financial-market participants, nonfinancial firms, and households — form their expectations of the economy and policy and how accurate their expectations are.

Todd Clark, a senior vice president in the Cleveland Fed's research department and head of its macroeconomics group, says that FRB/US "was a product of trying to build in a lot of the things that had been learned about macroeconomics since the old MPS model was put in place."

The results of FRB/US simulations make their way into monetary policymaking at the Fed in several ways. First, they are used directly by Fed economists and Federal Open Market Committee (FOMC) members to analyze the outcomes of possible policies. For example, then-Vice Chair Janet Yellen noted in speeches in 2012 that she had used FRB/US to obtain projections of how long inflation would remain in abeyance if the Fed continued its policy of low interest rates. Second, forecasts from FRB/US are included in the Tealbook, the set of materials that the research staff prepares for the FOMC in advance of committee meetings. Finally, and probably most importantly, FRB/US forecasts are one input into the staff's own forecasts, which are a central part of the Tealbook.

The staff forecasts are "judgmental," meaning the staff makes its own subjective decisions about how much weight to give various pieces of quantitative and non-quantitative information. Christopher Sims of Princeton University reported in a 2002 article that these judgmental forecasts have been "historically slightly better" than the FRB/US forecasts; in interviews he conducted with Board of Governors staff members, they told him that the superiority of the judgmental forecasts came, not from better foresight on the humans' part, but instead from superior knowledge of the *current* state of the economy. All other things equal, a more accurate starting point means better forecasts.

In assessing the current state of the economy, according to Sims, one area of advantage for the staff over FRB/US and other current computer models — beyond the staff's ability to assimilate unstructured quantitative and nonquantitative information — is a better ability to assess how unusual shocks to the economy are likely to play out. Events that have not been defined within a model, or are outside the statistical experience of the model, such as an oil-price shock, a major terrorist attack, or a large-scale financial crisis, are beyond the model's ken. "Analysis of such historically unusual disturbances — including the determination of whether they really are historically unusual — will inevitably involve an element of subjective judgment," Sims noted.

The Rivals

Outside the Fed, FRB/US has been criticized from a number of directions. For some economists, such as Ray Fair of Yale University, its way of handling expectations disconnected it from the statistical theory underlying the original Cowles Commission-style large models. For others, FRB/US does not go far enough in addressing the issues raised by the Lucas critique.

Two other families of macroeconomic models have swept macroeconomic research in academia, largely because they sidestep Lucas' objections to traditional models. One of these, known as DSGE models, for "dynamic stochastic general equilibrium" models, emerged in the 2000s. DSGE models generally embody a world in which individuals and firms know a lot about the future: While they don't know specifically what will happen, they do know all of the possible shocks to the economy and the chances of each of those shocks actually occurring. Richmond Fed research director Kartik Athreya, in his 2013 book *Big Ideas in Macroeconomics*, explained, "DSGE, taken literally, just means a model

in which decision makers think about the future, where that future is uncertain, and where the outcomes do not surprise people beyond what the realization of uncertainty itself does."

Use of DSGE models within the Fed has been growing. Economists at the Fed's Board of Governors have developed two, known as EDO (a model of the U.S. economy) and SIGMA (a multi-country model). The research departments of several Reserve Banks — the Chicago Fed, the New York Fed, and the Philadelphia Fed — have also developed and used DSGE models.

The answer to the question of whether FRB/US or DSGE models give better forecasts and policy analyses is not yet clear. Economists at the Board of Governors fed economic data from mid-1996 to late 2004 into EDO and found that its forecasts were "as good as, and in many cases better than, that of the forecasts of the Federal Reserve staff and the FRB/US model." But they noted that EDO, having been developed after the period in question, benefited from previous research, including the Board's own research, "on what types of models are likely to explain the data well."

Although DSGE models avoid the limitations of traditional models with regard to expectations, they do have limitations of their own. Current DSGEs assume a "representative" household — that is, they generally assume all households behave identically.

Yale's Ray Fair, a rare academic proponent of traditional large-scale macroeconometric models, contends that the level of knowledge of the future assumed by DSGEs is unrealistic. "That's a highly restrictive assumption," he says. "Sometimes stock markets and bond markets are pretty good, but to say that the average person or the average firm has that kind of sophistication seems highly unrealistic. And it makes a big difference: Properties of the model are very sensitive to whether you generally assume that or not."

Apart from the trade-offs made by builders of DSGEs, Fair argues, the significance of the Lucas critique as a practical matter has itself been overstated. "There's nothing wrong with the logic of it," Fair says of the critique. "The question is how empirically relevant it is. It may be that the things Bob [Lucas] was worried about may be small quantitatively relative to other things."

The other major family of macroeconomic models that has emerged in reaction to Lucas' 1976 article is VARs, or vector auto-regressions, first proposed by Princeton's Sims in 1980. In this approach, the researcher simply makes a list of the variables that he or she believes are relevant to whatever issue is being looked at. Beyond that list, there's no need for economic theory: The researcher doesn't need to specify how the variables are related to one another. Loosely speaking, the variables and some prior values of the variables are all regressed on past values of each other.

Clark of the Cleveland Fed says all three families of models have something to offer. "You see in modern central banking the use of a range of models within the Federal Reserve System," he says. "There's an old quote from a statistician, George Box. 'All models are wrong, but some are useful.'"

Of DSGE models and models like FRB/US, Clark says, "They are useful for helping us understand fundamental issues with monetary policy and other policies. They're also helpful for telling a story around a forecast and giving us insight into the structural forces that might be driving the outlook."

At the Richmond Fed, a type of VAR known as a time-varying parameter VAR, built by Thomas Lubik and Christian Matthes, is used to forecast the U.S. economy and to analyze policy questions. An advantage of this type of model, Lubik says, is that it can deal with nonlinear behavior in the way some variables influence the economy, such as the effects of interest-rate changes when interest rates are near zero. To work on diagnostic questions about the economy — what caused X to happen? — Richmond Fed researchers use a variety of other models, including a DSGE model.

One of the drawbacks of DSGEs and VARs, according to Lubik, is that they are difficult to analyze and adapt to the needs of the policymakers when they are implemented on a large scale. While they enjoy academic respectability, sometimes the utility of the theoretically imperfect model makes it the better choice. "This has been the tension for the last 10 to 20 years between academics and policymakers," he says.

On the policymakers' side, the theoretical limitations of traditional models, and of hybrids like FRB/US, are well understood. "But at some point, you need answers fast," Lubik says. "FRB/US in general tends to perform quite well for forecasting and policy analysis."

Whether quick and dirty or slow and theoretically clean, computer models are essential to monetary policymaking at the Fed. But when the next major negative shock to the economy occurs, it may well be one that model-makers didn't envision — putting human judgment at a premium over computer chips more than ever.   **EF**

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Network Effects

BY JESSIE ROMERO

In 1907, a group of investors that included J.P. Morgan took control of the American Telephone and Telegraph Company and named Theodore Vail president. (Vail had also been AT&T's president in the 1880s.) Roughly 6,000 independent phone companies had sprung up since Alexander Graham Bell's original patent expired in 1894, and Vail quickly embarked on a new strategy of acquiring them. Had these competitors not become part of the Bell system, Vail wrote in the company's 1908 annual report, "each little system would have been independent and self-contained without benefit to any other." A telephone without a connection at the other end, Vail explained, "is one of the most useless things in the world. Its value depends on the connection with the other telephone — and increases with the number of connections."

The term didn't exist at the time, but Vail was describing what's known today as a "network effect" or, by some economists, as a "network externality." Network effects occur when "the utility that a user derives from consumption of the good increases with the number of other agents consuming the good," as Michael Katz and Carl Shapiro of the University of California, Berkeley described in a 1985 article in the *American Economic Review*. (Shapiro later wrote a book about network effects with fellow Berkeley economist Hal Varian, now the chief economist at Google.)

In general, there are two types of network effects: direct and indirect. Direct effects occur when a good's value increases as the number of users goes up. Telephones exhibit direct network effects, as did fax machines before they were supplanted by email. Today, an oft-cited example of direct network effects is social media — the more friends you have using a given platform, the more enjoyment you'll get from it. An Internet search engine may also exhibit network effects; more users enable the company to refine the engine's algorithm, making it more effective and leading more people to use it. (See "Interview with Jean Tirole," *Econ Focus*, Fourth Quarter 2017.)

Indirect effects occur when an increase in consumers using a good leads to the creation of more complementary goods, thus making the original good more valuable. This is common in platform situations. For example, as more people use a particular videogame system, companies will create more games compatible with that system. Greater availability of games makes the system more attractive to future players, and competition among game developers drives down the price of games.

Robert Metcalfe, the electrical engineer primarily responsible for inventing Ethernet local networks, is widely credited with popularizing the idea of network effects. In the 1980s, Metcalfe's sales pitch for his new technology stated that the effect would be proportional to the square of the number of connected users of the system, a formula that came to be known as "Metcalfe's law." While there's little empirical evidence to support the law specifically, it's often still used as shorthand to assess technology companies' values.

Network effects can contribute to a situation known as "lock in," in which a particular standard becomes dominant and consumers find it very costly to switch. In these situations, the producer of the standard may be able to exercise monopoly power. In 1998, for example, the Department of Justice sued Microsoft for allegedly abusing Windows' ubiquity as an operating system to promote Internet Explorer. More recently, critics have contended that Google consistently manipulates its search results to direct users away from competing services in other markets that Google serves.

In addition, network effects don't increase indefinitely. Take a dating website, which initially becomes more useful as more people sign up and the number of potential matches increases. But after a certain point, there might be so many users that it's difficult for people to sort through the matches — a form of network "congestion." Congestion can also occur if a site or system's infrastructure is insufficient to support the number of users. Or, networks may become "polluted" if they reach a size such that the quality of each additional user declines.

It's also possible for an increase in users to create more value for one side of the market while detracting from the value for the other side. A website whose visitors increase will become more attractive to advertisers, but the increase in advertisers might then turn away some of those visitors. By many accounts, the ubiquity of advertising contributed to the demise of MySpace, which lost the social networking war to Facebook in the late 2000s. Today, many Facebook users complain about intrusive ads, but they continue using the site, in part because everyone else does — a testimony to the power of network effects.   **EF**

Misperceptions of Mobility

BY ANTHONY SWAMINATHAN

The American dream holds that with talent, good ideas, and hard work, anything is possible. In America, the common perception is that the market system is relatively fair and opportunities for mobility abound. Europeans, stereotypically, believe the opposite. There, the market system is viewed as fundamentally unfair; wealth is seen as the result of persistent socioeconomic advantages. Opportunities for mobility are supposedly few and far between.

Recent research on intergenerational mobility in the United States and Europe, however, shows that American optimism and European pessimism might be misplaced. Research shows that mobility in the United States may be lower than assumed, while mobility in Europe exceeds Europeans' perception of it. Indeed, new data show that the United States may have lower levels of mobility than most European countries.

A recent article by Harvard University economists Alberto Alesina, Stefanie Stantcheva, and Edoardo Teso in the *American Economic Review* tackled this issue of (mis)perception. The authors used survey and experimental data from the United States and Europe to compare perceptions of mobility with actual patterns and analyzed the relationship between individuals' perceptions of mobility and their support for redistributive programs. Their work built on previous research on the linkages between intergenerational mobility and preferences for redistributive policy, which highlights the importance of individual experiences, perceptions of inequality, beliefs about fairness, and self-fulfilling ideological models of mobility.

The main source of data for the article is an original survey administered in the United States and four European countries (Sweden, Italy, France, and the United Kingdom). The focus of the survey is questions about perceptions of mobility, including one asking respondents to indicate how many of 100 children from the lowest quintile in the respondents' country they believed would end up in each of the five income quintiles as adults. The survey also addressed participants' socioeconomic backgrounds, individual experiences of mobility, and views on fairness.

The survey results confirm that Americans and Europeans hold the stereotypical perceptions of mobility commonly ascribed to them. In general, Americans are more optimistic than Europeans. Moreover, Americans are generally too optimistic relative to reality, while Europeans are generally too pessimistic; Americans vastly overestimate the chances that those at the bottom will make it to the top, while Europeans underestimate those chances and overestimate the chances that those at the bottom will stay there.

Perceptions of mobility also correlate significantly with individual characteristics. In general, left-leaning respondents and the college-educated are more pessimistic. Women, parents, low-income respondents, children of immigrants, and those who have experienced mobility are generally more optimistic. Black Americans, though facing low real levels of mobility, are especially optimistic.

The survey data also show a significant correlation between individuals' perceptions of mobility and their support for redistribution. Pessimism is positively correlated with support for all dimensions of redistribution measured, while optimism is negatively correlated with most of them. Additionally, support for equality of opportunity policies, like investment in education and health care, is more sensitive to perceptions of mobility than support for equality of outcome policies, such as expanded safety nets or more progressive taxation. There are large differences between left- and right-leaning respondents, as the views of right-leaning respondents are much less sensitive to their perceptions of mobility.

To isolate the effect of mobility perceptions on redistributive policy preferences, the authors ran an experiment testing the effect of a pessimistic shift in perceptions of mobility. Participants in the experimental group watched two animations presented as summaries of recent research, one claiming that most poor children stay poor and few become rich and another claiming that most rich children stay rich and few become poor. The survey measure for perceptions of mobility was administered before and after the treatment. Overall, those who saw the films were more pessimistic relative to the control group.

The authors found no statistical difference in the effect of the films on perceptions of mobility between left- and right-leaning respondents. They did, however, find a difference between these groups in the effect of the treatment on redistributive policy preferences, as only left-leaning respondents subsequently increased their support for equality of opportunity polices (there was no effect on support for equality of outcome policies). Though they became more pessimistic, right-leaning respondents had no change in their support for any redistributive policies — perhaps, the authors suggest, because they view government as unable to fix the problem or perhaps as the problem itself. **EF**

> "Intergenerational Mobility and Preferences for Redistribution." Alberto Alesina, Stefanie Stantcheva, and Edoardo Teso. *American Economic Review*, February 2018, vol. 108, no. 2, pp. 521-554.

How Do Banks Use the Discount Window?

BY HELEN FESSENDEN AND RENEE HALTOM

> **Highlighted Research**
> "The Fed's Discount Window: An Overview of Recent Data." Felix P. Ackon and Huberto M. Ennis. Federal Reserve Bank of Richmond *Economic Quarterly*, First-Fourth Quarter 2017, vol. 103, nos. 1-4, pp. 37-79.

The discount window is the Fed's lending facility to depository institutions, meant to provide short-term loans to institutions with temporary liquidity shortfalls. But should the Fed have a discount window open at all times, including outside of widespread financial crises?

The potential costs of having a discount window have long been recognized. As an example, renowned economist Anna Schwartz regularly expressed reservations about having a discount window open and argued that historically it has been used to lend to not just illiquid, but insolvent banks. When this is the case, the discount window can have the effect of allowing uninsured depositors to pull out of the bank before incurring losses — increasing the costs of a bank's failure on the FDIC and ultimately on taxpayers. Forcing banks to rely only on private short-term funding sources can create greater market discipline.

Richmond Fed economist Huberto Ennis has been studying these issues for several years. "We need to better understand the role of the discount window and what it is being used for," he says. "Looking at recent transactions data, for example, can help us determine if we should continue having a discount window open at all times."

This has previously been difficult because the details around discount window activity weren't made public on a regular basis. That changed with a provision in the 2010 Dodd-Frank Act that requires the Fed to publish transactions data with a two-year lag. In a recent article, Ennis and research associate Felix Ackon analyzed 16,514 loans from July 2010 to June 2015 to identify patterns.

The loans fall into one of the discount window's three programs. Primary credit and secondary credit are emergency credit programs that constitute a backup source of funding for eligible financial institutions. In the former, institutions in good financial standing can get overnight loans with "no questions asked," paying an interest rate higher than the Fed's policy rate. Institutions not eligible for primary credit can access secondary credit; those loans come at an even higher interest rate and with greater Fed scrutiny. A third program, seasonal credit, is aimed at smaller institutions with a predictable and demonstrable seasonable pattern in their funding needs.

Ennis and Ackon found that even though this period covers the post-crisis years, when banks generally were awash with liquidity and large quantities of excess reserves, many of them still borrowed nontrivial amounts from the discount window.

To estimate just how common borrowing was, Ennis and Ackon needed to filter out "test" loans, which depository institutions conduct to make sure the systems involved in processing discount window loans are working as expected. Because the data don't state which loans are tests and which aren't, they assumed that loans in amounts greater than $10,000 were of the nontest variety (while noting that some smaller loans likely are actual loans, and some larger loans might be tests). Roughly one-third of the total loans were categorized as test loans.

In the primary credit program — the biggest of the three programs — there were almost 6,800 nontest loans over the five-year period, mostly overnight, with an average amount of $3.8 million. After 2012, primary credit borrowing dropped significantly (by 40 percent). Some banks were frequent users: While almost 600 banks took only one nontest loan during the five-year period, 28 banks took 30 or more nontest loans.

As might be expected given its higher interest rate, the secondary credit program is used much less often than primary credit. Of 650 total loans, only 39 were nontest loans.

Discount window lending is collateralized, which reduces the credit risk (to the Fed) of providing those loans. Ennis and Ackon studied the composition of collateral that borrowers pledged with the Fed (including consumer and commercial loans, securities, and other bank assets) and the loan-to-collateral ratios. In general, borrowing banks had more collateral than the amount they borrowed, although in some cases, collateral utilization was high, close to 100 percent.

Overall, Ennis says, "depository institutions do seem to see routine provision of backup funding by the central bank as a valuable option for short-term liquidity. However, a more clear understanding of the circumstances that trigger discount window borrowing is needed to better assess the value of having the discount window open at all times."

Ennis and Ackon's study is part of a broader range of questions Richmond Fed researchers have asked about the roles and implications of Fed lending. In 2016, Ennis and policy advisor John Weinberg looked at the role of Fed lending in the implementation of monetary policy. Ennis has also studied how discount window stigma — the fear banks may have that discount window borrowing connotes poor financial health — could affect the ability of Fed lending to smooth market distress. **EF**

The Economist as Public Intellectual

BY AARON STEELMAN

In 1977, Harvard University economist John Kenneth Galbraith published *The Age of Uncertainty*. The book was paired with a 12-part television series produced by the British Broadcasting Corporation. Galbraith generally took a skeptical view of the ability of unregulated markets to produce either efficient or equitable outcomes. Three years later, Milton Friedman of the University of Chicago hosted a 10-part television series produced by the Public Broadcasting Service based on *Free to Choose*, published the same year and co-authored with his wife, Rose. In contrast to Galbraith, Friedman argued that markets not only do a good job of allocating goods and services, they also provide the best means for low- and middle-income people to improve their circumstances. Galbraith and Friedman were "public intellectuals," presenting ideas on big topics in an engaging, nontechnical manner to lay audiences.

Galbraith and Friedman had long had outsized voices in the public arena. Galbraith had published *The Affluent Society*, a best-seller, and was a founding member of Americans for Democratic Action, which lobbies for progressive causes. Friedman also had already published a successful book aimed largely at noneconomists, *Capitalism and Freedom*, and had written regular columns for *Newsweek* magazine, alternating with Paul Samuelson of the Massachusetts Institute of Technology.

Both the economics profession and communications technology have changed dramatically in the years since. What has this meant for the role of economists as public intellectuals?

As the growth of the Internet and other forms of communication has exploded, the volume of economic commentary has grown sharply as well — a boon for discerning consumers. Some have worried, though, that as supply has increased, the caliber of discourse has declined, a trend that could worsen. But this concern may be overstated due to mechanisms that could foster quality control.

Economics faculties have an interest in monitoring the output of their colleagues. They can't formally prevent others from publishing relatively brief articles that lack the precise but often narrower statements that characterize peer-reviewed academic papers. But they can make it plain, especially to junior colleagues, that their professional interests would be best served if their popular writings were also careful and measured.

In addition, economics has become increasingly formal and specialized. Friedman and Samuelson were giants within the economics profession, but their interests were broader than the typical economist then and certainly today. As such, they were more inclined — and probably better equipped — to reach a general audience than someone whose work is narrower and often doesn't have direct policy relevance.

Still, it is likely that the overall flow of opinions coming directly from economists to the public will increase. For economists who have difficulty publishing in leading journals or those who find academia unsatisfying for other reasons, moving to positions in which they are rewarded for speaking more directly to the public may prove increasingly viable and desirable. Among those who stay, we may see more economists writing nontechnical essays but on fairly specific topics related to their academic work. In this vein, Glenn Hubbard, an economist at Columbia University and chair of the Council of Economic Advisers from 2001 to 2003, thinks that "people who contribute rigorous thought to public discourse are well thought of (even though many may disagree with their point of view)" and notes that the most effective communicators, whether junior or senior faculty members, "speak from a basis in their own scholarly ideas and explorations."

Some have asked: Might we see another Friedman or Samuelson, a "superstar" economist in the prime of his or her career who moonlights as a public intellectual? It seems doubtful. Friedman published *Capitalism and Freedom* a year prior to *A Monetary History of the United States, 1867-1960* (co-authored with Anna Schwartz), a monumental book and one of his most important academic contributions. But it's rare for someone to do work on the academic frontier as well as work that speaks to a lay audience simultaneously. The process is more likely to be sequential: publish significant academic papers and then turn to popular-level writing. *New York Times* columnist Paul Krugman — like Friedman and Samuelson, a Nobel Prize winner — started writing primarily for a popular audience after he had done most of his work on international trade and economic geography cited by the Nobel committee. Similarly, Gary Becker, also a Nobel laureate, greatly expanded his public output after publishing his most pioneering work using economics to analyze issues such as crime, the family, and labor market discrimination.

There is considerable popular demand for economic information and commentary. That much is clear. And, says Hubbard, such communication is important: "Good nontechnical writing on topics of economic importance is vital to build support for good policy." But the nature of the rewards may be different in this new era too. Where Galbraith and Friedman earned small fortunes from their best-selling books, today's public intellectual in economics may have to be satisfied with the less tangible reward of clicks and likes. As every economist knows, utility comes in many forms.   **EF**

TARIFFS and TRADE DISPUTES

How are recent moves affecting businesses in the Fifth District?

By Tim Sablik

O n July 6, 2018, a U.S. cargo ship raced across the Pacific toward the port of Dalian in China. Its mission: make landfall and unload its cargo of soybeans before a 25 percent Chinese tariff went into effect at noon. Unfortunately for the U.S. shippers and the Chinese buyers, the boat arrived a few hours too late.

China's tariffs on nearly $34 billion in U.S. exports — including food products, such as soybeans and pork, and other products, such as cars — were a response to tariffs imposed by the United States on a similar amount of Chinese exports on manufacturing inputs and capital equipment. In late August, the United States raised tariffs on an additional $16 billion of Chinese exports, and China responded in kind.

President Donald Trump has made trade policy a focus of his administration. His first major action this year came in March when he implemented a 25 percent tariff on steel and a 10 percent tariff on aluminum. They are the first significant tariffs on steel imports since President George W. Bush raised tariffs on steel in 2002, later removing them in 2003. In recommending the tariffs to President Trump, the Commerce Department said that the measure was intended to increase domestic steel and aluminum production. Initially, key U.S. trading partners such as Canada, Mexico, and the European Union (EU) were exempt. But the Trump administration ended the exemptions in June, prompting Canada, Mexico, and the EU to respond with tariffs of their own.

This flurry of tariff activity is significant in the modern era. Recent decades have seen most developed nations move toward opening up their markets to foreign trade. According to the World Bank, the weighted average of U.S. tariffs across all imports in 2016 was just 1.6 percent, similar to that of the EU. What is behind the new rise of trade barriers, and how will they affect businesses in the Fifth District?

The Trade Debate

For most of the postwar era, trade grew faster than world GDP. After World War II, Allied leaders were interested in getting the world economy back on track and avoiding the isolation and protectionism that many blamed for the Great Depression. Under the General Agreement on Tariffs and Trade, which later became the World Trade Organization (WTO), member nations

agreed to work together to reduce tariffs and other trade barriers. World trade accelerated rapidly in the 1990s and early 2000s with the dissolution of the Soviet Union and the entry of China into the WTO. (See "Goodbye, Globalization?" *Econ Focus*, Fourth Quarter 2015.)

Most economists view this expansion of trade as a good thing. For example, 85 percent of economists responding to a 2012 survey by the University of Chicago's Initiative on Global Markets (IGM) Forum agreed that freer trade allows firms to improve production efficiency and offers consumers better choices. While some industries are harmed by exposure to foreign competition, economists generally agree that in the long run, the overall gains from trade are much larger than the losses for some industries.
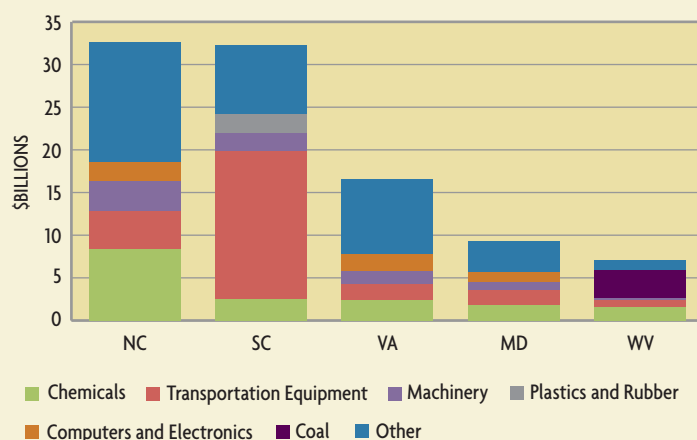
That said, some economists have recently noted that the costs of open trade may be larger and more persistent for affected industries and workers than previously thought. Traditional economic models have assumed that workers in harmed industries could easily transition to businesses that benefit from trade. But in a series of research papers, David Autor of the Massachusetts Institute of Technology, David Dorn of the University of Zurich, and Gordon Hanson of the University of California, San Diego found that this transition process may not work as smoothly as economists hypothesized.

Autor, Dorn, and Hanson found that China's entry into world markets beginning in the 1990s significantly hurt manufacturing workers in southern states, such as North Carolina, Tennessee, and Mississippi. Those regions experienced higher unemployment for a decade after the initial China trade shock, and some workers in impacted industries experienced lower annual earnings relative to workers in regions that were less exposed to trade with China.
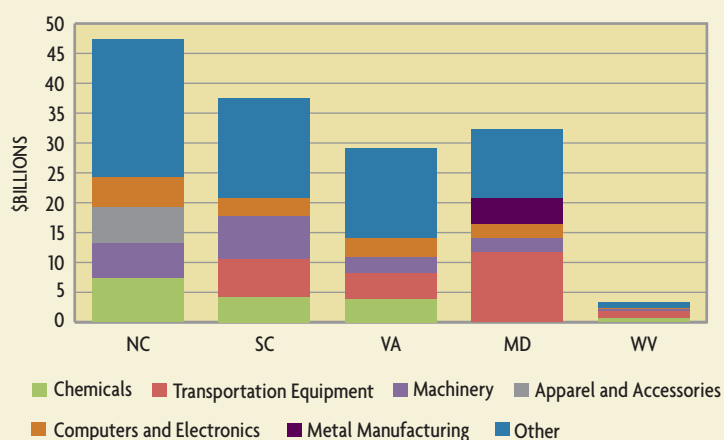
The Trump administration has also emphasized the costs of unrestricted trade. To impose tariffs on China, President Trump invoked the Trade Act of 1974, which empowers the president to take action in response to trade practices by foreign governments that either violate international agreements or are "unjustified" or "unreasonable." The Trump administration has alleged that China has used improper practices to obtain intellectual property from U.S. companies. President Trump has also voiced a desire to reduce the U.S. trade deficit, which he attributes to unfair practices on the part of U.S. trading partners. In imposing the steel and aluminum tariffs, the president cited national security concerns and the need to protect America's metal industry and its workers.

But tariffs entail costs as well. Tariffs imposed by the United States on other countries raise the cost of imports. They may also raise the price of the same goods produced domestically since U.S. producers face less competition from foreign producers subject to the tariffs. Tariffs imposed by other nations on the United States raise the costs domestic exporters face in those markets. What costs will recent tariffs impose on importers and exporters in the Fifth District?

What We Export (2017)

Legend: Chemicals, Transportation Equipment, Machinery, Plastics and Rubber, Computers and Electronics, Coal, Other

What We Import (2017)

Legend: Chemicals, Transportation Equipment, Machinery, Apparel and Accessories, Computers and Electronics, Metal Manufacturing, Other

SOURCE: U.S. Census Bureau

Fifth District Manufacturing
South Carolina is one of the biggest exporters in the Fifth District, shipping around $32 billion in goods in 2017, roughly 15 percent of the state's GDP. A significant portion of those exports came from South Carolina's growing manufacturing sector, specifically transportation manufacturing. South Carolina's largest category of exports is transportation equipment, which includes cars, car parts, airplanes, and airplane materials. BMW's plant in Spartanburg, S.C., employs 10,000 people and was the largest U.S. automobile exporter by value in 2017. Workers at Boeing's facility in North Charleston, S.C., assemble and ship the firm's new 787 Dreamliners. All told, transportation equipment accounted for more than half of the value of the state's exports in 2017. (See charts.)

Those industries stand to be directly hit by China's recently adopted tariffs. China was South Carolina's top trading partner for exports in 2017; in July, it raised its tariffs on U.S. vehicles to 40 percent, after previously pledging

to reduce its tariffs on all imported cars from 25 percent to 15 percent. All told, the U.S. Chamber of Commerce estimates that China's recent tariffs could affect $2.8 billion of South Carolina's exports. On the import side, U.S. steel and aluminum tariffs may squeeze auto and aerospace manufacturers in the state by increasing the cost of inputs. South Carolina's top two import commodities in 2017 were machinery and transportation equipment.

So far, however, the impact has been minimal, says Scott Baier of Clemson University. Baier has studied trade issues and spoken with local business owners about the effects of the recent tariffs. "Businesses are more concerned about things that may be coming down the road," he says.

In May, the Commerce Department initiated an investigation into imposing tariffs on imported automobiles and parts. Car tariffs have been a point of contention for trade negotiations with the EU, which imposes a 10 percent tariff on U.S. automobiles, compared to the 2.5 percent tariff the United States imposes on European cars. Raising car tariffs would certainly affect South Carolina's auto industry.

West Virginia's largest export is coal, which is on the list of products targeted by China's August tariffs. The state also exported $157 million in aluminum products in 2017. Domestically, metal manufacturers stand to benefit from the aluminum tariffs on foreign competitors, but exporters also face increased costs from retaliatory tariffs on metal. According to the U.S. Chamber of Commerce, West Virginia exports steel and aluminum products to Canada, Mexico, China, and the EU, all of which have imposed tariffs on metals in response to the U.S. tariffs. All told, the U.S. Chamber of Commerce estimates that foreign tariffs may affect $178 million in exports from West Virginia.

The steel and aluminum tariffs also matter for Maryland manufacturers. As a share of total imports, Maryland is the fourth-largest importer of steel and aluminum in the country, according to the Brookings Institution. The tariffs have already begun to impact the prices and supply chains of Maryland firms that rely on those inputs, according to a report from the state Chamber of Commerce. Additionally, the state imported about $11 billion worth of cars in 2017, which would be exposed to any future escalation of auto tariffs.

Farming in the District
Like its southern neighbor, North Carolina is also home to several aerospace manufacturers that exported nearly $3 billion in products and parts combined in 2017. But North Carolina's biggest exposure to tariffs so far is in the agricultural sector. The tariffs China imposed in July included a variety of U.S. agricultural exports, such as pork, soybeans, and tobacco. North Carolina is responsible for about one-tenth of all pork produced in the United States, making it the second-largest pork-producing state in the country.

Andy Curliss, CEO of the North Carolina Pork Council, says that pork exports to China have fallen since April, but producers have shifted some of those exports to South Korea. Mexico also imposed a 20 percent tariff on U.S. pork, which may further disrupt exports.

"It remains to be seen how this will all shake out economically," Curliss says.

Agriculture is also the sector of Virginia trade most directly impacted by the current tariffs. It exported nearly $600 million in soybeans in 2017, making it the state's leading agricultural export and third most valuable exported commodity overall. More than half of those soybeans went to China, making it the largest importer of Virginia's agricultural products. With so much of their sales tied to China, Virginia farmers are approaching the coming harvest season with concern.

"Already this year our exports of soybeans to China have decreased by 50 percent," says Stephanie Agee, director of marketing and development for the Virginia Department of Agriculture and Consumer Services.

In the short run, changes in prices for goods subject to tariffs, such as cars or soybeans, are likely to be the most visible effects of the tariffs. Global soybean prices fell to their lowest in years on the news of the Chinese tariffs, and car manufacturers such as BMW have stated that they will raise the price of cars exported to China to pass along the cost of the country's higher auto tariffs. But in the modern global economy, tariffs may disrupt more than just the prices of the goods they target.

Ripple Effects
Econ 101 students learn that trade allows countries to specialize in goods that they have a comparative advantage in producing. Each country can then trade with other nations for the goods they lack. This simplified model of trade imagines that all goods are wholly produced by domestic firms and then traded in their final form.

In reality, modern multinational firms divide their production processes across many countries based on their comparative advantages, and final goods may be assembled from parts that cross foreign borders many times. These global supply chains have been a big driver of world trade and economic growth. According to a June 2018 article in the *Journal of Economic Literature*, only a small subset of firms export or import, but these firms are larger and more productive than those that stick to purely domestic production. Moreover, the largest and most productive firms export and import a lot, accounting for a substantial share of aggregate trade volume.

"Because of the reliance on global supply chains and interfirm trade now, tariffs are more likely to be disruptive than in the past," says Clemson's Baier. He is hardly the only economist who thinks so. In a recent IGM Forum survey, 77 percent of responding economists agreed that import tariffs are likely to be "substantially more costly" than they would have been a quarter of a century ago because of the importance of global supply chains.

Complex global supply chains also mean that countries

targeted by tariffs are unlikely to be the only ones who feel pain. For example, Alonso de Gortari of Princeton University found in a 2017 paper that nearly 75 percent of the foreign inputs used in Mexican vehicles exported to the United States were produced in America. Using this information, de Gortari estimated that when Mexico exports cars to the United States, an average of 38 percent of the value from those cars is actually domestic production returning home. This share is much larger than economists previously thought. If supply chains for other goods follow a similar pattern, it suggests that tariffs on foreign imports may substantially harm domestic firms as well.

Mary Lovely of Syracuse University and Yang Liang of San Diego State University explored whether this might be true of the recent tariffs in a May 2018 article for the Peterson Institute for International Economics. They found that many of the goods targeted by U.S. tariffs on China are produced by multinational firms operating in China rather than domestic Chinese companies. Moreover, many of these products are purchased by American firms as inputs into production processes here at home. Raising the cost of those inputs through tariffs would likely harm American production. In theory, firms can rearrange their supply chains to avoid the added costs of tariffs, perhaps choosing to obtain more inputs from American producers. But this may not be so straightforward in practice.

"It's costly for firms to change their supply chain," says Gary Hufbauer, a nonresident senior fellow at the Peterson Institute for International Economics. "A lot of their supplies have gone through a lengthy regulatory approval process, and it's not easy for firms to find an alternative supplier who meets the same level of quality and specifications."

For example, in late July the EU agreed to buy more U.S. soybeans, which could partially make up for lost sales to China. But Agee of the Virginia Department of Agriculture and Consumer Services says that Europe has different standards for agricultural products than China, which may limit the ability of farmers to shift products originally grown for the Chinese market to Europe unless those differences are addressed.

Firms also face uncertainty about whether to seek new suppliers for imports and new markets for exports or whether to ride out the higher cost of tariffs in the hope that they prove to be temporary.

Uncertain Future

In the July 2018 Fed Beige Book, which summarizes business conditions in each of the 12 Federal Reserve districts, all Reserve Banks reported that businesses were feeling direct effects or facing some uncertainty related to changes in trade policy — compared to three a year ago. Should firms decide to act and seek new suppliers or new exports markets because of tariffs, those decisions could easily outlast the policies that prompted them.

"If China establishes other sources for soybeans that can meet their needs, why would they come back to the United States?" says Agee.

In the simple case, trade disagreements could merely reshuffle trading partners for a while. In the extreme case, an escalating trade war between many countries could call the whole global supply chain model into question.

"We haven't seen very large global tariffs since the 1930s," says Hufbauer. "If that happens, that's going to give a lot of multinational firms pause as they try to figure out where the world economy is headed and how they fit into it. It would be a real shakeup to the order we know."

So far, most firms appear to be taking a wait-and-see approach. Only about 20 percent of national businesses responding to a recent survey by the Atlanta Fed said they were reassessing their capital expenditure plans as a result of the tariffs. The share was slightly higher for manufacturers — about 30 percent — but the authors of the study note that "tariff worries have had only a small negative effect on U.S. business investments to date."

And while most businesses have focused on the potential downside from the tariffs, others have highlighted the potential upside. In a June 2018 survey, the Richmond Fed asked businesses in the Fifth District what they thought the effect of the steel and aluminum tariffs would be on the overall economy. About half of the respondents expected the effect would be negative, but more than a quarter of business owners thought the tariffs could ultimately be positive if they improved domestic production or led to better trade deals in the future.

"There is the promise of more talks with Europe aimed at achieving zero industrial tariffs," says Hufbauer. "If that happens, that would be a big payoff. But right now it is just a promise to talk, not a promise to act." **EF**

Readings

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PRODUCERS UNDER PRESSURE?

What role do producers' costs play in determining inflation?

By Jessie Romero

Between June 2017 and June 2018, trucking transportation costs in the United States increased 7.7 percent. Steel, aluminum, and copper were all up more than 10 percent. Wheat prices climbed more than 20 percent, and food processors paid 13 percent more for chickens. Yet in many cases, rising costs for businesses were not reflected in the prices paid by consumers. Finished appliances were up only 1.1 percent over the same period; food prices increased just 1.4 percent. Companies including Sysco, Procter & Gamble, and Unilever all have reported difficulty raising prices in the U.S. market.

How long will that last? Overall, the prices producers pay for inputs, as measured by components of the Bureau of Labor Statistics' Producer Price Index (PPI), have been outpacing consumer prices for more than a year (see chart

below), which had led some observers to predict that more rapid inflation is imminent. But while the PPI does paint a picture of the costs facing various industries, it isn't necessarily a good predictor of consumer measures of inflation, such as the Consumer Price Index (CPI). In part, that's because the indexes are designed to measure different things; in part, it reflects that firms make pricing decisions based on many factors in addition to input prices. And even to the extent the PPI does help predict consumer price changes in the short run, in the long run, the overall level of prices depends on monetary policy.

Piecing Together the PPI

To calculate the PPI, the Bureau of Labor Statistics (BLS) surveys a sample of firms about the revenue they receive on more than 10,000 goods and services, from rivets to refrigerators to radio advertising. The BLS then aggregates that information into two main categories: final demand and intermediate demand. Final demand is the revenue domestic producers receive for the goods and services they sell to consumers, to the government, to businesses for capital investment, and for export — in other words, for goods and services that are not used as inputs to create other domestic products. Intermediate demand is the revenue domestic producers receive for goods and services that are sold as inputs into other domestic products. When a retailer sells a refrigerator to a homeowner, the retailer's revenue is counted in final demand; when the manufacturer sold the refrigerator to the retailer, the manufacturer's revenue was counted in intermediate demand, as was the revenue received by the companies that supplied the manufacturer.

The BLS has two different systems for categorizing intermediate demand. In the "commodity type" system, the BLS calculates separate indexes for processed goods, such as tires or cement; unprocessed goods, such as crude

Ups and Downs

Swings in the PPI don't necessarily translate into changes in the CPI

PERCENT CHANGE FROM A YEAR AGO

— CPI   — PPI: Processed Goods   — PPI: Unprocessed Goods   — PPI: Services
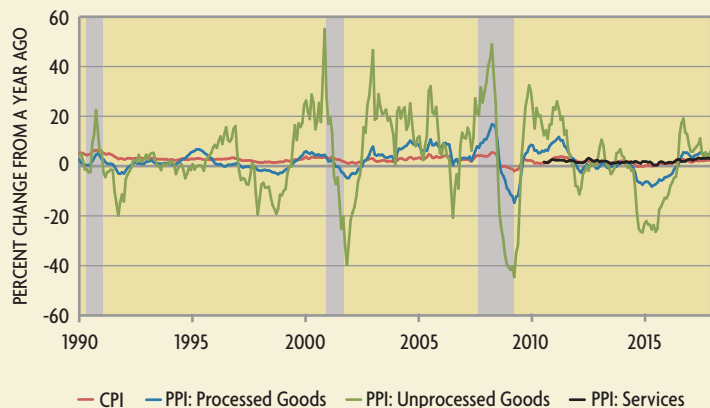
NOTE: Data on Services for Intermediate Demand are available beginning in 2010. Shaded areas denote recessions.

SOURCE: Bureau of Labor Statistics via Federal Reserve Economic Data (FRED)

petroleum or gravel; and services, such as warehousing or financial services. In the "production flow" system, the BLS calculates indexes for goods and services in four stages. Stage 1 goods are the first in the process; stage 4 goods are finished products and are sold to final demand.

Because the PPI for final demand includes goods and services sold for personal consumption, there is a high degree of overlap between items covered by that portion of the PPI for final demand and its more famous sibling, the CPI — the refrigerator sold in the above example would be included in both. But, as the names suggest, the fundamental difference between the two indexes is that the PPI measures prices from the producer's perspective while the CPI measures prices from the consumer's perspective. This leads to a number of differences in the ways data are collected. For example, the PPI does not include sales and excise taxes since these are not revenues that accrue to a producer, but taxes are included in the CPI since they're part of what a consumer pays.
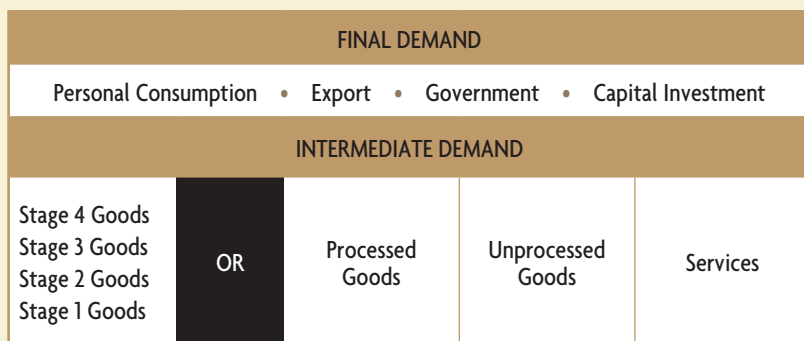
Another difference between the two indexes is that the CPI includes only the health care costs consumers pay themselves, while the PPI also includes health care paid for by a third party, such as an insurance company or the government. The PPI also includes the interest rate component of financial services, so changing rates change the index; interest rates don't directly affect the CPI. In addition, owners' equivalent rent — the amount homeowners would have to pay to rent rather than own their homes — is not included in the PPI, but it makes up about one-quarter of the CPI. An additional significant difference is that the PPI, by definition, does not cover imports since they are not domestically produced.

From Producers to Consumers
Do changes in the PPI predict changes in the CPI? "This is not an uncommon take on the PPI," says Todd Clark,

a senior vice president at the Cleveland Fed. "And it's not a crazy idea since one of the things the PPI measures is input prices. But the linkage isn't actually that strong."

Clark first studied the relationship between the PPI and the CPI in a 1995 article. He found that, historically, changes in the PPI had to some extent preceded changes in the CPI, but he also found that the PPI was of little value in forecasting future values of the CPI, which suggested that the producer price changes weren't necessarily driving the consumer price changes.

Clark's research preceded major changes the BLS made to its aggregation system in 2014, but more recent research also suggests that changes in input prices are not a good predictor of future inflation. In a 2018 article, Mark Bognanni and Tristan Young, also with the Cleveland Fed, studied the predictive power of the ISM Manufacturing Price Index, another measure of input prices; it did help to improve forecasts of the PPI, but that did not translate into improving forecasts of changes in the index of Personal Consumption Expenditures, or PCE (the consumer inflation measure generally used by the Federal Open Market Committee).

Eyeballing the data also suggests that changes in the PPI for intermediate demand don't have much of relationship to future values of the CPI; this is especially true for unprocessed goods. (See charts.)

An "Org Chart" for the Producer Price Index
The Bureau of Labor Statistics aggregates PPI data into multiple categories

FINAL DEMAND			
Personal Consumption • Export • Government • Capital Investment			

INTERMEDIATE DEMAND				
Stage 4 Goods Stage 3 Goods Stage 2 Goods Stage 1 Goods	OR	Processed Goods	Unprocessed Goods	Services

Scattered
The CPI doesn't have a strong relationship with previous values of the PPI
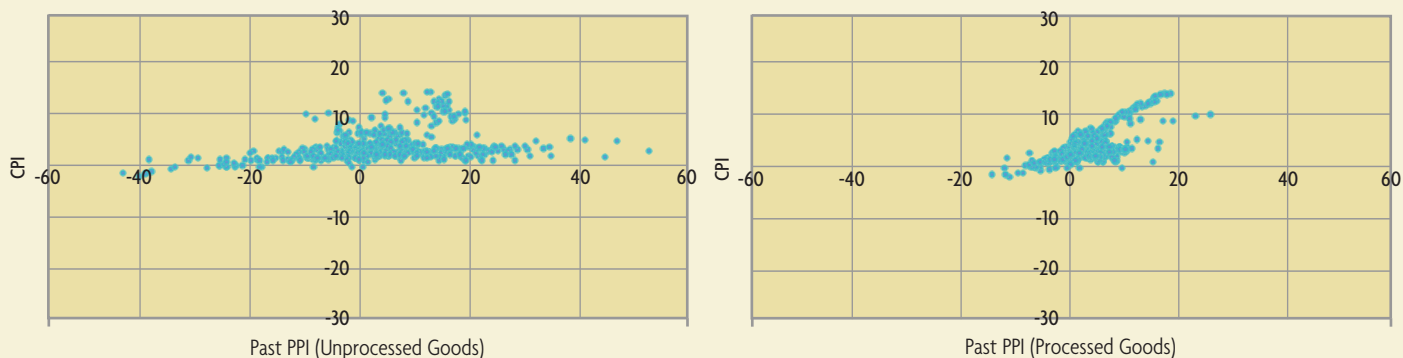
NOTE: The figures plot the CPI against the PPI for Intermediate Demand two quarters previously. Both series present percent changes from a year ago. Data are for 1975-2018.

SOURCE: Bureau of Labor Statistics via Federal Reserve Economic Data (FRED)

In a 2016 article, Jonathan Weinhagen, an economist at the BLS, found that price increases in earlier stages of intermediate demand did help predict price increases at later stages in the PPI. So why isn't there a stronger relationship between the CPI and the PPI? One reason might be that both measures are averages across a large number of different industries. There are some industries in which higher input prices do translate directly into higher consumer prices, but these "pass through" effects could be masked when they're averaged with industries with different cost structures. For example, increases in food-related PPIs tend to lead to increases in the CPI for food purchased in grocery stores but not for food purchased at restaurants, where service and preparation are a large part of the value.

The relationship, or lack thereof, between the PPI and CPI also reflects the measurement differences. For example, the exclusion of imports, which account for about 15 percent of GDP, means that the PPI doesn't reflect any cost savings producers achieve from buying intermediate inputs overseas. Nor does it reflect cost increases if imports become more expensive, for example because of tariffs. (See "Tariffs and Trade Disputes," page 10.)

In addition, growing global trade in intermediate inputs means that the baskets of goods measured in the CPI and the PPI have less and less in common over time. In a recent working paper, Shang-Jin Wei and Yinxi Xie of Columbia University documented a growing divergence between producer price indexes and consumer price indexes in most industrialized countries, including the United States, beginning around 2001. They attributed this divergence to the increasingly global nature of many companies' supply chains.

Making the Markup

While there is some evidence that producers pass on cost increases, intermediate input costs are just one factor in a firm's pricing decisions. A firm also has to consider labor and capital costs and the competitive landscape, all of which affect how much a firm marks up the prices of its goods over intermediate input costs. "If all these conditions were static, then yes, one might expect to see a consistent and stable relationship between the prices of materials inputs and the prices of finished goods," says Alex Wolman, vice president for monetary and macroeconomic research at the Richmond Fed. "But of course, these conditions aren't static."

One of the most important considerations is the customer. While it won't come as a huge surprise to most shoppers, a large body of research has demonstrated that different firms charge different prices for essentially the same goods, and that the same firm may charge different prices at different times. Nicholas Trachter of the Richmond Fed, with collaborators elsewhere, has shown how this price dispersion can arise based on the variation in consumers' abilities and willingness to shop around, and how stores employ pricing strategies in response. The more costly it is for a consumer to search for a different seller, either because other sellers are hard to find or because the consumer is unwilling to spend much time searching, the higher the price a given firm can charge.

In this respect, the Internet might be one factor making it more difficult for producers to raise prices, both by making it easier for customers to shop around and by making it easier for new companies to set up shop. Procter & Gamble, for example, announced last year it was cutting prices on its Gillette razors by up to 20 percent in response to competition from online retailers. Fed Chairman Jerome Powell attributed low inflation in part to the "Amazon effect" in his semiannual testimony before the Senate Banking Committee in March. (The Internet isn't the first technology to affect prices; see "The Great Telegraph Breakthrough of 1866," page 28.)

Another factor potentially limiting firms' abilities to pass on cost increases is the concentration of the retail sector: In 2017, the five largest retailers in the United States accounted for 36 percent of the 100 largest retailers' total U.S. sales. And when retailers get large enough, they may be able to exercise what's known as monopsony power, where they are effectively the only buyer and can dictate terms and prices to their suppliers.

Many manufacturers have reported being forced to sell their products at lower prices lest they lose their place on a store's shelves. Some companies might even get large enough for this to affect the economy as a whole. In the early 2000s, for example, Jerry Hausman of the Massachusetts Institute of Technology estimated that Walmart and its ilk had lowered annual food price inflation by three-quarters of a percentage point.

Retail isn't the only sector that's highly concentrated; concentration has been increasing across all public firms since the late 1990s. (See "Are Markets Too Concentrated?" *Econ Focus*, First Quarter 2018.) Intuitively, one would expect greater market concentration to enable firms to raise prices, but economists studying market power have come to conflicting conclusions about the extent to which markups have increased economy-wide. One way that increasing market concentration could coexist with low prices is if the firms that have grown large are also the firms that have built their strategy around low prices — and thus exert their influence over their suppliers rather than their customers.

In the Long Run

Another reason producers might not be willing or able to pass on higher input costs could be the virtuous circle of inflation expectations. Economists have found that one of the most important determinants of future inflation is what people expect inflation to be. So if firms believe the central bank is committed to keeping inflation low and

stable, they won't try to raise prices beyond that rate — which, in turn, contributes to keeping inflation low and stable. (See "Great Expectations," page 40.) Most measures of inflation expectations have ticked up in recent months, but they remain relatively low and well-aligned with the Fed's 2 percent target for the inflation rate.

Even if firms in sectors with rising input costs were to pass on those costs to consumers, it wouldn't necessarily lead to inflation in the sense that monetary policymakers use the word, to mean a persistent increase in prices across the entire economy. In the short run, changing supply and demand conditions might lead to higher prices for certain goods and services. But in the long run, under this definition, inflation is determined by monetary policy, and those supply and demand conditions affect only relative prices of the particular goods and services. "If apples get more expensive relative to oranges, that's not inflation," says Clark. "Inflation is when prices increase for both apples and oranges — and everything else."

The relationship between the PPI and CPI illustrates the complex interactions between costs and competition that influence firms' pricing decisions. And while the PPI might not be a perfect harbinger of what's to come, it's still a valuable indicator for policymakers. "It's one of many tools we can use to assess the overall state of the economy and where we are in the business cycle," Clark says. "It's useful even if it's not predictive of the inflation measure we've chosen to target."   **EF**

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IS CASH STILL KING?

Despite new technologies for electronic
payments, cash has never been more popular.
What's driving the demand?

By Tim Sablik

In Sweden, signs declaring "no cash accepted" or "cash free" are becoming commonplace. In 2018, more than half of households surveyed by the Riksbank (Sweden's central bank) reported having encountered a business that refused to accept cash, compared with just 30 percent four years earlier. Many banks in Sweden no longer accept cash at the counter. Customers can still rely on ATMs for their cash needs, but those are becoming increasingly scarce as well, falling from 3,416 in 2012 to 2,850 in 2016.

In part, the country's banks and businesses are responding to changing consumer preferences. Use of debit cards and Swish, Sweden's real-time electronic payment system that launched in 2012, has surged in recent years while cash usage has steadily declined. Swedish law allows businesses to refuse to accept cash, and many firms have championed noncash payments as cheaper and safer than cash. (Thieves have also responded to Sweden's shift toward a cashless society. According to a recent article in *The Atlantic*, the country had only two bank robberies in 2016 compared with more than 100 in 2008.)

Given the spread of payment innovations around the world, one might expect that many other countries are following Sweden's example. But when it comes to cash, Sweden is an outlier. In a 2017 paper, Clemens Jobst and Helmut Stix of Austria's central bank measured currency demand for the United States and a handful of other countries going back to 1875. They found that while currency in circulation as a share of GDP has fallen over the last 150 years, that decline has not been very large given the evolution in payment technologies over the same period. Moreover, starting in the 1980s, currency demand in the United States actually began rising again.

Over the last decade, dollars in circulation as a share of GDP have nearly doubled from 5 percent to 9 percent. Today there is $1.6 trillion in cash in circulation, or roughly $4,800 for every person in the United States. And the United States is hardly unique; cash in circulation has surged in recent years in much of the world despite the spread of new ways to pay.

As the number of dollars in circulation continues to swell, it raises an important question: What is driving the demand for cash? While monetary

authorities that issue currency, such as the Fed, have good data on how much currency is out there, determining what happens to cash once it's in the wild presents a much bigger challenge.

Medium of Exchange

One way to understand the demand for cash is to study how people pay. Cash has a long history of facilitating exchange going back to the coins minted from precious metals and used by ancient civilizations. And despite the availability of new electronic payment options today, cash remains popular with consumers. According to the Survey of Consumer Payment Choice conducted by the Federal Reserve System, consumers used cash in 27 percent of transactions in a typical month in 2017, making cash the second most popular payment option after debit cards. That share has held fairly constant since 2008 when the survey began.

The Diary of Consumer Payment Choice, also published by the Fed, provides a more detailed snapshot of how consumers use cash. Participants are asked to record information about every payment they make over a three-day period. According to the latest data from the 2016 Diary, consumers frequently relied on cash for low-value purchases. Cash was used for more than half of all in-person purchases costing less than $10. In contrast, consumers used it in only 8 percent of purchases over $100.

"Consumers rate cash highly for being low cost and easy to use," says Claire Greene, a payments risk expert at the Atlanta Fed who works on the Survey and the Diary. "At the same time, there are other characteristics where cash rates poorly. It's dead last for record-keeping and rates poorly in terms of security." While consumers are protected from fraudulent charges to their debit or credit cards, cash comes with no such protection; once it's lost or stolen, it's gone. This may explain why most consumers are hesitant to carry enough cash for large purchases but are happy to use it for small ones.

The data also indicate that cash is an important payment option for low-income households. According to the 2016 Diary study, households that earned less than $25,000 a year used cash for 43 percent of their payments. Lower-income households are less likely to have access to some payment methods such as credit cards, making cash an attractive option. Indeed, a 2016 article by Zhu Wang and Alexander Wolman of the Richmond Fed illustrated the importance of cash for this demographic. Wang and Wolman studied billions of transactions from a national discount retail chain that primarily serves low-income households. They found that while the share of cash transactions declined from 2010-2013, cash was still used in more than 70 percent of purchases at the stores.

These data indicate that cash remains an important medium of exchange in the modern economy, but they don't explain the growing volume of dollars in circulation. Since consumers mostly use cash for small-dollar purchases, they typically don't carry much cash on them. The

Currency Demand Driven by $100s
U.S. currency in circulation continues to grow despite new payment options
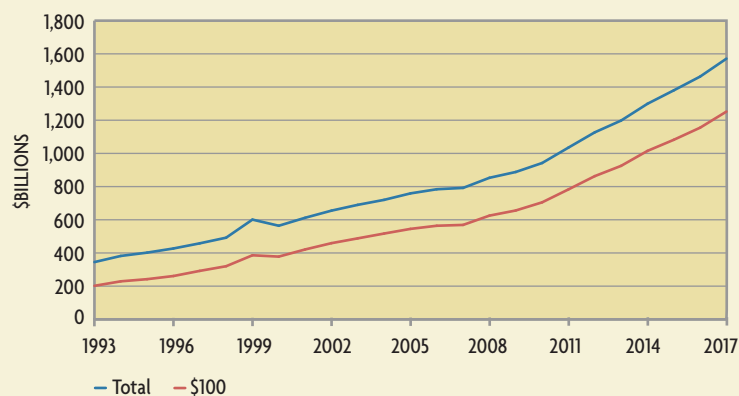
SOURCE: Federal Reserve Board of Governors

$100s Recently Surpassed $1s
Volume of U.S. Notes in Circulation by Denomination
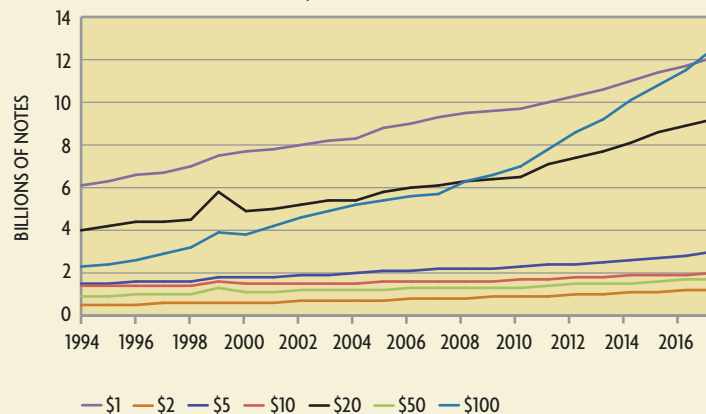
SOURCE: Federal Reserve Board of Governors

respondents to the 2016 survey had an average of $219 in cash on their person or property. That still falls short of the $4,800 per capita of U.S. currency in circulation. Who holds the bulk of that money, and how is it being used?

Flight to Safety

In addition to being used for exchange, cash also acts as a store of value. High-denomination notes are best suited for this purpose, so tracking their circulation can provide a sense of how important this aspect of cash is for explaining currency demand.

In the United States, large-denomination notes seem to be driving the growth in cash. The $100 bill accounts for most of the total value of currency in circulation. (See chart.) Demand for $100 bills has significantly outpaced other denominations in terms of pure volume as well, averaging an annual growth rate in notes of nearly 8 percent since 1995 compared with 3 percent to 4 percent for most other notes. In fact, in 2017, the $100 bill surpassed the $1 bill as the most widely circulated U.S. note. (See chart.)

While some of this demand may come from domestic savers, researchers believe a significant share of $100 bills are traveling overseas. Ruth Judson, an economist at the Fed Board of Governors, has spent years attempting to estimate how much currency is outside the United States using available data on cross-border currency flows and comparisons to similar economies whose currencies are not as widely used abroad.

"We think that the significance of foreign demand is unique to the dollar," says Judson. "Other currencies are also used outside their home countries, but as far as we can tell, the dollar has the largest share of notes held outside the country."

One way to measure the importance of foreign demand for the dollar is to compare currency circulation in Canada and the United States. Both have similar payment technologies and are close to each other in geography and economics, but the Canadian dollar is not as widely used in other countries. In 2017, Canadian dollars in circulation were equivalent to 4 percent of the country's GDP, or less than half of the U.S. share. Using this as a starting point, Judson estimated in a 2017 paper that as much as 70 percent of U.S. dollars are held abroad. Additionally, Judson estimated that as much as 60 percent of all Benjamins are held by foreigners.

"Overseas demand for U.S. dollars is likely driven by its status as a safe asset," says Judson. "Cash demand, especially from other countries, increases in times of political and financial crisis."

Some countries, such as Ecuador and Zimbabwe, have adopted the dollar as their primary currency in response to economic crises or pressures on their own currencies. And U.S. Treasuries as well as dollars remain safe-haven assets in times of global distress, like the financial crisis of 2007-2008. For example, Judson found that while international demand for dollars began to decline in 2002 after the introduction of the euro, that trend reversed after the 2007-2008 crisis.

Crises prompt domestic households to seek the safety of currency as well. In their 2017 paper, Jobst and Stix found that even countries without strong international demand for their currency experienced increased cash demand after 2008. Their analysis suggests that heightened uncertainty following the global financial crisis may explain some of the widespread currency growth over the last decade.

Another factor that may be contributing to the recent growth in cash demand is the historically low cost of holding it. Inflation creates a disincentive to hold cash since it erodes its value over time. But over the last decade, the United States and much of the rest of the world have experienced very low inflation and interest rates. Japan has experienced low inflation and near-zero interest rates for decades, which may partly explain why its ratio of currency in circulation relative to its GDP is nearly 19 percent, the highest among developed economies.

But even the best estimates of dollars held abroad or in domestic safes or under mattresses still leave a significant amount of cash unaccounted for. Some researchers argue that there is another source for the growing demand for high-denomination notes: the underground economy.

The Costs of Cash

"A key thing about cash is that it's anonymous and hard to trace," says Kenneth Rogoff of Harvard University. In his 2016 book *The Curse of Cash*, he argued this makes cash the ideal medium of exchange for consumers who value privacy, both for legitimate and illegitimate reasons. "There's a lot of evidence that cash plays a big role in tax evasion and crime," says Rogoff.

Even setting aside the U.S. dollars circulating overseas, Rogoff estimates that cash used in the domestic economy to hide otherwise legal transactions from tax authorities plays a significant role in roughly $500 billion in lost federal revenues annually. Cash is also used in illegal businesses like drug trade, human trafficking, and terrorism.

In addition, high-denomination notes are targets for counterfeiting, requiring monetary authorities to develop new security features to stay ahead of counterfeiters. Although authorities estimate that the volume of counterfeit dollars in circulation today is small, it has been a costly problem for the United States in the past. (See "The Counterfeiting Weapon," *Region Focus*, First Quarter 2012.) And staying on top of new counterfeiting threats to ensure today's cash is genuine is not without cost.

The availability of large-denomination notes may also impose costs on monetary policymakers, Rogoff argues. During the Great Recession, the Fed lowered its interest rate target to near zero, but some economists argued it should have gone even lower. Cash poses a potential problem for maintaining negative interest rates, however, because households and businesses can choose to hold cash instead of assets that bear a negative rate of interest. (See "Subzero Interest," *Econ Focus*, First Quarter 2016.) Of course, there is some cost to holding large sums of cash, which means that in practice central banks could reduce rates into slightly negative territory, as the European Central Bank has done with its deposit rate. Importantly, as Rogoff shows in his book, it is possible to use taxes and subsidies on deposits of cash at the central bank to create significant space for negative rates without otherwise changing anything about cash. But the availability of cash, especially large-denomination notes, nevertheless imposes some floor on how low interest rates can go.

Despite these costs, Rogoff doesn't advocate for completely eliminating physical cash, at least not anytime in the foreseeable future.

"It's really about regulating it better," he says. One option to regulate cash would be to track it better at the point of sale, using modern scanners to record serial numbers, for example. This would make cash less anonymous,

which Rogoff argues would largely eliminate much of the demand for it.

"If there is no way for criminals to launder cash back into the system, the demand for cash for tax evasion and illegal transactions will drop," he says.

Another way to potentially reduce some of the costs associated with cash would be to eliminate higher-denomination notes. As data from the Fed Survey and Diary studies suggest, cash in the legal economy is mainly used for small-value purchases, which would be unaffected by the elimination of large notes. On the other hand, underground economic activity is more reliant on the portability of large-denomination notes. Eliminating large-denomination notes would also increase the cost of holding cash to avoid negative interest rates, perhaps loosening the lower-bound constraint on monetary policymakers.

"For most people, it would be good to still have cash for small transactions," says Rogoff. "But that's not an argument for keeping $100 bills, many of which are concentrated in the wrong hands."

Indeed, some regions have already moved to eliminate high-denomination currency. The eurozone ended production of the 500 euro note in 2016, citing concerns that it was being used to "facilitate illicit activities."

Some have speculated that these steps could be taken even further, by replacing cash with new digital alternatives.

Cash 2.0?
Can new technology provide the benefits of cash without the costs? With the advent of cryptocurrencies like Bitcoin, it's a question more researchers have been asking. In light of the decline in cash use in Sweden, the Riksbank has begun investigating the possibility of issuing an electronic currency. A recent paper from the Bank for International Settlements argued that issuing digital currency could provide new monetary policy options for central banks, but it would also raise new questions about the central bank's role in providing payment and banking services to the public.

The Fed has stated it has no plans to issue a digital currency, and in a forthcoming paper with Charles Kahn of the University of Illinois at Urbana-Champaign and Francisco Rivadeneyra of the Bank of Canada, Richmond Fed economist Tsz-Nga Wong argued that the central bank wouldn't have much comparative advantage in issuing one anyway. Electronic money requires different safeguards from cash to ensure that each transaction is properly authorized and that payers are not attempting to spend the same digital dollar twice. Decentralized networks, such as Bitcoin, solve this problem by recording all transactions on a public ledger and relying on other users to verify transactions. This verification process is slow and energy inefficient — but moving the public ledger to the central bank's ledger wouldn't make much difference.

Another solution is to rely on trusted intermediaries to manage user accounts and verify transactions. This system already exists in the private financial sector. Whenever individuals make electronic payments using the ACH network or a credit or debit card, financial intermediaries verify the transaction and manage the transfer of funds from payer to payee. In order to implement the same account-based verification system for central bank-issued digital currency, individuals would need to open accounts with the central bank. Today, the Fed needs to settle only a relatively small number of transactions between banks each day after banks have aggregated their own transactions. It would be much costlier for the Fed to directly manage a significantly larger number of frequently used retail accounts for every consumer in the country, a problem the private financial system has already solved. Replacing bank accounts with central bank electronic currency would also destroy the social value created by the private financial system, which reallocates balances in checking accounts and deposits to business loan and investment.

Physical cash also offers some advantages over digital currency. It is not susceptible to theft or disruption from cyberattacks, and it offers users anonymity that account-based digital money lacks. While this anonymity facilitates illegal transactions, as Rogoff argues, it also grants law-abiding consumers a measure of privacy. Overall, taking cash digital would not be a simple swap.

"I definitely don't favor getting rid of cash anytime soon," says Rogoff. "In the end, it's a cost-benefit analysis, and the benefits of cash are not zero." **EF**

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Chad Syverson

Editor's Note: *This is an abbreviated version of EF's conversation with Chad Syverson. For additional content, go to our website: www.richmondfed.org/publications*

Productivity growth drives economic growth, and for about the last 15 years, the United States and much of the world has experienced a significant productivity slowdown. The causes remain a puzzle to economists, and the predictions about when — or if — the United States will emerge from this slowdown vary widely.

Chad Syverson, an economist at the University of Chicago's Booth School of Business, has spent much of his career researching issues related to productivity at both the macro and micro levels. His research has shed light on why some firms are significantly more productive than others within the same industry, a long-standing question among economists working in the field of industrial organization. His work has also helped us better understand the process of learning by doing, why some firms have vertical ownership structures (and why those might not be very different from horizontal ownership structures), and the value of carefully done industry case studies. He recently has started researching the economics of artificial intelligence and what future developments in that area may mean for productivity growth.

Syverson joined the University of Chicago faculty in 2001, initially in the Department of Economics. In 2008, he moved to the university's Booth School of Business. He is currently an editor of the *RAND Journal of Economics* and was formerly an editor of the *Journal of Industrial Economics*. In addition to publishing prolifically in top professional journals, he is also the co-author of a microeconomics textbook with his colleagues Austan Goolsbee and Steven Levitt. Syverson earned undergraduate degrees in both economics and mechanical engineering and attributes his interest in productivity and firm dynamics to his engineering background.

Aaron Steelman interviewed Syverson in his office on the University of Chicago campus in June 2018.

EF: Some have argued that the productivity slowdown since the mid-2000s is due to mismeasurement issues — that some productivity growth hasn't been or isn't being captured. What does your work tell us about that?

Syverson: It tells us that the mismeasurement story, while plausible on its face, falls apart when examined. If productivity growth had actually been 1.5 percent greater than it has been measured since the mid-2000s, U.S. gross domestic product (GDP) would be conservatively $4 trillion higher than it is, or about $12,000 more per capita. So if you go with the mismeasurement story, that's the sort of number you're talking about and there are several reasons to believe you can't account for it.

First, the productivity slowdown has happened all over world. When you look at the 30 Organization for Economic Co-operation and Development countries we have data for, there's no relationship between the size of the measured slowdown and how important IT-related goods — which most people think are the primary source of mismeasurement — are to a country's economy.

Second, people have tried to measure the value of IT-related goods. The largest estimate is about $900 billion in the United States. That doesn't get you even a quarter of the way toward that $4 trillion.

Third, the value added of the IT-related sector has grown by about $750 billion, adjusting for inflation, since

the mid-2000s. The mismeasurement hypothesis says that there are $4 trillion missing on top of that. So the question is: Do we think we're only getting $1 out of every $6 of activity there? That's a lot of mismeasurement.

Finally, there's the difference between gross domestic income (GDI) and GDP. GDI has been higher than GDP on average since the slowdown started, which would suggest that there's income, about $1 trillion cumulatively, that is not showing up in expenditures. But the problem is that was also true before the slowdown started. GDI was higher than GDP from 1998 through 2004, a period of relatively high-productivity growth. Moreover, the growth in income is coming from capital income, not wage income. That doesn't comport with the story some people are trying to tell, which is that companies are making stuff, they're paying their workers to produce it, but then they're effectively giving it away for free instead of selling it. But we know that they're actually making profits. We might not pay directly for a lot of IT services every time we use them, but we are paying for them indirectly.

As sensible as the mismeasurement hypothesis might sound on its face, when you add up everything, it just doesn't pass the stricter test you would want it to survive.

EF: What might we learn from past examples of the diffusion process of general-purpose technologies, such as electricity, when considering future productivity trends?

Syverson: I think there are a couple of lessons. One is that it is not unusual at all to have an extended period — and by extended, I mean measured in decades — of slow productivity growth, even after a major technology has been commercialized and a lot of its potential has been recognized. You saw that with the internal combustion engine, electrification, and early computers. There was about a quarter-century of pretty slow productivity growth before you saw the first acceleration in productivity coming from those technologies.

The second part is that you don't necessarily have just one acceleration and then it's over. There were multiple accelerations from electrification separated by a decade. To me, that says that just because we've had one IT-related acceleration, that doesn't necessarily mean it's over. We can have a second wave. Technologies don't just have to come, give what they have to give, and then go away. You can get multiple waves.

Why that would happen is tied to some of the complementarity stories where the first set of gains is driven by direct replacement of the old technology with the new technology. The second wave comes when people recognize there are completely different ways of doing

> We are going out on a limb a little bit by saying this, but we think artificial intelligence checks the boxes for a general-purpose technology. And it seems that with some fairly modest applications of AI, the productivity slowdown goes away.

things that the new technology made possible. So it's not that you are simply swapping the old widget for a better one. You are actually doing completely different things now that you have the new technology. This is related to Paul David's widely cited work on how the electric motor didn't just directly replace the steam engine. It eventually led to a complete change in the way factories were designed once people realized you could put a little motor on every single machine. The work didn't have to be stacked on many floors around the single power source any more.

EF: Would you consider artificial intelligence (AI) a general-purpose technology? If so, how do you assess the view that the returns on investment in AI have been disappointing?

Syverson: It's way too early. There are two things creating this lag for AI. First, aggregate AI capital right now is essentially zero. This stuff is really just starting to be used in production. A lot of it is simply experimental at this point. Second, a lot of it has to do with complementarity. People have to figure out what sorts of things AI can augment, and we're not anywhere down that road yet.

Erik Brynjolfsson, Daniel Rock, and I are going out on a limb a little bit by saying this, but we think AI checks the boxes for a general-purpose technology. And it seems that with some fairly modest applications of AI, the productivity slowdown goes away. Two applications that we look at in our paper are autonomous vehicles and call centers.

About 3.5 million people in the United States make their living as motor vehicle operators. We think maybe 2 million of those could be replaced by autonomous vehicles. There are 122 million people in private employment now, so just a quick calculation says that's an additional boost of 1.7 percent in labor productivity. But that's not going to happen overnight. If it happens over a decade, that's 0.17 percent per year.

About 2 million people work in call centers. Plausibly, 60 percent of those jobs could be replaced by AI. So when you do the same kind of calculation, that's an additional 1 percent increase in labor productivity; spread out over a decade, it's 0.1 percent per year. So, from those two applications alone, that's about a quarter of a percent annual acceleration for a decade. So you only need maybe six to eight more applications of that size and the slowdown is gone.

EF: Many explanations have been offered about why we observe very large productivity differences among firms in the same industry. As the use of micro-productivity data has grown, do you think economists have been converging on a consensus?

Syverson: An important fact is that the skewness of everything is increasing within industries. Size skewness, or concentration, is going up. Productivity skewness is going up. And earnings skewness is going up. To describe why our earnings are stretching out like this, why there is a bigger gap between the right tail and the median, I think you have to understand the phenomenon of increasing skewness in productivity and size. Is that technological? Is it policy? Is it a little bit of both? I don't think we really know the answer.

That said, I think it's less of a mystery now than it was when I started working on this many years ago back in graduate school. At that time, people would tell stories about maybe it's this, maybe it's that, maybe it's everything. There was a lot of speculation and not a lot of evidence. Since that time, I think the profession has been really good at systematically going after an answer.

The biggest change is the amount of work that has been done on management practice. There's still much more work to do, but increasing productivity dispersion seems related at least in part to management practices. Nick Bloom and John Van Reenen deserve a lot of credit for collecting systematic evidence on management practices in their World Management Survey program. The program has gathered information on tens of thousands of firms now. They and their co-authors have also been able to put supplemental management practice questions on the Census Bureau's annual survey of manufacturers.

So we have a lot more systematic data on that now, and there's no doubt productivity is correlated with certain kinds of management practices. People have also developed more causal evidence. There have actually been some randomized controlled trials where people intervened in management practices and saw productivity effects.

Is that all of the story? No, I don't think so. If I had to guess, it's probably 15 to 25 percent of the story. There's a lot more going on. I think part of it has to do with firm structure. I have done work on that.

I think we have gotten better at measuring quality differences in labor and a little bit better at measuring quality differences in capital, though I think capital mismeasurement is still the biggest issue with measuring productivity on the input side. A lot of work has also been done on the way we measure productivity on the demand side. We

Chad Syverson

➤ **Present Position**
Eli B. and Harriet B. Williams Professor of Economics, University of Chicago Booth School of Business (at Chicago Booth and, previously, the Department of Economics, University of Chicago, since 2001)

➤ **Education**
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➤ **Selected Publications**
"Challenges to Mismeasurement Explanations for the U.S. Productivity Slowdown," *Journal of Economic Perspectives*, 2017; "Healthcare Exceptionalism? Performance and Allocation in the U.S. Healthcare Sector," *American Economic Review*, 2016 (with Amitabh Chandra, Amy Finkelstein, and Adam Sacarny); "Vertical Integration and Input Flows," *American Economic Review*, 2014 (with Enghin Atalay and Ali Hortaçsu); "Toward an Understanding of Learning by Doing: Evidence from an Automobile Plant," *Journal of Political Economy*, 2013 (with Steven Levitt and John List); "Market Structure and Productivity: A Concrete Example," *Journal of Political Economy*, 2004; and numerous other papers

have learned about the importance of each side and what drives the fundamentals on both sides. That's going to help us get a more comprehensive answer of the causes of productivity dispersion within industries.

EF: Regarding management practices, it seems a little puzzling that lagging firms wouldn't have done more to replicate what more successful firms have done. You could imagine possible stories about why that may be the case, but it seems like an important question to answer.

Syverson: I agree, and there is some evidence we can look at from work done by Bloom and some colleagues. I'll call it the India experiments. They did a randomized controlled trial with textile producers in India. They provided management consulting practices to 28 plants — a small sample but still useful — and asked the management of every plant why they hadn't previously instituted some of the management practices that the consultants recommended. Basically, there were three classes of explanations. First, there was, I didn't know about them. The second was, I knew about them, but they're just not going to work here. The third was, they might work here, but I didn't have the time to put them into place. And then they tracked the plants over time and asked those who still had not adopted those practices why they hadn't. Obviously, plants are unlikely to still give the first answer, but you still had a lot giving answer two or three.

Now, maybe there's something special or unusual about the setting of that experiment. But I do think the fact that management is often just mistaken is a nontrivial factor. There is evidence coming out of this body of work that suggests companies don't know where they are in the distribution — they don't know whether they are well-managed or not. You can't fix yourself until you know you have a problem.

Also, I think even if you know you have a problem, a lot of firms can't simply say, well, we see this competing company over there has an inventory management tracking system that seems really useful, so we'll install it on our computers and our problems will be solved. That's not how it works. The firm that has adopted this practice has people trained in how to do it. It has changed its system, so that there's an interaction and a feedback loop between

what the system is recording and recommending and what you do. If you just say, OK, we're going to start collecting these data now and then do nothing else, you're not going to get the productivity benefits that the company with the complements is getting. I just think this stuff is way more complex than people might initially think.

An example I talk about in class a lot is when many mainline carriers in the United States tried to copy Southwest and created little carriers offering low-cost service. For instance, United had Ted and Delta had Song. They failed because they copied a few superficial elements of Southwest's operations, but there was a lot of underlying stuff that Southwest did differently that they didn't replicate. I think that presents a more general lesson: You need a lot of pieces working together to get the benefits, and a lot of companies can't manage to do that. It also typically requires you to continue doing what you have been doing while you are changing your capital and people to do things differently. That's hard.

EF: It is often argued that the health care sector is fundamentally different than other sectors of the economy — and that these differences might produce relatively less variation in productivity within the health care sector. What does your work suggest about the idea of health care "exceptionalism"?

Syverson: In general, we think companies that do a better job of meeting the needs of their consumers at a low price are going to gain market share, and those that don't, shrink and eventually go out of business. The null hypothesis seems to be that health care is so hopelessly messed up that there is virtually no responsiveness of demand to quality, however you would like to measure it. The claim is that people don't observe quality very well — and even if they do, they might not trade off quality and price like we think people do with consumer products, because there is often a third-party payer, so people don't care about price. Also, there is a lot of government intervention in the health care market, and governments can have priorities that aren't necessarily about moving market activity in an efficient direction.

Amitabh Chandra, Amy Finkelstein, Adam Sacarny, and I looked at whether demand responds to performance differences using Medicare data. We looked at a number of different ailments, including heart attacks, congestive heart failure, pneumonia, and hip and knee replacements. In every case, you see two patterns. One is that hospitals that are better at treating those ailments treat more patients with those ailments. Now, the causation can go either way with that. However, we also see that being good at treating an ailment today makes the hospital big tomorrow.

Second, responsiveness to quality is larger in instances where patients have more scope for choice. When you're admitted through the emergency department, there's still a positive correlation between performance and demand, but it's even stronger when you're not admitted through the emergency department — in other words, when you had a greater ability to choose. Half of the people on Medicare in our data do not go to the hospital nearest to where they live when they are having a heart attack. They go to one farther away, and systematically the one they go to is better at treating heart attacks than the one nearer to their house.

What we don't know is the mechanism that drives that response. We don't know whether the patients choose a hospital because they have previously heard something from their doctor, or the ambulance drivers are making the choice, or the patient's family tells the ambulance drivers where to go. Probably all of those things are important.

It's heartening that the market seems to be responsive to performance differences. But, in addition, these performance differences are correlated with productivity — not just outcomes but outcomes per unit input. The reallocation of demand across hospitals is making them more efficient overall. It turns out that's kind of by chance. Patients don't go to hospitals that get the same survival rate with fewer inputs. They're not going for productivity per se; they're going for performance. But performance is correlated with productivity.

All of this is not to say that the health care market is fine and we have nothing to worry about. It just says that the mechanisms here aren't fundamentally different than they are in other markets that we think "work better."

EF: What does your work tell us about why some firms benefit from common ownership of production chains, how those benefits can be measured, and how large those benefits might be?

Syverson: In a paper with Enghin Atalay and Ali Hortaçsu, we found that most vertical ownership structures are not about transferring the physical good along the production chain. Let's say you are a company that owns a tire factory and a car factory. When you look at instances analogous to that, most of the tires that these companies are making are not going to the parent company's own car factory. They are going to other car factories. In fact, when you look at the median pair, there's no transfer of goods at all. So the obvious question becomes: Why do we observe all this vertical ownership when it's not facilitating the movement of physical goods along a production chain? What we speculated, and then offered some evidence for, was that most of what's moving in these ownership links are not tangible products but intangible inputs, such as customer lists, production techniques, or management skills.

If that story is right, it suggests a reinterpretation of what vertical integration is usually about in a couple of ways. One, physical goods flow upstream to downstream, but it doesn't mean intangibles have to flow in the same direction. Management practices, for instance, could just as easily go from the downstream unit to the upstream unit.

The second thing is that vertical expansions may not

be as unique as we have thought. They may not be particularly different from horizontal expansions. Horizontal expansions tend to involve firms starting operations in a related market, either geographically or in terms of the goods produced. We're saying that also applies to vertical expansion. A firm's input supplier is a related business, and the distributor of its product is a related business. So why couldn't firms take their capital and say, well, we think we could provide the input or distribute the product just as well too? So, conceptually, it's the same thing as horizontal expansion. It's just going in a particular direction we call vertical because it's along a production chain. But it's not about the actual object that's moving down the chain.

We were able to look at this issue, by the way, because we had Commodity Flow Survey microdata, which were just amazing. It's a random sample of shipments from a random sample of establishments in the goods-producing and goods-conveying sectors of the U.S. economy. So, if you make a physical object and send it somewhere, you're in the scope of the survey. We get to see, shipment by shipment, what it is, how much it's worth, how much it weighs, and where it's going. And then we can combine that with the ownership information in the census to know which are internal and which are external.

EF: You have done a lot of work examining the concrete industry. Why concrete? And what can we learn about more general phenomena by looking at some pretty narrow industries?

Syverson: And not just concrete, but ready-mix concrete in particular. The reason is that it is a great laboratory for testing economic theory. It has a set of characteristics that not many industries have. One, it's geographically ubiquitous. Two, because of the transport costs and the perishability of the product, every one of these geographic markets is basically independent, and you can only ship this stuff so far. So every city is basically a different market. Three, almost all concrete is bought by the construction sector, but it's a small share of construction costs. What that means is that construction activity is basically an exogenous mover of concrete demand. Furthermore, there are a lot of firms in the concrete business, so even a modest-sized market is going to have multiple plants run by multiple companies. This means that it is like an economist having a laboratory full of petri dishes where you tweak each one and see what happens differently in response to different stimuli. On top of all that, the stuff is relatively easy to measure because it's physically homogeneous. It's not a differentiated product, so the prices are pretty comparable and the units are comparable. Just about everything you would want in an ideal, clean case study exists in this industry.

So that's why I have done so much work on concrete. What can we learn more generally? You hear jokes about people working in industrial organization (IO) looking at case studies and discussing the ketchup literature, or the yogurt literature, or in this case the ready-mix concrete literature. I have tried to be clear about what I think the broader lessons are from these case studies and what we can learn from them. One of the first studies I did on ready-mix concrete looked at whether variations in consumer scope for substitution show up in the equilibrium productivity distribution. In other words, is it indeed harder to be an inefficient producer in a market where customers can more easily find the more efficient producers? The answer is yes. I think that is a more general phenomenon; it's just one I can measure much better in that setting than in others. That said, I wrote a companion paper that does look across manufacturing industries and found similar things with different measures of substitutability to bolster the generalizability of the findings in the earlier paper.

Also, Ali and I looked at vertical integration between the cement and concrete industries. There is clearly an element of industry specificity to that work. But, on the other hand, those were sort of the poster-child industries for the market foreclosure literature. So if you thought that vertical mergers provide incentives for collusion and anticompetitive foreclosures, this is where you would see it. We looked, and we didn't find it. That might make you think differently about how likely you would find it in other industries too.

I understand the case-study method, why it's important and what advantages it has. I don't think people in IO should cede ground to those who question the value of individual case studies just because we haven't done case studies on the hundreds of other industries out there. We should use what we know from a case study, along with theory, to extend our understanding of economics as far as we can.

EF: You were given access to detailed production data from an auto assembly plant over the course of a year. What were those data able to tell you about the sources of learning by doing?

Syverson: Regarding the data, as a car is being made, there are things constantly being recorded in the factory's information system, either in an automated fashion or by workers manually inputting information. So Steve Levitt, John List, and I were able to see every step of the way whether the step went right or wrong. And then we looked at subsequent defect rates for every car that was made – about 190,000 over the course of a year.

Most of the empirical learning-by-doing literature has looked at unit costs, such as how many worker hours it took to make a unit, and then examined that over time and traced out the learning curve that way — how fast people adapted, for instance. Our more detailed data let us learn something about where the knowledge resided inside the organization and how it moved around.

There are a few facts that are important to understanding that in this setting. One is that a lot of learning happened early, as is pretty common. So, for example, defect rates fell 70 percent in the first two months of production. Now, as it happens, the factory only ran on one shift for the first two months of data we observed, and then starting in the eighth week, the second shift started. The second shift's training was to watch the first shift for one week. That was it. They weren't on the line itself. Once the second shift comes online, they are right at this new, lower defect level that the first shift achieved. So you immediately know that it's not just being on the line for a while that leads to improvements.

Two, there is a high correlation between defect rates for a particular operation across shifts. Operations don't go wrong with equal frequency. There is a right tail of processes that go wrong a lot of the time, and then there's a left tail where things never go wrong. That's true across shifts. So if some operation is problematic on the first shift, it's problematic on the second shift, even though the workers are different.

Three, we were able to see absenteeism every day at the factory and in which part of the production process the absent workers were placed. There is a positive relationship between absenteeism rates and defect rates along a set of operations on the line, but it's very weak.

So those three things suggest it's not the workers who are carrying the knowledge, which, again, is substantial. Defect rates over the course of the year came down 90 percent total.

What happened is the factory had a set of practices to take knowledge from the workers and as quickly as possible put it into the capital of the factory — either the physical capital, such as changing a faulty part on the line, or the organizational capital, such as workers conveying information to each other.

EF: Following the accounting scandals of the early 2000s, there were proposals to require companies to rotate auditing firms. You have looked at the possible effects of such a mandate. What did you find? Similarly, what is the potential impact if one of the Big Four firms were to fail, perhaps because of regulation or legal action?

Syverson: As you said, Joseph Gerakos and I looked at two things: mandated auditor rotation and what would happen if one of the Big Four were to fail. The two issues are related. A good way to start thinking about them is to ask whether companies choose auditors based on certain characteristics or do they just go with the lowest price. The answer is clear that the auditors are differentiated to the companies that hire them; companies are looking for the best match.

When you move around prices exogenously, you see the customer's willingness to substitute based on those changes in prices, and they're not nearly as willing to substitute one auditor for another as they would be if the auditors were not differentiated. So it's clear something is driving the value of the match-specific relationship. What does that mean? It means that if one of the Big Four were to fail, there would be losses suffered by the audited companies because you can't just swap one for the other and not lose that match-specific value. It also means if you mandate that they switch auditors after a certain number of years, you won't have that match-specific value anymore.

All that said, there is another side to the mandated switching policy. If you think too much coziness between firm and auditor can create the potential for corruption, there's value in eliminating that. We are not trying to measure that or saying that it's zero. We are simply saying that on the other side of the scale is a real cost.

EF: What do you think are some of the big open questions in IO and understanding firm dynamics?

Syverson: With IO, I would like people to pay greater attention to more general lessons we might be able to take from case studies. That could involve adding some comment in the paper and maybe writing a companion paper. I would also like people to avoid thinking that any empirical work that involves more than one industry is ipso facto flawed. I think there is a little too much stridency along that line — not across the board, but I would like to see people be more accepting of some broader approaches.

One really positive move I've seen in IO over the past 10 years is I think the field has moved toward answering more important questions. That's not to say the questions were unimportant before, but I think we're moving in a good direction. As I tell people at IO conferences, other fields are doing IO now. Look at macro and finance and development, just to name a few. They're trying to answer IO questions. And in part I worry that they're doing it because we haven't done enough. I think people working in IO can bring useful insights to the conversations people in other fields are having.

In terms of firm dynamics, I think we still have further to go to explain productivity dispersion, in particular what's creating this increase in skewness. I also think the micro aspects of the productivity slowdown are still a mystery. We have some understanding of these issues, but there's a lot we don't know.

EF: Do you think being an engineer might have affected your choice of research interests as an economist?

Syverson: There is no doubt. I got into productivity in grad school because of my engineering background. I was a mechanical engineer. I like looking at how systems work together to produce something and how those systems can be improved. Also, as an engineer, it's simply fun to go to factories and see how things are done.   **EF**

ECONOMICHISTORY

The Great Telegraph Breakthrough of 1866

The transatlantic telegraph cable amounted to the information revolution of the day, tying global markets together in unprecedented ways

BY HELEN FESSENDEN

At the height of summer in 1866, U.S. newspapers were abuzz with the news of a technological marvel: A transatlantic telegraph cable successfully linked the United States with Great Britain. Completed on July 27, the cable generated congratulatory headlines across the country and ushered in a new era of "real-time" journalism.

"Since Sunday morning we may say that America has been in direct telegraphic communication with Europe," announced the *New York Herald* on July 31. "Intelligence of vast importance to the interests of the latter continent ... has reached us on the submarine wire."

Rather than taking a week or more by ship, this information was transmitted within a day. And it wasn't just about war and foreign intrigue but about the markets connecting the two continents. In record time, the prices of commodities traded on both sides of the ocean could be transmitted to merchants who needed that information to buy or sell their product. Newspapers at the time noted this particular salience for commerce, with the *New York Herald* commenting that the "cable and the news which was flashed over it exerted a controlling influence in business circles," including in grain, coffee, cotton, and gold.

What the *Herald* called a "controlling influence" has relevance for economists today in understanding how technology and information intersect in the context of information frictions. These frictions occur when buyers and sellers lack timely access to information that enables markets to function efficiently, such as prices or the drivers of supply and demand. In the context of trade, these frictions can lead importers and exporters to misjudge markets and misprice goods. This can produce a deadweight loss, when diminished efficiency means that both sides are unable to maximize the gains from trade — similar to the effect of formal trade barriers, such as tariffs.

Economists have been increasingly studying the role of technology, in particular, as a way to break down information frictions and make markets more transparent. This field of inquiry applies not just to trade but to any kind of economic activity, especially when real-time information is critical but difficult to find. For example, economists have looked at the effect of Internet shopping on life insurance markets — cheaper on net for consumers, according to Jeffrey Brown of the University of Illinois at Urbana-Champaign and Austan Goolsbee of the University of Chicago. As these and other studies suggest, the speed and ease of online shopping can reduce these frictions for consumers.

To anyone who surfs websites to shop, these insights are intuitive. But as the case of the transatlantic telegraph cable shows, history is rich with examples of how earlier breakthroughs had similar effects. In a stroke, the cable helped reshape many U.S. industries, including one of the biggest exports, raw cotton, ultimately growing U.S. exports through increased efficiency.

This story has special resonance in the Fed's Fifth District, especially in the Carolinas, where the cotton industry recovered with surprising speed in the years following the Civil War. Even though cotton production and exports sharply fell during the war, both rebounded to prewar levels by 1870. In particular, the communication revolution that the telegraph ushered in helped turn splintered local markets into a national network, leading to the 1871 founding of the New York Cotton Exchange.

Missed Connections

By the time the cable joined the two sides of the Atlantic, the telegraph's reach had been expanding in the United States for more than two decades. In 1844, inventor Samuel Morse attempted an experiment to see whether electromagnetism could be applied to telecommunications, resulting in the first telegraph line, between Washington, D.C., and Baltimore, on which he famously clicked "What hath God wrought?" By 1851, there were 75 companies that connected major U.S. cities through multilateral monopolies, in which different lines often competed on the same links but cooperated via connecting lines. This hodgepodge of networks led to poor and overlapping service, which was gradually resolved through greater system integration and horizontal integration by the late 1850s.

Despite this progress on the domestic front, it took multiple attempts, starting in 1857, for engineers to succeed in laying the transatlantic cable amid challenges posed by bad weather and deep-sea terrain. The string of failures fed growing public pessimism; there was even speculation that the idea of a working connection was a hoax. But on the fifth try, under the supervision of financier Cyrus Field, a cable between Newfoundland and Ireland finally linked the two continents. The first messages transmitted included a congratulatory note from Queen Victoria, news of Otto von Bismarck's victory over the Austrian army — and cotton prices, which were quoted in both New York and Liverpool.

Why were cotton prices so prominent in those initial reports? Most cotton was sent to U.S. ports for export, with New York City as the most important hub linking U.S. producers to importers in England. In turn, British textile workers spun raw cotton into finished cloth, which was sold for domestic consumption and for export. Prior to the transatlantic cable, however, there was often a lag between the price of cotton quoted in Liverpool and what was quoted in New York, often by a week or more, depending entirely on ship travel. One common problem was that the information on foreign demand that New York merchants got from Britain was outdated, so it was difficult to make accurate purchasing decisions. Moreover, foreign demand fluctuated considerably, especially on the European continent. (Building up storage capacity could only partly address this issue, due to the fire hazard posed by cotton and prohibitive construction costs.) In short, this was a classic case of information frictions causing inefficiencies in trade.

At the same time, the cotton trade was adjusting to profound shocks on both the supply and demand side. Prior to the Civil War, U.S. cotton production — supported almost entirely by African-American slave labor — rapidly expanded to meet growing demand abroad for textiles. In 1860, about 70 percent of U.S. raw cotton was shipped to Britain, which came to almost 60 percent of all U.S. exports in terms of dollar value. On Britain's side, U.S. cotton was an overwhelming share (almost 90 percent) of all cotton imports and highly favored due to its strength and high quality.

This changed abruptly with the onset of the Civil War and the highly effective Union blockade, which caused cotton exports to drop by more than 90 percent within a year. One solution for Britain was to cultivate new sources for cotton, including India, which soon became a leading supplier. But once the war and blockade ended, foreign demand for U.S. cotton rebounded. With the abolition of slavery, sharecropping became the dominant labor arrangement in the South. Postwar production and exports grew quickly enough that by 1870 they reached their volumes of the late 1850s.

What Hath Morse Wrought?

In several recent papers, Massachusetts Institute of Technology economist Claudia Steinwender has studied the effects of the transatlantic telegraph breakthrough of July 1866, as a critical positive shock to cotton markets. The fact that this shock was instant and independent of outside economic conditions, she notes, makes it easier to see how it affected prices and markets right away. And indeed, by comparing prices on both sides of the Atlantic, she found there was an abrupt change. Whereas the average difference between New York and Liverpool prices was 2.56 pence per pound of cotton prior to the cable, it
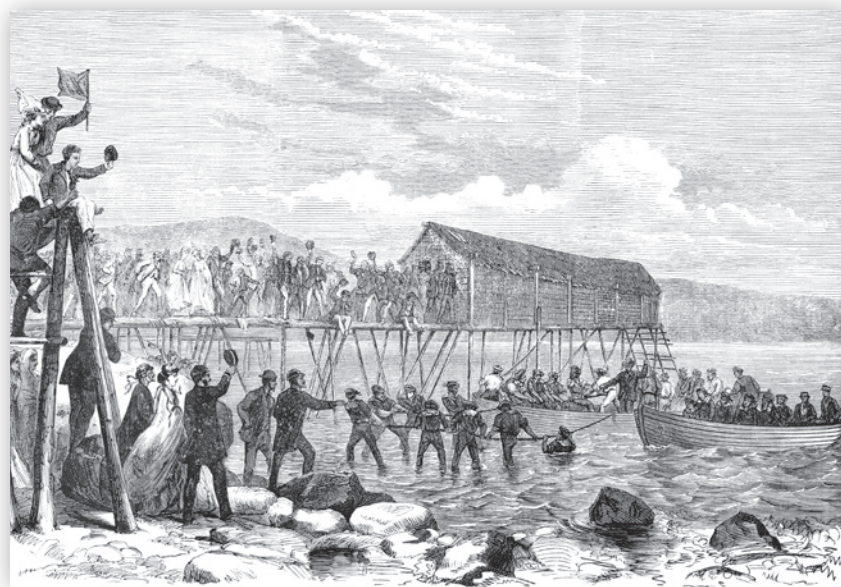
Transatlantic telegraph cable arrives at Heart's Content, Newfoundland, July 27, 1866. Engraving by unknown artist.

fell to 1.65 pence per pound — a drop of more than a third — right after. Furthermore, the transatlantic price differences were much less subject to major swings.

In turn, thanks to more timely and accurate information, New York traders were better able to adjust export volumes to meet fluctuations in foreign demand. Rather than spend money on costly storage, which required leaving some of their product idle, exporters could calibrate their shipments more efficiently. In Steinwender's calculations, this boosted average daily cotton exports by 37 percent. The variance in daily volume increased even more, by 114 percent — reflecting the fact that exporters were able to make these adjustments quickly. Overall, she concluded, the cotton trade experienced an 8 percent efficiency gain in annual export value, mostly from the reduced variations in price differences due to the cable. Put another way, this efficiency gain was equivalent to a 20 percent drop in storage costs, or the elimination of a 7 percent ad valorum tariff.

"This is a case of how a technological breakthrough addressed a classic puzzle in trade," says Steinwender. "Information about foreign demand is not a given. Exporters don't know how much those markets need and how much they will pay. So how do you know how much you can supply those markets?"

In a recent paper co-authored with Columbia University's Réka Juhász, Steinwender extended this analysis to see how the telegraph's information revolution affected the global textile industry's supply chain. They found that its impact was especially concentrated in boosting trade in intermediate goods like yarn and plain cloth, for which information could be most easily transmitted by telegraph rather than require the inspection of physical samples. More broadly, the telegraph helped diffuse information about the technology used in the production process.

The Real-Time Effect

As this work suggests, the transatlantic telegraph cable had a profound impact on the cotton trade. But even before 1866, the telegraph was reshaping domestic markets as well.

To be sure, the telegraph was too pricey for frequent personal use. One reason why prices stayed relatively high was that they were largely set by Western Union, which had become the dominant provider during the Civil War and consolidated its monopoly status by 1866; until 1900, it enjoyed a market share of 90 percent or more in each state. In those decades, rates fell from $1.09 to $0.30 per message, but Western Union still netted $0.30 to $0.40 per dollar of revenue. (For comparison, mail postage was only pennies, while the average hourly wage in 1901 was around $0.25.)

Because of the telegraph's real-time value, however, certain industries — notably railways, newspapers, and finance — quickly found important applications in the 1840s and 1850s. The instant transmission of prices in commodities markets and financial assets, for example, helped cut out middlemen who used to benefit from arbitrage, while wholesalers and retailers became more tightly linked in a truly national economy. The telegraph also aided the railway industry by allowing single tracking through timely signaling, rather than requiring two tracks to avoid collisions. This innovation facilitated the transport of goods across the country as it became linked by rail; by the estimation of economist Alexander Field, the efficiency gain came to around 7 percent of GDP by 1890.

Meanwhile, beyond cotton, the transatlantic cable's effects could be seen in other pockets of global markets. One case in financial markets was the common shares of the New York and Erie Railroad, which were traded in both Britain and the United States. Economist Christopher Hoag of Trinity College has studied how the advent of the cable equalized share prices, finding the telegraph was correlated with a reduction in the transatlantic difference in prices from 5 percent to 10 percent before to 2 percent to 3 percent after. U.S. bonds that traded in U.S. and London markets also saw their prices converge. More broadly, the telegraph cable played a direct role in stimulating trade in general in the latter part of the 19th century, especially in the years immediately after 1866, due to improved coordination of shipping and timelier transmission of market-sensitive information, according to Trent University economists Byron Lew and Bruce Cater.

Cotton's Revival

Postwar cotton production and exports in the South, including in the Carolinas, both rebounded quickly even as other cotton-producing countries expanded their reach.

Did the efficiency gains in exports resulting from the telegraph cable play a role in this domestic recovery? According to Steinwender, a very rough estimate is that the United States benefited more on net than Britain, receiving perhaps 75 percent of efficiency gains. "But as to how this was distributed across producers, middlemen, and speculators is harder to resolve," she adds. "The data don't provide a clear answer on how the gains from higher exports and higher prices were distributed domestically."

More broadly, however, the telegraph's information revolution was one of the factors behind another market innovation — the introduction of futures trading in 1871 with the New York Cotton Exchange. With a telegraph network connecting London with New York and the major cotton centers in the South, merchants could conduct spot and futures trading based on multiple reports a day. The exchange played a leading role in cotton market integration in the following years in its function as a clearing house, reducing the role of local middlemen (who charged commissions) and helping regional growers market crops nationally. Notably, the exchange also allowed merchants to hedge through futures trading, which was especially important given the volatility of cotton prices; once a commodity was hedged, it was easier for merchants and shippers to secure credit. In turn, the growth of a nationally integrated cotton market helped spur the development of North Carolina's textile sector in the late 19th century as raw cotton from across the South was diverted to domestic textile production.

The disruptive role of technology in this era did not go unnoticed by one observer at the time. In an 1870 report, William Forwood, a Liverpool Chamber of Commerce official, addressed the Civil War's effects on supply, demand, and prices and the broader global response. Amid the turmoil in the cotton market, he concluded, the higher prices resulting from the wartime drop in U.S. supply brought in new producers, while advances in communication and transportation encouraged activity in previously quiet markets, not to mention more efficient cultivation. "As water finds its level, so will price regulate supply," he wrote. "[B]ut these maxims have never been so fully demonstrated as during the crisis through which the greatest trade of the world has gone during the past 10 years." **EF**

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When the Robots Come
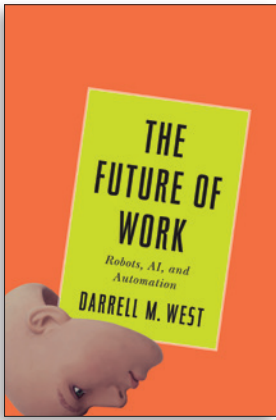
THE FUTURE OF WORK: ROBOTS, AI, AND AUTOMATION

BY DARRELL M. WEST, WASHINGTON, D.C.: BROOKINGS INSTITUTION PRESS, 2018, 205 PAGES

REVIEWED BY RENEE HALTOM

Retail cashiers make up roughly 2.2 percent of the U.S. labor force. But technologists predict they will eventually be replaced by microchips that debit the accounts of shoppers as they exit stores.

The technology to replace harder-to-automate jobs — paralegals, radiologists, even jazz musicians — is starting to emerge. The prospects for employment in general are bleak, argues Darrell West, director of governance studies at the Brookings Institution, in *The Future of Work: Robots, AI, and Automation*. "Unless we get serious about impending economic transformations, we may end up in a dire situation of widespread inequality, social conflict, political unrest, and a repressive government to deal with the resulting chaos."

West details advances that have the potential to change virtually any personal or professional task through robotics, artificial intelligence, and the "Internet of things" (generally defined as fixed and mobile devices connected to the Internet). Most of this is thus far conceptual, so the ultimate labor impacts are murky. Estimates of the share of existing jobs that will be automated in the next three decades range from around a tenth to one-half. Some experts predict a high chance that robots will eventually outperform humans at all tasks, from surgery to writing best-selling novels.

Such trends clearly command some rethinking about the role of work in our economy and society. At the same time, displacement of workers can't be the end of the story. Mentioned but unexplored by West is what robots and AI will free up humans to do. Who anticipates robots' needs, determines how they'll be used, and manages them? Who translates their output into actionable business decisions, firm-level strategies, and the next big innovations?

Without wading into complacency, it is worth noting that history is on the side of labor. The literature on immigration, for example, has found that in many cases, native wages rise. And historically, job loss to innovation has been met with wage growth and new jobs in previously unimagined areas. Many of the nation's 7.4 million tech occupation jobs did not exist 30 years ago (and they tend to pay wages far higher than the national average). In the end, economic theory suggests things depend on the extent to which technology becomes cheaper than labor in the long run.

For labor to win in that equation, workers will need greater skills. West advocates a new culture of lifelong learning, a challenging task since retraining programs and apprenticeships have struggled to provide skills that stay relevant over time. A promising avenue may be investment in soft skills, which are inherently more transferable across tasks. West cites Massachusetts Institute of Technology economist Andrew McAfee's argument that the educational system needs to produce graduates who can negotiate, motivate, provide compassionate service and great experiences, and intuit the next business problem several steps in advance. One avenue that West doesn't mention is investments in early childhood education; there is evidence that students who lack soft skills early on only fall further behind in that dimension.

While not explicitly endorsing all of them, West offers a range of possible ways to buffer the costs to workers. He would like to see the nation consider health, retirement, and other benefits tied to "citizen accounts" that are portable across jobs and that could be credited for socially beneficial activities such as volunteer work (as is done in the United Kingdom). He also cites paid family leave; revamping the earned income tax credit to help the working poor; expanding trade adjustment assistance to include technology disruptions; providing a universal basic income; and deregulation of licensing requirements so that it is easier for workers to change industries. West advocates a "solidarity tax" on high net worth individuals to pay for much of this.

Most of these prescriptions are not specific to technology, and many are things society may want to consider anyway. But West makes a familiar and compelling case that the political system may be slow to act. Whereas society responded to disruptions resulting from the industrial revolution — with reforms ranging from worker safety to the creation of primary elections to break up political power — today the combination of political polarization and economic inequality may make consensus and then productive change more difficult. West believes recent populist movements spurred in part by economic disenfranchisement are only the beginning. He advocates reforms to make the political system more representative, and these, too, are worth consideration regardless of the scale of automation to the extent that they make politics more fair.

Though one wonders if labor will become quite as irrelevant as West imagines, his is a comprehensive, though rather high-level, review of the coming challenges and proposed remedies. It is hard to imagine that most people won't be left far better off due to technological progress. But West makes a compelling case that the extent to which they are depends on how public and private decisions alike prepare us. **EF**

The Opioid Epidemic, the Fifth District, and the Labor Force

BY SONYA WADDELL

In 2016, there were more than 63,600 drug overdose deaths in the United States, 70 percent more than the number of motor vehicle deaths the same year. The age-adjusted rate of overdose deaths has more than tripled since 1999. Of the deaths in 2016, about two-thirds were related to opioids; those deaths increased fivefold since 1999.

Certain states in the Fifth Federal Reserve District — which includes the District of Columbia, Maryland, North Carolina, South Carolina, Virginia, and most of West Virginia — have been particularly hard hit by the increased opioid use and misuse. The most striking data come out of West Virginia. At 52 deaths per 100,000 people, West Virginia had the highest drug overdose death rate in the country in 2016, followed by Ohio at 39.1 deaths. In fact, three district jurisdictions — West Virginia, Maryland, and D.C. — were in the top seven states for fatal drug overdoses, and most of those were opioid-related. (See chart.)

Many have tried to quantify the economic impact of the national opioid crisis. For example, in an October 2016 article, Curtis Florence, Chao Zhou, Feijun Luo, and Likang Xu of the Centers for Disease Control and Prevention (CDC) estimated the national economic burden of prescription opioid abuse in 2013 (including health care costs, criminal justice costs, and lost productivity costs) to be $78.5 billion. In a later paper, Alex Brill and Scott Ganz of the American Enterprise Institute and Georgia Tech estimated the 2015 per capita state- and county-level economic burden of the opioid crisis. They estimated that the per capita nonmortality costs were

highest in D.C. ($493) and New Hampshire ($360), and the highest per capita total costs (including mortality) were in West Virginia ($4,378) and D.C. ($3,657).
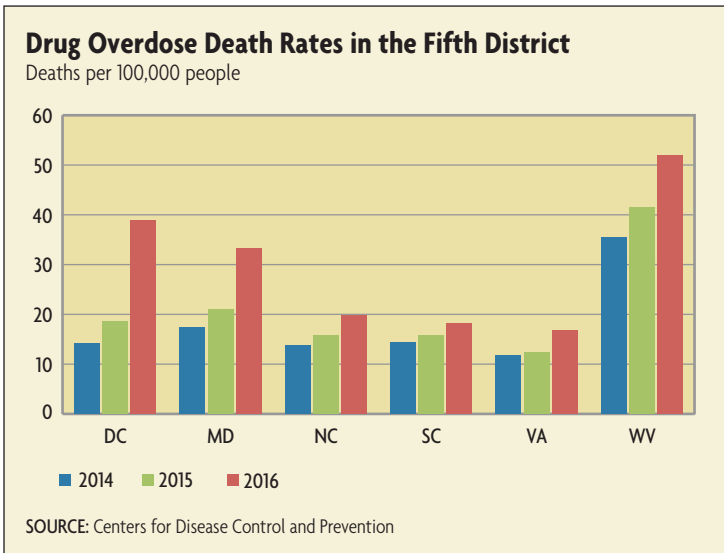
Apart from the obvious public health concerns created by the crisis, there are two primary economic reasons why a Federal Reserve Bank such as the Richmond Fed seeks to better understand the impact of the opioid crisis. First, a Reserve Bank is tasked with understanding economic conditions in its region and identifying any economic impact of the use and misuse of opioids on the district's states and localities is part of that effort. Second, the Fed's dual mandate of maximum employment and stable prices requires an understanding of any factor that might affect labor markets. With historically low unemployment and widespread stories of employers struggling to find workers, it becomes even more relevant to understand the extent to which the opioid crisis affects the pool of available labor throughout the nation.

Documenting the Crisis

The CDC looks at three primary categories of opioids: natural and semisynthetic opioid analgesics that are often available by prescription (such as morphine, codeine, oxycodone, and hydrocodone); synthetic opioid analgesics (such as tramadol and fentanyl); and heroin. According to the CDC, processing and analyzing death certificates indicates two distinct but interconnected trends in the opioid epidemic: an increase in deaths from prescription opioid overdoses over a 17-year period, and a recent surge in illicit opioid overdoses driven mainly by heroin and illegally made fentanyl. (See chart.)

So what explains the national evolution of the opioid crisis outlined by the CDC? First, there is evidence that much of the addiction to opioids in the United States began with a prescription. Three out of four new heroin users report abusing prescription drugs before using heroin, and people who are addicted to prescription opioids are 40 times more likely to also be addicted to heroin. Further, opioid prescription rates rose considerably for two decades starting in the mid-1990s, just prior to the beginning of the rise in opioid-related deaths.

In the Fifth District, overdose death rates have been highest in West Virginia — where the rate of opioid prescribing has also been high. Data from the CDC indicate that at the peak of opioid prescribing in West Virginia (2009), medical professionals in the state wrote 146.9 opioid prescriptions per 100 people. This was the highest prescription rate

Drug Overdose Death Rates in the Fifth District
Deaths per 100,000 people

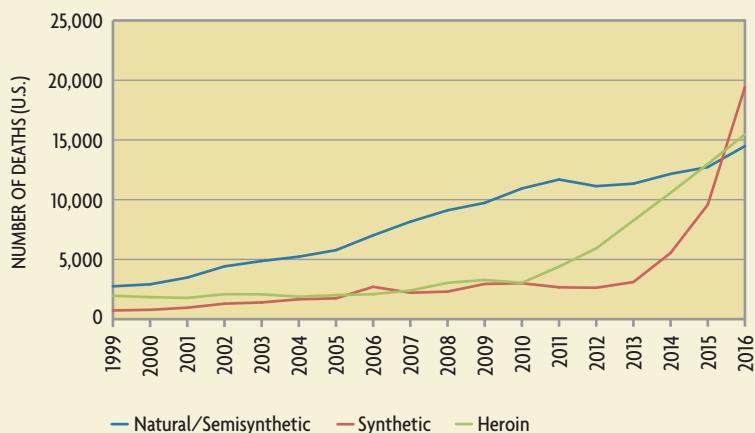SOURCE: Centers for Disease Control and Prevention

in the country by a wide margin: The next highest rates were in Tennessee, Kentucky, and Alabama, which had rates in the 130s. On the other hand, conditions are changing. By 2016, the rate in West Virginia was down to 96 prescriptions per 100 people. This was still the highest in the Fifth District, and one of the highest in the nation, but it ranked below some states with much higher prescription rates: Alabama (121.0), Arkansas (114.6), Tennessee (107.5), Mississippi (105.6), Louisiana (98.1), Oklahoma (97.9), and Kentucky (97.2).

Two other factors in the evolution of the crisis involved the reformulation of a specific drug and a decline in the price of heroin. One of the most widely prescribed drugs was OxyContin, made by Purdue Pharma, which contained a formulation that released the active ingredient (oxycodone) over the course of 12 hours. Users soon realized, however, that the extended release properties could be circumvented by crushing the pill into a powder that could be snorted, smoked, or liquefied and injected. In August 2010, Purdue Pharma stopped shipping its original formulation of OxyContin and began shipping exclusively a new formulation, what they called an abuse-deterrent formulation, which was much more difficult to abuse.

A few papers, including a January 2017 National Bureau of Economic Research (NBER) working paper by Abby Alpert of the Wharton School and David Powell and Rosalie Liccardo Pacula of the RAND Corporation, as well as a 2018 NBER working paper by William Evans and Ethan Lieber of the University of Notre Dame and Patrick Power of Boston University, indicate that rather than reduce overall opioid misuse or overdose deaths, this reformulation led to the substitution of heroin for other opioids. Evans, Lieber, and Power argue that each prevented prescription or semisynthetic opioid death was replaced with a heroin death. A big part of the reason was that the price of heroin fell from more than $3,000 per pure gram in 1981 to less than $500 per pure gram in 2012. This, in turn, was due primarily to vastly increased supply and increased purity, primarily coming from Mexico. In 2014, 79 percent of U.S. heroin came from Mexico, compared to 15 percent a decade earlier.

A final piece of the evolution came with the increase in overdoses from illicit synthetic opioids, such as fentanyl. Pharmaceutical fentanyl is a synthetic opioid pain reliever that is 50 to 100 times more potent than morphine and is thus often used to treat severe pain. But the increase in fentanyl-related overdoses and deaths in the United States arose from illicit fentanyl that is often mixed with heroin or cocaine, both with and without the user's knowledge.

Opioid Overdose Deaths by Type for the United States

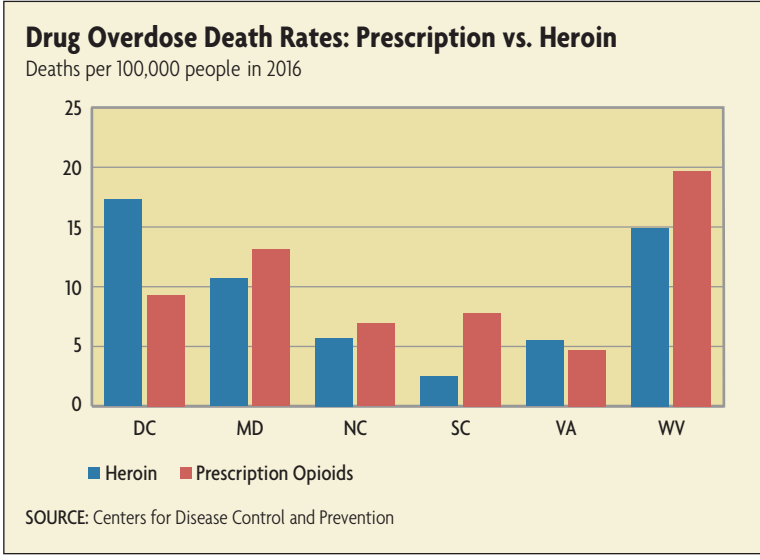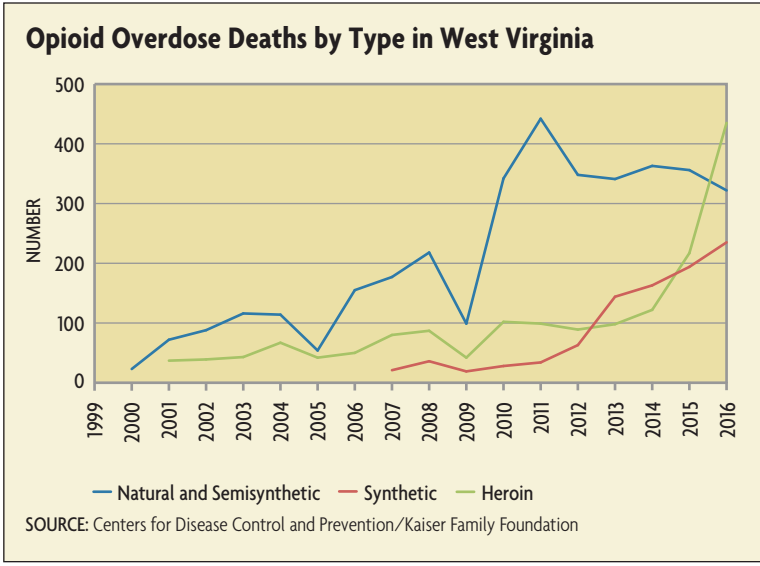**Opioid Overdose Deaths by Type for the Fifth District**
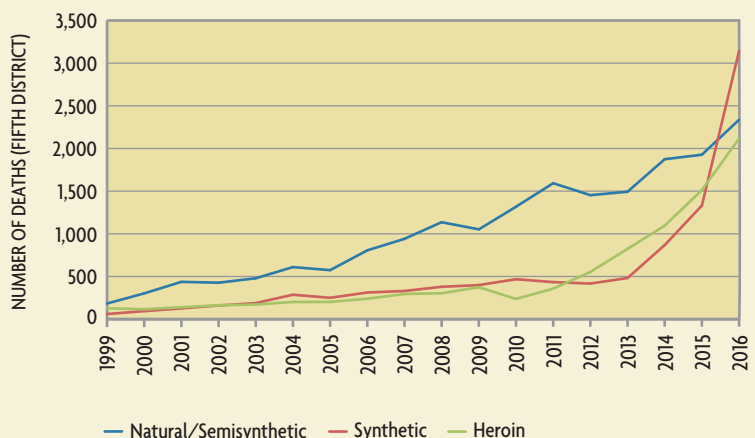
SOURCE: Centers for Disease Control and Prevention/Kaiser Family Foundation

The rate of overdose deaths involving synthetic opioids other than methadone doubled from 2015 to 2016 and confiscations of fentanyl have been on the rise.

Although the national pattern in the evolution of the opioid crisis holds true in the Fifth District overall (see chart), it is not consistent across states. In West Virginia, for example, the natural and semisynthetic opioid deaths are only just being overtaken by synthetic opioid deaths, and heroin use is far lower. (See chart on next page.) In the District of Columbia, however, heroin overdose rates are well above those of prescription drug rates. (See chart on next page.)

Effect of Opioid Use on the Labor Force
In May 2018, the U.S. unemployment rate fell to 3.8 percent — a rate so low that it has been seen only a handful of times in the 70-year history of the series. Yet the share of the population aged 25 to 54 years — the prime working-age population — in the labor force has fallen from a high of almost 85 percent in the late 1990s to less

Opioid Overdose Deaths by Type in West Virginia

SOURCE: Centers for Disease Control and Prevention/Kaiser Family Foundation

Drug Overdose Death Rates: Prescription vs. Heroin

Deaths per 100,000 people in 2016

SOURCE: Centers for Disease Control and Prevention

than 81 percent by the end of 2015, although it has since risen to around 82 percent. There are reports that drug use explains much of the decline in labor force participation, and, in fact, many employers report high rates of drug test failure among job applicants. The evidence, however, is mixed.

Most of the work done to disentangle the relationship between opioid use and employment outcomes corroborates the intuition that higher overdose rates and higher prescription rates are correlated with worse employment outcomes. In one of the most cited papers, published by the Brookings Institution in 2017, Alan Krueger of Princeton University reported two major findings. First, in a survey of 571 prime-aged men out of the labor force, 31 percent reported taking prescription pain medication on the previous day. Further, nearly 80 percent of those who took prescription pain medication in the initial survey also reported taking it in a follow-up survey. Second, by linking 2015 county-level opioid prescription rates to individual labor force data in two time

periods (1999-2001 and 2014-2016), Krueger finds that labor force participation is lower in areas of the United States with a higher rate of opioid prescriptions and that labor force participation fell more in the 15-year period in areas with a high rate of opioid prescriptions. These results hold when controlling for things like demographics, the share of employment in manufacturing, and fixed characteristics of counties.

Although the relationship between the high level of opioid prescription rates at the outset and sharper declines in labor force participation suggests the possibility of a causal link from opioid prescriptions to employment outcomes, that leap requires, among other things, differences in opioid prescription rates to be independent of factors related to the labor market. For example, both prescription rates and labor force participation rates could be related to, say, workers' health conditions. Krueger himself refers to the results as "preliminary and highly speculative."

Another widely discussed work is that of Anne Case and Angus Deaton of Princeton University published in 2017. They document, among other things, a rise in mortality predominantly among white, non-Hispanic, lower-educated Americans due to drugs, alcohol, and suicide. They refer to these as "deaths of despair," and they narrate, in their words, a "preliminary but plausible story in which cumulative disadvantage from one birth cohort to the next — in the labor market, in marriage and child outcomes, and in health — is triggered by progressively worsening labor market opportunities at the time of entry for whites with low levels of education." With respect to opioids, they argue that the prescription of opioids for chronic pain was not a fundamental factor but added "fuel to the flame," making the epidemic much worse than it otherwise would have been. In other words, the opioid epidemic is a symptom of a larger problem.

The question of whether bad economic circumstances lead to higher opioid use fits into a larger literature that works to understand the effect of changing economic circumstances on health outcomes. The results of these analyses are mixed. Some earlier work by Christopher Ruhm of the University of Virginia suggests that recessions might improve health outcomes because, for example, unemployed people may have more leisure time for physical activity. On the other hand, other researchers have shown a negative effect of individual job displacement on health outcomes. Recently, Kerwin Kofi Charles, Erik Hurst, and Mariel Schwartz of the University of Chicago found that a decline in manufacturing in a local area in the 2000s had large and persistent negative effects on employment rates, hours worked, and wages and that declining local manufacturing employment increased opioid use and

deaths. Further, Ruhm, Alex Hollingsworth of Indiana University, and Kosali Simon of Indiana University reported in a 2017 NBER working paper that increased unemployment in a county increases opioid fatalities. In this paper, however, they do not address the possibility of reverse causality — that is, whether an increase in opioid fatalities has an adverse effect on employment outcomes. In other words, in this economy in which firms struggle to find skilled workers to fill vacancies, is the opioid epidemic further restricting our pool of available labor?

To answer this question, Janet Currie and Jonas Jin of Princeton University and Molly Schnell of Stanford University used quarterly county-level data on opioid prescription rates and employment-to-population ratios and engaged an econometric technique that allowed them to tease out causality. They find no effect of opioids on employment-to-population ratios for men and find that for women, a doubling of opioid prescriptions would lead to a 3.8 percent increase in employment for women in counties with education above the mean and a 5.2 percent increase in employment for women in counties with education below the mean. Thus, they argue that although opioids are addictive and dangerous, they may allow some women to work who would otherwise leave the labor force.

In contrast, Dionissi Aliprantis and Mark Schweitzer from the Federal Reserve Bank of Cleveland — whose Fed district has also been particularly impacted by the opioid crisis — published a working paper in May 2018 that finds evidence that opioid availability does decrease both employment and labor force participation. They do not find that the opioid prescription rate affects the number of unemployed in the same way, but — consistent with anecdotal reports — they do find that opioid prescription levels affect the individual's decision to participate in the labor force at all. In other words, an increase in opioid prescriptions reduces the chance that someone will be employed, but rather than joining the ranks of unemployed, they fall out of the labor force altogether — that is, they stop looking for a job. They also found that opioids reduced participation rates more for prime-aged men in geographies with high prescription rates than in geographies with lower prescription rates. If these results are true, then there are particular implications for West Virginia, which, in addition to having a high rate of opioid prescriptions and drug overdoses, also maintains the lowest labor force participation rate of all states in the country.

So why the different results? The answer is not clear. The two papers used different estimation strategies and different data, and researchers are still working to investigate where the different approaches might have led to different results. There does seem to be a relationship between labor market outcomes and opioid prescriptions, but empirically understanding the nature of that relationship is important to policy determination, and the question of correlation versus causality is still an open one.

Where Do We Go Next?
Much remains to be understood about the crisis and its effects. One area of uncertainty is the quality of the data that we use. Two of the most commonly cited data sources are the National Survey on Drug Use and Health, which relies on self-reporting and excludes the incarcerated or those living on the street, and overdose death rates, which can be understated since many death certificates in drug overdose cases do not specify the drug involved. Furthermore, while the data we have — prescription rates and overdose death rates — might be correlated with the phenomena we are seeking to study, such as misuse, abuse, or nonfatal overdose rates, they are not the same. Better data on misuse and not just deaths would help researchers to better understand the impact of the crisis.

In addition, data limitations thus far require analysis to be done at the county level. Could there be counties where misuse is high among those living there but where prescription rates or overdose rates are low because, for example, the high-prescribing doctors are in neighboring counties or there is less illicit fentanyl on the market? What does data at the county level not tell us about an individual's use of opioids or an individual's relationship to the labor market?

The paper by Currie, Jin, and Schnell brings into question the causal relationship between prescription opioid use and employment-to-population ratios. But they do not address the relationship between heroin use and labor market outcomes; it is not unreasonable to think that while, in many cases, a prescription for opioids might enable a person to keep working, heroin use might be a different story. As the national crisis evolves from a prescription drug epidemic to an illicit drug epidemic, researchers will need to find a way to better understand the relationship between illicit drug use and labor market participation. In other words, there is much left to learn.   **EF**

State Data, Q4:17

	DC	MD	NC	SC	VA	WV
Nonfarm Employment (000s)	793.8	2,722.1	4,440.6	2,103.8	3,955.7	747.4
Q/Q Percent Change	0.5	-0.2	0.4	0.7	0.0	0.3
Y/Y Percent Change	1.0	0.4	1.6	1.6	0.6	0.1
Manufacturing Employment (000s)	1.3	107.2	467.5	241.9	234.8	47.0
Q/Q Percent Change	0.0	0.6	-0.1	0.3	0.4	1.0
Y/Y Percent Change	8.3	1.2	0.7	2.2	0.8	0.8
Professional/Business Services Employment (000s) 166.8		443.8	627.9	280.9	732.2	66.1
Q/Q Percent Change	0.1	0.0	1.9	1.5	0.1	-1.0
Y/Y Percent Change	0.8	0.4	3.1	1.8	1.8	0.5
Government Employment (000s)	239.0	503.3	734.5	366.8	716.1	153.6
Q/Q Percent Change	-0.4	-0.1	-0.4	0.0	-0.2	-0.1
Y/Y Percent Change	-1.0	-0.2	0.8	0.8	0.1	-2.5
Civilian Labor Force (000s)	401.4	3,222.2	4,967.4	2,319.1	4,319.5	781.9
Q/Q Percent Change	0.0	-0.1	0.2	0.1	0.0	0.3
Y/Y Percent Change	1.2	0.7	1.6	0.9	1.1	0.2
Unemployment Rate (%)	5.9	4.1	4.5	4.2	3.6	5.4
Q3:17	6.1	4.0	4.4	4.2	3.7	5.2
Q4:16	6.0	4.4	5.1	4.6	4.1	5.7
Real Personal Income ($Bil)	47.5	321.6	397.6	181.2	409.7	61.2
Q/Q Percent Change	-0.2	0.4	0.6	0.5	0.3	-0.2
Y/Y Percent Change	1.4	1.6	2.6	2.1	1.9	1.8
New Housing Units	2,347	2,817	16,367	7,844	7,792	603
Q/Q Percent Change	92.2	-41.5	-9.3	-12.7	-4.5	-14.6
Y/Y Percent Change	119.6	-5.5	25.7	13.7	26.8	-5.9
House Price Index (1980=100)	865.8	469.7	366.2	375.2	454.3	237.0
Q/Q Percent Change	1.2	1.0	0.6	1.2	0.6	1.8
Y/Y Percent Change	7.2	4.1	6.1	6.6	3.7	2.6

NOTES:
1) FRB-Richmond survey indexes are diffusion indexes representing the percentage of responding firms reporting increase minus the percentage reporting decrease. The manufacturing composite index is a weighted average of the shipments, new orders, and employment indexes.
2) Building permits and house prices are not seasonally adjusted; all other series are seasonally adjusted.
3) Manufacturing employment for DC is not seasonally adjusted

SOURCES:
Real Personal Income: Bureau of Economic Analysis/Haver Analytics.
Unemployment Rate: LAUS Program, Bureau of Labor Statistics, U.S. Department of Labor/Haver Analytics
Employment: CES Survey, Bureau of Labor Statistics, U.S. Department of Labor/Haver Analytics
Building Permits: U.S. Census Bureau/Haver Analytics
House Prices: Federal Housing Finance Agency/Haver Analytics

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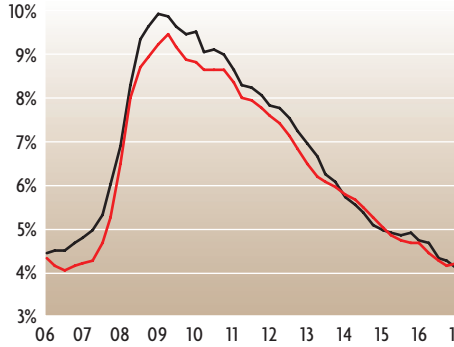
Nonfarm Employment
Change From Prior Year
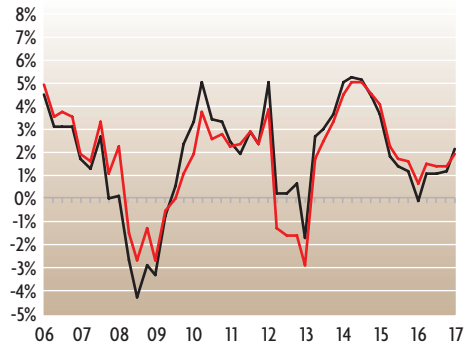Fourth Quarter 2006 – Fourth Quarter 2017
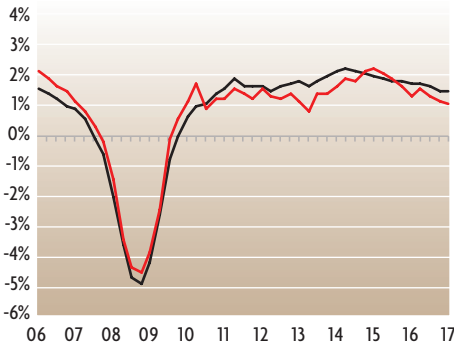
Unemployment Rate
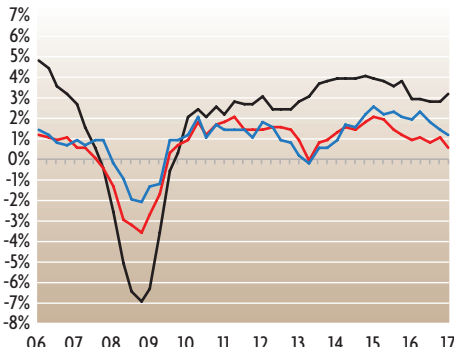Fourth Quarter 2006 – Fourth Quarter 2017

Real Personal Income
Change From Prior Year
Fourth Quarter 2006 – Fourth Quarter 2017

—— **Fifth District**   —— **United States**

Nonfarm Employment
Major Metro Areas
Change From Prior Year
Fourth Quarter 2006 – Fourth Quarter 2017

—— **Charlotte**   —— **Baltimore**   —— **Washington**

Unemployment Rate
Major Metro Areas
Fourth Quarter 2006 – Fourth Quarter 2017

—— **Charlotte**   —— **Baltimore**   —— **Washington**

New Housing Units
Change From Prior Year
Fourth Quarter 2006 – Fourth Quarter 2017
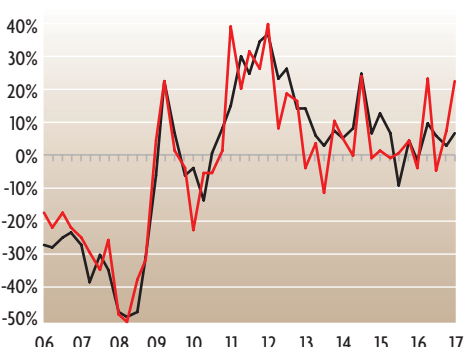
—— **Fifth District**   —— **United States**

FRB—Richmond
Services Revenues Index
Fourth Quarter 2006 – Fourth Quarter 2017

FRB—Richmond
Manufacturing Composite Index
Fourth Quarter 2006 – Fourth Quarter 2017

House Prices
Change From Prior Year
Fourth Quarter 2006 – Fourth Quarter 2017
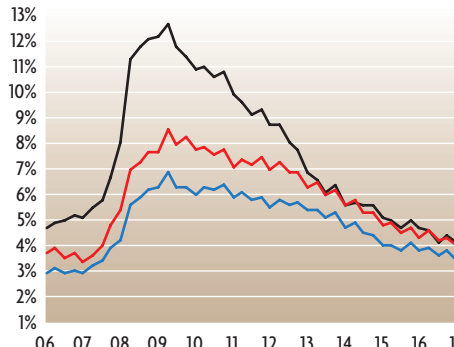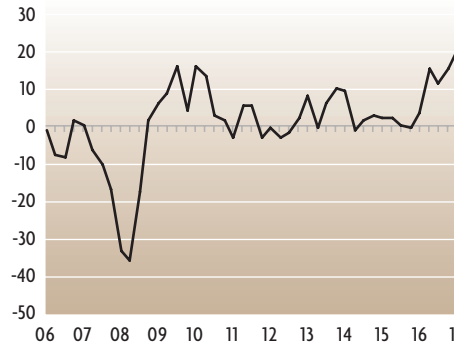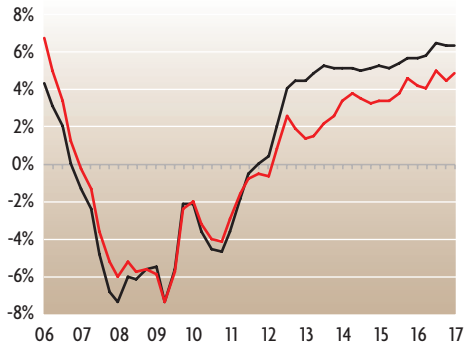
—— **Fifth District**   —— **United States**

Metropolitan Area Data, Q4:17

	Washington, DC	Baltimore, MD	Hagerstown-Martinsburg, MD-WV
Nonfarm Employment (000s)	**2,708.8**	**1,412.2**	**107.6**
Q/Q Percent Change	1.0	0.6	2.5
Y/Y Percent Change	1.3	0.6	-0.3
Unemployment Rate (%)	**3.6**	**4.2**	**4.3**
Q3:17	3.7	4.2	4.3
Q4:16	3.9	4.5	4.6
New Housing Units	**6,799**	**1,149**	**298**
Q/Q Percent Change	3.5	-49.9	-16.8
Y/Y Percent Change	46.7	-0.1	26.8

	Asheville, NC	Charlotte, NC	Durham, NC
Nonfarm Employment (000s)	**194.3**	**1,206.9**	**313.8**
Q/Q Percent Change	2.2	2.4	1.2
Y/Y Percent Change	1.9	3.2	1.3
Unemployment Rate (%)	**3.7**	**4.2**	**4.0**
Q3:17	3.7	4.2	3.9
Q4:16	4.1	4.7	4.4
New Housing Units	**689**	**5,660**	**1,124**
Q/Q Percent Change	-16.6	-14.9	-0.9
Y/Y Percent Change	57.3	35.9	17.6

	Greensboro-High Point, NC	Raleigh, NC	Wilmington, NC
Nonfarm Employment (000s)	**363.0**	**626.3**	**126.6**
Q/Q Percent Change	1.9	1.2	0.1
Y/Y Percent Change	-0.2	2.6	2.0
Unemployment Rate (%)	**4.8**	**4.0**	**4.3**
Q3:17	4.7	3.9	4.2
Q4:16	5.1	4.3	4.7
New Housing Units	**591**	**3,457**	**691**
Q/Q Percent Change	-20.8	4.5	44.9
Y/Y Percent Change	-4.7	14.6	17.9

NOTE:
Nonfarm employment and new housing units are not seasonally adjusted. Unemployment rates are seasonally adjusted.

	Winston-Salem, NC	Charleston, SC	Columbia, SC
Nonfarm Employment (000s)	**266.4**	**356.3**	**397.5**
Q/Q Percent Change	1.7	0.5	0.7
Y/Y Percent Change	0.3	2.3	-1.2
Unemployment Rate (%)	**4.3**	**3.6**	**4.3**
Q3:17	4.3	3.6	4.1
Q4:16	4.7	4.0	4.3
New Housing Units	**635**	**1,611**	**1,026**
Q/Q Percent Change	-49.8	-2.0	-17.7
Y/Y Percent Change	172.5	19.1	-1.0

	Greenville, SC	Richmond, VA	Roanoke, VA
Nonfarm Employment (000s)	**421.5**	**675.9**	**161.0**
Q/Q Percent Change	1.8	0.4	0.8
Y/Y Percent Change	1.7	0.4	-1.0
Unemployment Rate (%)	**3.8**	**3.8**	**3.7**
Q3:17	3.9	3.8	3.9
Q4:16	4.1	4.2	4.2
New Housing Units	**1,192**	**1,416**	**N/A**
Q/Q Percent Change	-26.0	-24.5	N/A
Y/Y Percent Change	-6.6	48.6	N/A

	Virginia Beach-Norfolk, VA	Charleston, WV	Huntington, WV
Nonfarm Employment (000s)	**781.2**	**117.4**	**140.3**
Q/Q Percent Change	-0.6	0.4	1.7
Y/Y Percent Change	0.3	-0.9	0.1
Unemployment Rate (%)	**4.0**	**5.5**	**5.6**
Q3:17	4.1	5.2	5.6
Q4:16	4.6	5.6	6.0
New Housing Units	**1,361**	**30**	**52**
Q/Q Percent Change	9.6	0.0	0.0
Y/Y Percent Change	4.7	0.0	0.0

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Great Expectations

BY JOHN A. WEINBERG

Why hasn't inflation increased more quickly, given the strength of the economy? Part of the answer might be that firms and households don't *expect* inflation to increase more quickly.

Let's start with how individual firms set prices. Under an assumption of perfect competition, as you learned from your *Economics Principles* textbook, firms don't have any pricing power; they just accept the market price, which is determined by the demand for, and supply of, the good being sold. But a textbook is about the only place you'll find perfect competition; in the real world, goods aren't identical, entering or exiting a market can be costly, and information is far from complete. That means firms have opportunities to seek to maximize their profits given their costs, the demand for their goods, and the behavior of their rivals.

There is currently some debate about the extent to which the market power of the largest firms has increased economy-wide and the ensuing effect on the overall price level. There is little debate among economists, however, about the role of expectations in determining the price level. Beginning in the 1960s, a large body of research has investigated the role that expectations play in dictating the future path of inflation — and the "stagflation" of the 1970s, when unemployment and inflation rose together, demonstrated how inflation expectations, once they are embedded in household and business decisions, can make it hard to bring inflation down.

What does this have to do with firms and prices? In addition to competitive factors, firms also have to factor in future inflation when making pricing decisions. If a firm expects prices on average to rise by 3 percent over the coming year, it will take into account the expected increase in the costs of inputs and the prices of substitutes when setting its own prices today. Multiply that across all the firms in an economy, and expected inflation directly influences actual inflation.

Temporary shocks can alter the path of inflation in the short run. For example, suppose there is a significant increase in the intensity of competition in a large sector of the economy that unexpectedly depresses prices in that sector. The deviation in that one sector — if big enough — could hold down overall measured inflation for a period of time. But in the long run, if inflation expectations remain well-anchored, the underlying trend of low inflation will eventually reassert itself. That is arguably what happened last year when competition drove down the price of wireless telephone plans; by some estimates, that decline contributed to nearly half of the decline in core consumer price index inflation. In recent months, however, inflation has been moving back toward the Fed's 2 percent target, as the Federal Open Market Committee believed it would.

Economists and policymakers can obtain indicators of inflation expectations by asking people what they expect, or they can infer expectations from market activity. In the first category, a well-known survey of consumers conducted by the University of Michigan indicates that inflation expectations have been fairly stable, between 2.2 percent and 2.8 percent in the last three years. In the second category, an important measure is the 10-year "breakeven" rate, which compares the yield of a 10-year Treasury bond to the yield of its inflation-indexed equivalent, the 10-year Treasury Inflation-Protected Security (TIPS). This spread has ranged between 1.2 percent and 2.2 percent in the last three years.

Survey-based measures tend to be higher than market-based measures, which brings me to an important point: We shouldn't interpret the level of any given indicator of inflation expectations as the precise level of expectations for the Fed's benchmark measure of inflation, the index for personal consumption expenditures (PCE). Consumers, for example, might place different weights on various categories of goods than the weights used to calculate the PCE. And the spread between TIPS and nominal bond yields contains not only inflation expectations, but also a risk premium, which is hard to isolate. What matters, then, is not necessarily the level of any measure per se, but rather the changes in that level. Given that levels have remained steady, current inflation expectations appear well-anchored in line with the Fed's target.

The Fed's inflation target is symmetric, which means we are concerned about inflation persistently above or below 2 percent. Because core PCE inflation was below target for quite some time, some observers and policymakers have argued that we should now allow inflation to run above 2 percent for a while. But expectations have not drifted down decisively despite inflation being relatively low. So a period of above-target inflation to ensure stable expectations may not be necessary, since they're reasonably steady to begin with. At the same time, while it may be encouraging that expectations have remained well-anchored despite a number of disinflationary impulses since the Great Recession, this was accomplished in part by unprecedented and unconventional monetary policy actions. Now, as the impulses to inflation appear to be pushing in the other (upward) direction, we have relatively little in the historical record to tell us what might make expectations less stable — which means we shouldn't take their stability for granted.   **EF**

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NEXT ISSUE

Help Wanted

Many companies say they're having a hard time finding employees. Is the problem that there aren't enough workers — in other words, we're simply in a tight labor market — or that workers don't have the right skills? The answer has implications for productivity, wage growth, and inflation.

Leaving LIBOR

Trillions of dollars of financial contracts are based on an interest rate known as LIBOR. But LIBOR, which was at the center of a market-manipulation scandal in recent years, may disappear after 2021. Is the financial system ready?

Sustaining Sovereign Debt

The U.S. debt-to-GDP ratio is high and projected to grow in coming decades. Throughout history, many sovereign nations have defaulted on debt obligations they could no longer honor — sometimes repeatedly — yet creditors continue to lend to them. What enables nations to issue debt in light of this uncertainty, and what are the costs of default once a debt burden becomes unsustainable?

Economic History

Founded in 1876, Baltimore's Johns Hopkins University quickly became America's first research university. Its emphasis on advanced research, doctoral education, and academic publishing created a model that leading universities in the United States emulated by the turn of the century. Today, America's top research universities are considered the best in the world.

Jargon Alert

Machine learning is a hot technology making inroads into insurance, retail, health care, and other sectors. But what the heck is it and how does it work?

Interview

Antoinette Schoar of the Massachusetts Institute of Technology discusses her research on entrepreneurship, the influence of artificial intelligence and big data on the financial industry, and whether the housing crisis was really a "subprime" crisis.

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