Economic Insights

Contents
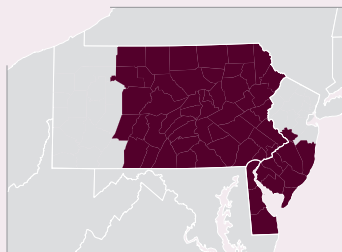
Fourth Quarter 2020   Volume 5, Issue 4

Economic Insights

A publication of the Research Department of the Federal Reserve Bank of Philadelphia

Economic Insights features nontechnical articles on monetary policy, banking, and national, regional, and international economics, all written for a wide audience.

The views expressed by the authors are not necessarily those of the Federal Reserve.

The Federal Reserve Bank of Philadelphia helps formulate and implement monetary policy, supervises banks and bank and savings and loan holding companies, and provides financial services to depository institutions and the federal government. It is one of 12 regional Reserve Banks that, together with the U.S. Federal Reserve Board of Governors, make up the Federal Reserve System. The Philadelphia Fed serves eastern and central Pennsylvania, southern New Jersey, and Delaware.

About the Cover

Supply and Demand

This issue's cover depicts supply and demand. The horizontal axis represents the quantity of a good. The vertical axis represents its price. The downward-sloping diagonal line represents the demand for a good; the upward-sloping line represents the supply. The intersection of these two diagonal lines represents market equilibrium—the price at which you sell just the right amount of a good to maximize your profits and supply the good to everyone who wants it. However, either diagonal line can move in response to changed circumstances. For example, if a fad develops for a product, the demand line should shift up to reflect the higher price and higher demand for that good. This simple graphic—and the core principles it represents—is the cornerstone of modern microeconomics.

Connect with Us

We welcome your comments at:
PHIL.EI.Comments@phil.frb.org

E-mail notifications:
www.philadelphiafed.org/notifications

Previous articles:
https://ideas.repec.org/s/fip/fedpei.html

Twitter:
@PhilFedResearch

Facebook:
www.facebook.com/philadelphiafed/

LinkedIn:
https://www.linkedin.com/company/philadelphiafed/
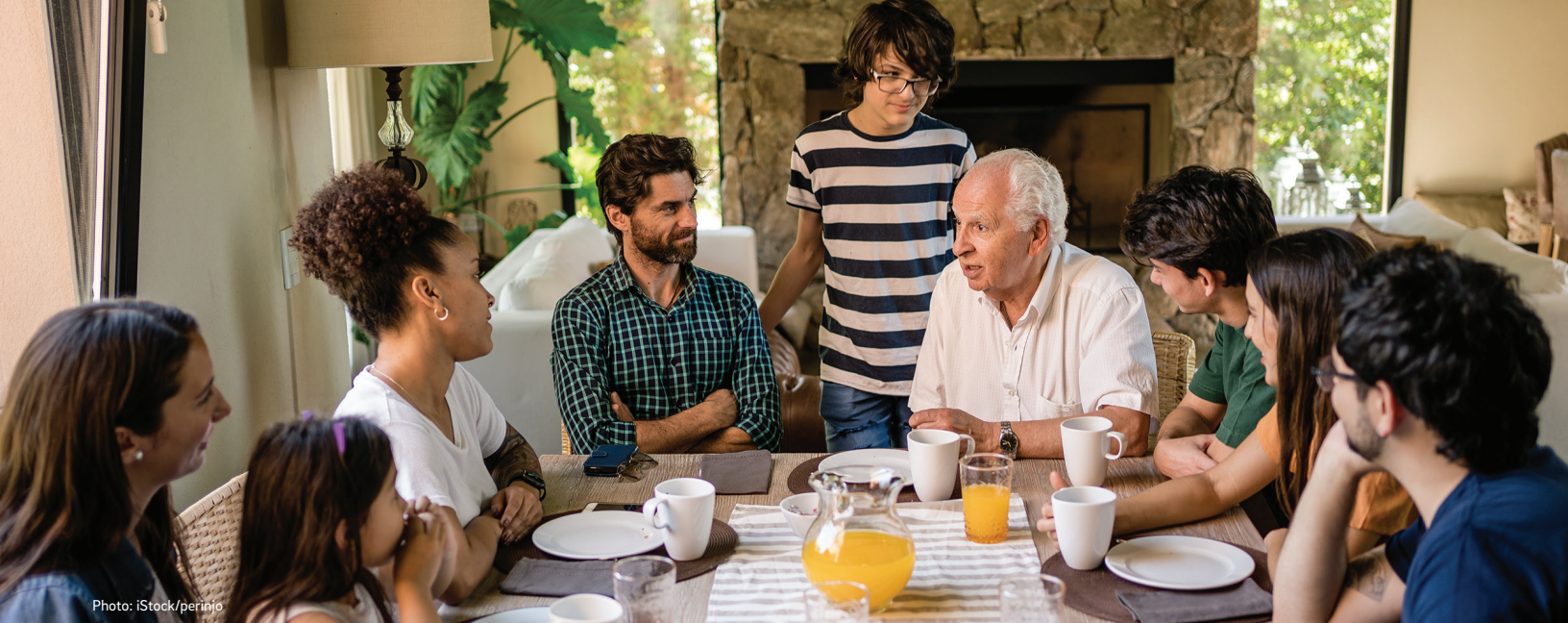
Photo: iStock/perinjo

Baby Boomers vs. Millennials Through Monetary Policy?

Monetary policy affects retired and working households differently. To maintain its commitment to stable prices and maximum employment in an aging society, the Fed may need to rethink monetary policy.

Makoto Nakajima is an economic advisor and economist with the Federal Reserve Bank of Philadelphia. The views expressed in this article are not necessarily those of the Federal Reserve.

BY MAKOTO NAKAJIMA

In many countries, including the U.S., the population is aging and will continue to do so as fewer children are born and medical advancements extend average life expectancy. The proportion of people age 65 and above in each of the (generally rich) Organisation for Economic Co-operation and Development (OECD) countries has been increasing over the past several decades (Figure 1). Across all OECD countries, less than 10 percent of the population was older than 65 in 1970, but that percentage had steadily increased to 17 percent in 2018. Although the U.S. is aging at a slightly slower pace than other OECD countries, the change in its demographic composition is still substantial. In the U.S., the share of the population age 65 and above increased from 10 percent in 1970 to 16 percent in 2018. The proportion of individuals age 65 and above in the U.S. is projected to rise to more than one-fifth by 2050.[1]

Does this aging trend affect the way monetary policy is conducted? Potentially, yes.

Central banks typically conduct monetary policy using one primary policy tool: the policy interest rate. In the case of the

Elderly Population Increasing Fast in OECD Countries
Other countries age faster, but the U.S. is nonetheless experiencing substantial aging.
Percentage of people age 65 and older in each OECD country, actual (1970–2018) and projected (2019–2060)

Source: OECD.

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Federal Reserve Bank of Philadelphia
Research Department

1
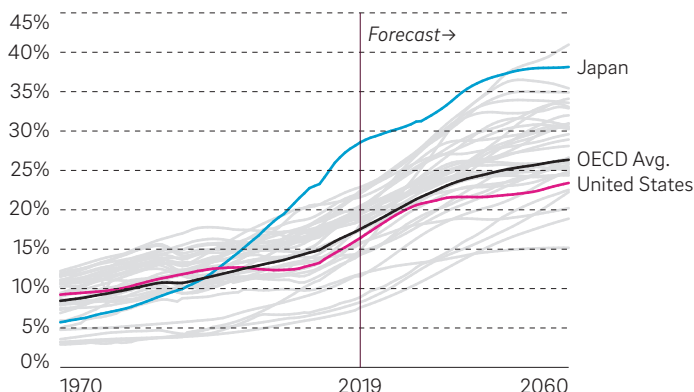
Federal Reserve, its policy interest rate is a target range for the effective federal funds rate. Since they have only one primary policy tool, central banks focus on only a few important goals. The Fed, for example, has just two policy goals: achieving maximum employment and maintaining stable prices. It strives to use the policy interest rate to balance the two.[2] The Fed maintains that its dual goals of maximum employment and stable prices benefit everyone—especially the less-favored segments of society, which particularly benefit from a better labor market. However, to successfully balance these two goals, the Fed must consider how its policies will affect a diverse society, one where people differ in terms of age, income, wealth holding, race, education, and so on. When the composition of society changes significantly, the Fed needs to reconsider how to maintain that balance. For example, if more people are retired, the Fed might want to put less emphasis on maximum employment. In this article, I examine how people in different stages of life differ in terms of income and wealth, how the young and the old may prefer different monetary policies, and how the aging of society potentially affects the conduct of monetary policy because of the differences between the young and the old.

An Overview of Age, Income, and Wealth

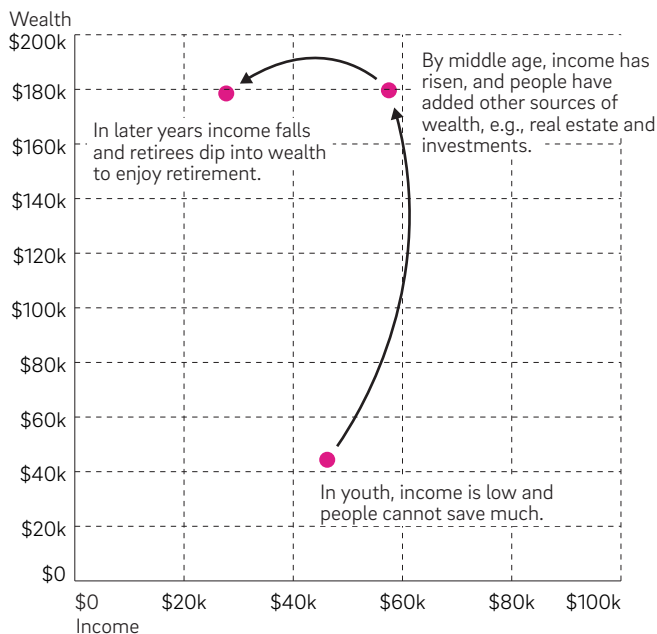Young (age 25-45), middle-aged (46-65), and old (66 and above) households differ in terms of income and wealth (Figure 2).[3] The median income is hump-shaped over the three life stages: It is $46,000 among the young, increasing to $58,000 among the middle-aged, and tapering to $28,000 in old age (Figure 3).[4] Although it is not the focus of this article, there is also a large dispersion of income within each age group.[5] The composition of income shifts from wage income to transfers (Social Security and other pension income) as households age.[6]

As with income, wealth holding increases from youth to middle age as households keep accumulating wealth, but it stays high among the old (Figure 4).[7] The median wealth is $44,000 when young, rising to $180,000 during middle age, and staying at $179,000 after age 65. In terms of composition of wealth, housing is the most important single item in all age groups, but households typically take out a mortgage to buy a house only when they are young or middle aged.[8] As households age, they repay mortgage debt, and the importance of financial assets—in particular, nonequity financial assets—increases.

The Mix of Wealth and Income Shifts from Youth to Old Age

Median wealth and income, young, middle-age, and old households, 2004

In later years income falls and retirees dip into wealth to enjoy retirement.

By middle age, income has risen, and people have added other sources of wealth, e.g., real estate and investments.

In youth, income is low and people cannot save much.

Source: Survey of Consumer Finances.

Median Income Peaks During Middle Age

Most older households are retired and earn less.
Median income by age group, 2004
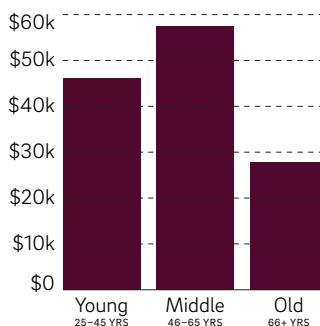
Source: Survey of Consumer Finances.

Note: Age represents age of the head of the household.

Young Have Little Wealth

Young households lack rainy day funds to sustain expenditures when income declines.
Median wealth by age group, 2004

Source: Survey of Consumer Finances.

Note: Age represents age of the head of the household.

2   Federal Reserve Bank of Philadelphia
Research Department

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Young Households (Figure 5)

Relying on Wage Income

Young households have typically just started their working life and their income tends to be lower than the income of middle-aged households. In terms of sources of income, they overwhelmingly rely on income from work: Wage income represents 95 percent of total income for the young. Since the young rely more on wage income, they are more likely to be affected by a monetary policy action that stimulates the labor market (raising wages or lowering the unemployment rate). This channel is more important for the young because the unemployment rate among the young tends to be higher and volatile. For example, during the Great Recession, the overall unemployment rate more than doubled from below 5 percent to 10 percent, which was high. But the unemployment rate for those 16-24 years of age rose from 10 percent to almost 20 percent.

For median young households, only 4 percent of income comes from transfers, but lower-income young households rely more on transfer income from the government. Because they are adjusted for inflation, government transfers do not respond to monetary policy, so these households are probably less strongly affected by monetary policy.[9] In contrast, only 2 percent of income for the median young households is related to business and financial income, whereas higher-income households earn more from business and financial income, which are sensitive to monetary policy. However, these nonwage income sources are relatively minor for median young households, who rely overwhelmingly on income from work.

Living Hand to Mouth

Since most households start their working life with little wealth, it is not surprising that young households own less wealth than other age groups. Therefore, they have less savings (that is, a smaller rainy-day fund) to sustain expenditures when their income declines. They could use credit cards or other forms of borrowing to supplement their income, but young households may have not yet established the solid credit history needed to gain access to credit. These young households are more likely to live month to month, or hand to mouth. Therefore, these hand-to-mouth young households, typically lacking a rainy-day fund or easy access to credit, could benefit from a better labor market in yet another way: If monetary market in yet another way: If monetary policy improves the labor market (and wage income) in a downturn, the hand-to-mouth young do not need to cut as much expenditures. If, however, a downturn is not mitigated by a monetary policy action, the hand-to-mouth young must unwillingly cut expenditures when they experience an income cut or a spell of unemployment, whereas other households with savings or credit cards can sustain expenditures even if their income declines.

Future Homebuyers

At the beginning of their economic life, households usually don't own their homes, either. However, young households are often saving for the down payment on their first house. If monetary policy pushes up house prices, they need to either save more for the down payment to buy the same house or delay their home purchase. In other words, the young as future homebuyers might suffer from higher house prices. This is somewhat counterintuitive: People often assume that it is a good thing when monetary policy raises house prices, because higher house prices make homeowners wealthier, or at least enable them to borrow more using home equity. But renters may suffer from the same increase in house prices.[10]

FIGURE 5

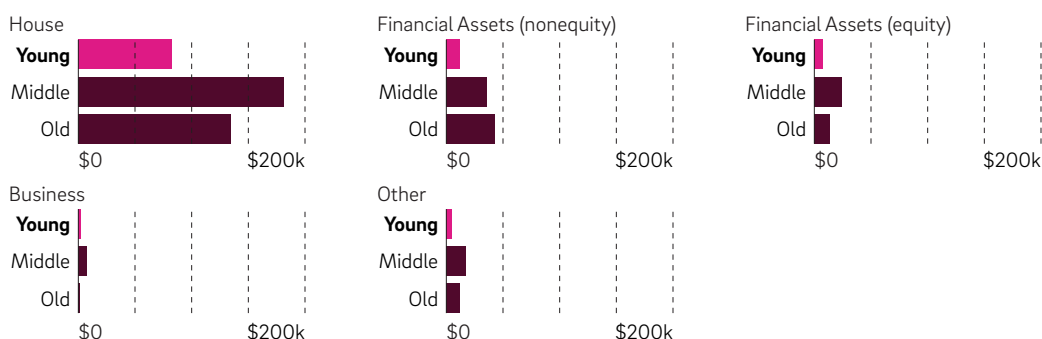## The Young Are Very Reliant on Wage Income

Composition of income, composition of wealth, mean of each age group's 40th to 60th percentiles, 2004

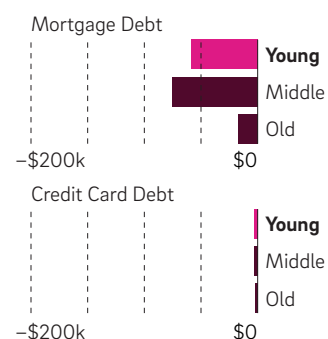**Source:** Survey of Consumer Finances. **Note:** Age represents age of the head of the household.

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Federal Reserve Bank of Philadelphia
Research Department

3

Middle-Aged Households (Figure 6)

Financially Active

Typically, individuals earn their highest income during middle age, so this is when many middle-aged households buy a home and start saving for retirement. Middle-aged households earn more than young households because they have accumulated skills and experiences or climbed the career ladder. They earn more than the old, many of whom are retired. The median middle-aged get the majority (81 percent) of their income from wages. The percentage is lower than for the young, because middle-aged households have more income from other sources, such as business and financial returns. This is especially true for middle-aged households with a higher income.

Middle-aged households on average hold the largest amount of wealth among the three age groups. Although both the young and the middle-aged are typically working, there are stark contrasts between the two working periods. While young households tend to be in less stable employment and have just started saving, possibly for buying a house, middle-aged households are more likely to be in more stable employment, and many have accumulated some wealth.[11] Also, the middle-aged probably have a longer credit history and can use credit more easily than the young. These characteristics make them less likely to be hand-to-mouth than many young households are.

Housing and Mortgages

When households are in middle age and have the highest amount of wealth, housing and mortgage debt comprise the largest part of their portfolio. Eighty percent of middle-aged households are homeowners, compared with 63 percent among the young. (Among the young, the number is higher for those approaching middle age.) And they tend to carry a large balance of mortgages. In other words, they are taking a leveraged position with mortgage debt. This is especially common among relatively young and lower-wealth households: They often have just purchased their house, taking a large mortgage, or they cannot repay their mortgage and accumulate home equity.

When they own a house and hold a large mortgage balance, a monetary policy action that affects the value of housing and mortgages has a relatively large effect on middle-aged homeowners. Here's why: If a middle-aged homeowner has a large fixed-rate mortgage (FRM), and mortgage interest rates go down as a result of a monetary policy action, this household can benefit by refinancing and resetting its mortgage interest rate to the lower rate. This lower mortgage rate could free up some money for middle-aged homeowners to increase their expenditures. Interestingly, this channel is asymmetric. If the mortgage interest rate rises, possibly due to monetary policy tightening, homeowners can stick with their existing FRM and remain unaffected by the higher mortgage rate.

How many homeowners with FRMs respond to a lower interest rate? That depends on the interest rate of existing mortgages among homeowners. If many homeowners have a mortgage with a high interest rate, lowering the policy rate could encourage them to refinance their mortgage and benefit from a lower interest rate. In other words, the effect of monetary policy action through mortgages depends on the recent history of interest rates.[12] This argument mainly applies to FRMs, which is the most common choice for homeowners in the U.S., but it could also apply to adjustable-rate mortgages (ARMs)

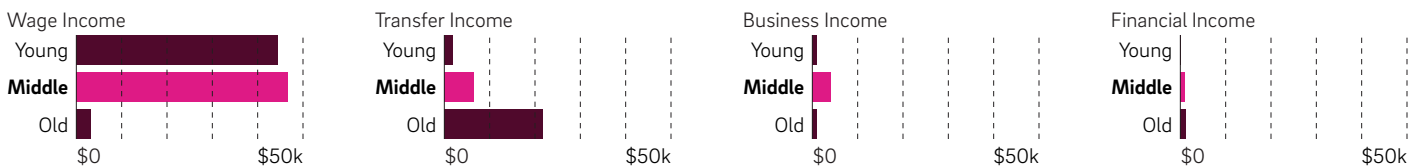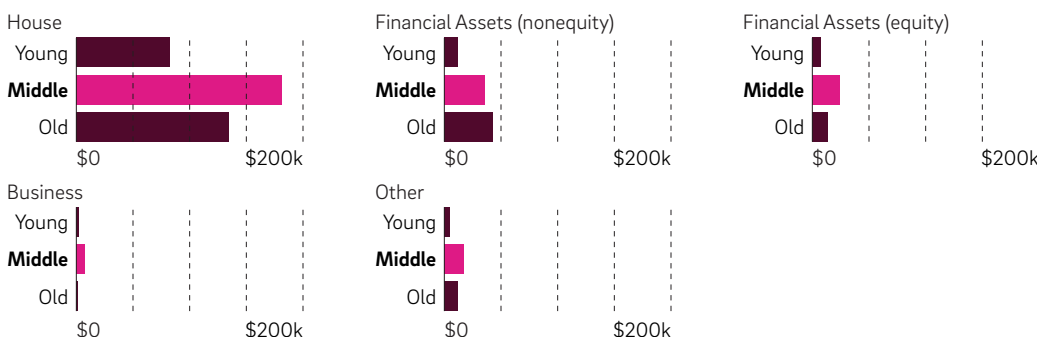*See **Fixed-Rate vs. Adjustable-Rate Mortgages**.* →

The Middle–Aged Are Also Reliant on Wage Income, but Actively Accumulating Housing and Financial Wealth

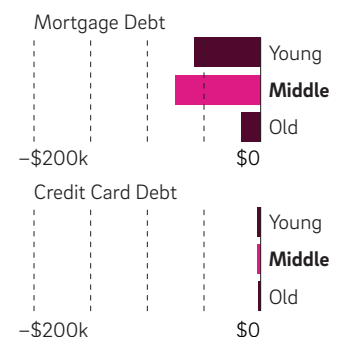Composition of income, composition of wealth, mean of each age group's 40th to 60th percentiles, 2004

Source: Survey of Consumer Finances.   **Note:** Age represents age of the head of the household.

when the rate is adjusted infrequently, such as every year or every five years.

Because many middle-aged households are home-owners, they could benefit when an accommodative monetary policy positively affects house prices. But things might not be so simple. First, buying and selling a house is costly, financially and possibly psychologically. If middle-aged homeowners do nothing when their house becomes more valuable, house prices have no immediate effect on those households. Second, if they are planning to buy a bigger house to live in, possibly because the family is expanding, they suffer from higher house prices, just like younger households saving for the down payment on their first house.

Liquidity of Assets Held

The fact that buying and selling a house is costly leads to another consideration: liquidity. Imagine a middle-aged homeowner who is unwilling or unable to sell or refinance their house, cannot find a good house to move to, or cannot easily find a buyer. In that case, their house is an illiquid asset, and they cannot use the value of the house as a rainy-day fund even if the house is valuable. In other words, although the home-owner has a house, the situation is similar to that of a young household without any savings, in the sense that neither has liquid assets, which are easily used to supplant lost income. The liquidity issue is not limited to housing. Middle-aged households also accumulate wealth in 401(k), Roth IRA, and other retirement saving plans. These retirement saving vehicles are often costly to liquidate or borrow against, making middle-aged households with these assets like homeowners who cannot liquidate their house.

Because middle-aged homeowners who cannot easily sell their house or liquidate their retirement savings are similar to young hand-to-mouth house-holds (who do not have savings), Greg Kaplan, Giovanni Violante, and Justin Weidner name these middle-aged households "wealthy hand-to-mouth."[14] If monetary policy action improves labor market conditions and their income increases, they could benefit from that action–just like young households without savings–by increasing their expenditures, which they weren't able to do previously because of the illiquidity of housing or retirement savings.

Indeed, recent empirical research finds that monetary policy affects the economy through its effect on mortgages. Moreover, research suggests that this effect is amplified because of the illiquidity of housing assets.

*See **Effects of Monetary Policy Through Mortgages: What the Data Say.***

Fixed-Rate vs. Adjustable-Rate Mortgages

Figure 7 shows the percentage of all mortgages that were ARMs from 1985 to 2008. As Emmanuel Moench, James I. Vickery, and Diego Aragon at the Federal Reserve Bank of New York discuss, the share fluctuates substantially over time, reaching the highs of 60 to 70 percent in 1988 and 1994 but falling significantly to the record lows leading to the Great Recession.[13] The authors use a separate data series (the Lender Processing Service) to show that the percentage remained below 10 percent until 2010. They argue that low long-term interest rates help account for the declining popularity of ARMs.

FIGURE 7

The Mortgage Market Shifted Away from ARMs Prior to the Great Recession

Low long-term interest rates may account for the declining popularity of adjustable-rate mortgages.

Percentage of all mortgages that have adjustable rates, 1985–2008

Source: Federal Home Finance Agency, Monthly Interest Rate Survey.

Note: The data include all conventional single-family mortgages on both newly built homes and existing homes. The data were discontinued in 2008.

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Federal Reserve Bank of Philadelphia
Research Department

5

Effects of Monetary Policy Through Mortgages: What the Data Say

Although detecting monetary policy's effect on different groups of households is far from easy, a recent study finds that homeowners with mortgages are significantly affected by monetary policy. Using data from the UK and the U.S., James Cloyne, Clodomiro Ferreira, and Paolo Surico (2020) look at how monetary policy actions affect expenditures by various households. They find that homeowners with a mortgage increase consumption expenditures significantly in response to a policy rate cut, while homeowners without a mortgage do not adjust their expenditures at all. Renters also increase their spending but less so than mortgage holders. They argue that the stronger response of mortgage holders is due to the combination of the lower expenses associated with having a mortgage and their being wealthy hand-to-mouth.[15]

However, the empirical research about the effects of monetary policy on diverse households is generally limited and inconclusive, because there is no easily accessible high-quality and high-frequency data on individual consumption expenditures. In addition to availability of microdata, there are three issues that make it hard to cleanly isolate the effect of a monetary policy action. First, the government might implement a fiscal stimulus while an accommodative monetary policy action is implemented. This makes it difficult to distinguish the two policy effects. Second, if consumers and firms expect a monetary policy action, they might respond before the action is taken, and not when the action is taken. In that case, consumption data after a monetary policy action does not reveal the response of consumers to a monetary policy action, which is something we want to observe. Finally, at least in the U.S., there are generally only eight possible monetary policy changes per year, and we can use data only up to 2007 (after which the policy rate became zero).[16]

Older Households (Figure 8)

Relying on Pension Income

Older households earn less than middle-income households because most older households are retired. This is why typical households save during their working life, especially during their peak earning years, as they prepare for life after retirement. There is a striking contrast between old households and those of working ages (young and middle-aged) in terms of sources of income. The majority (78 percent) of income for median older households is transfer income, which mainly consists of Social Security benefits and other pension income. Meanwhile, only 11 percent comes from wage income, because few older households continue to work after age 65. Older-household income is lower than that of the middle-aged because Social Security benefits and pension income are typically lower than wage income before retirement. Business and financial income make up the rest. Although business and financial income is more important for higher-income older households, the large share of transfer income is common across different income groups.

How does monetary policy affect retirement income? It depends on the type of retirement income. Social Security and defined benefit (DB) pensions are largely unaffected by economic conditions, because the amount of benefits is pre-determined. Moreover, Social Security benefits are adjusted for the cost of living, which means that the amount of benefits is adjusted to reflect changes in the inflation rate, nullifying the effects from inflation. Some DB pensions offer cost-of-living adjustments as well.

However, defined contribution (DC) pensions and individual retirement accounts (IRAs) are becoming more widely used. For both DC pensions and IRAs, the effect of monetary policy depends on how they invest money across different asset categories. If DC pensions and IRAs invest mostly in equities, the performance of equity markets affects pension income. Thus, monetary policy could affect income from DC pensions

See *Shifting Composition of Retirement Savings*. ↘

FIGURE 8

Older Americans Are Heavily Reliant on Transfer Income

Composition of income, composition of wealth, mean of each age group's 40th to 60th percentiles, 2004

Income by Type

Wealth Assets by Type

Wealth Liabilities by Type

Source: Survey of Consumer Finances. **Note:** Age represents age of the head of the household.

and IRAs, insofar as monetary policy affects equity returns. If DC pensions or IRAs invest mostly in bonds, retirement income is affected by retur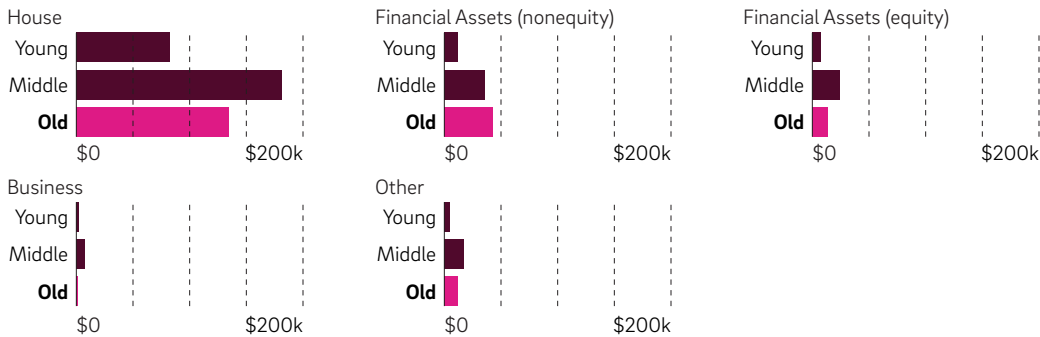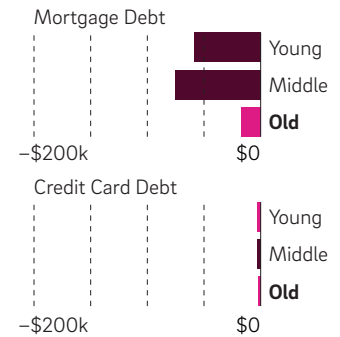ns from bonds. How monetary policy affects the returns of bonds depends on various factors. Generally, a lower interest rate pushes up prices of bonds. On the other hand, if a rate cut causes inflation, the value of nominal bonds decreases. In the end, there is no single answer to the question of how monetary policy affects the income of the retired.

Housing Wealth Effect

Older households hold as much wealth as middle-aged ones, but there is a shift in the composition of their wealth. First, older households hold only a small balance of their mortgage outstanding (9 percent of wealth), as they are almost finished repaying their mortgages. Second, housing is still the biggest item (73 percent) in their portfolios. This means that a typical older household owns its house free and clear. Third, there is a shift from equity to nonequity financial assets as households transition to retirement. However, there are differences among wealth groups. Although middle-wealth and low-wealth older households typically shift their portfolios to nonequity financial assets, top-wealth older households keep a significant fraction of their portfolios in equity and business assets.

Since most older individuals are no longer working and have mostly repaid their mortgages, monetary policy actions do not directly affect older households through the labor market (unlike the young) or mortgages (unlike the middle-aged). Instead, older households are more likely affected through prices of assets,

especially housing. Unlike younger cohorts, they are more likely to downsize (that is, move into a smaller house, switch to renting, or move into a nursing home). Therefore, they benefit more from an increase in their home values as they can cash in the higher value of their houses when they sell. Indeed, they could increase their expenditures even before selling, anticipating the income they expect to receive when they sell their houses. This is called the wealth effect.

Importance of the Time Horizon

Although the wealth effect applies to equity prices, too, many older households, especially not the wealthiest ones, own less equity after liquidating their retirement assets, and thus the effect of monetary policy through equity prices is limited among the old. This reduced exposure to equity is consistent with a simple portfolio allocation theory, which says that elderly households should shift their asset portfolios from risky assets like stocks to safer assets, since they do not have a long time horizon (that is, remaining life) to average out the higher-on-average but volatile returns of risky assets. However, depending on what kind of safe financial assets are held, how older households are affected by monetary policy differs. A higher interest rate is usually considered a form of monetary policy tightening. But if elderly households invest more in interest-bearing assets such as savings accounts as they move away from equity, they could benefit from a higher interest rate. On the other hand, if they invest in bonds, they benefit from a looser monetary policy, because bond prices rise in response to a lower interest rate.

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Federal Reserve Bank of Philadelphia
Research Department

7

All these channels could affect the expenditure behavior of older households more strongly than of younger households because older households have a shorter time horizon. For example, if a younger and an older household each receives $100, the latter is likely to spend the money faster because it has less time to spend it.[17] Indeed, according to recent empirical research,

consumption by older individuals responds more strongly to an accommodative monetary policy action.[18] This research indicates that, although a lower interest rate may hurt those who own interest-bearing assets, the effect isn't strong enough to counteract the positive effects on asset values.

Shifting Composition of Retirement Savings

In the U.S., the composition of retirement savings except for Social Security has been shifting consistently from DB pensions to DC pensions and IRAs (Figure 9, data depicted two ways). In 1970, almost all retirement savings were DB pensions, but many employers since then have switched to DC pensions. In addition, since 1981, IRAs have become an important part of retirement savings. As a result, the proportion of DB pensions shrank from 95 percent in 1970 to 47 percent in 2019, and DC pensions (24 percent) and IRAs (29 percent) had become a large part of retirement savings.

The shift from DB to DC pensions is even more dramatic in the private sector, where the fraction of DB pensions (excluding IRAs) declined from 83 percent to 34 percent, whereas DB pensions

FIGURE 9

Composition of Retirement Wealth

The decline in defined benefit pensions may expose more older households to asset price risks.
Percent of retirement funds, by category, 1970–2019

Source: Flow of Funds, Federal Reserve Board.

Note: The data include pensions from the private sector and from the federal, state, and local government sectors.
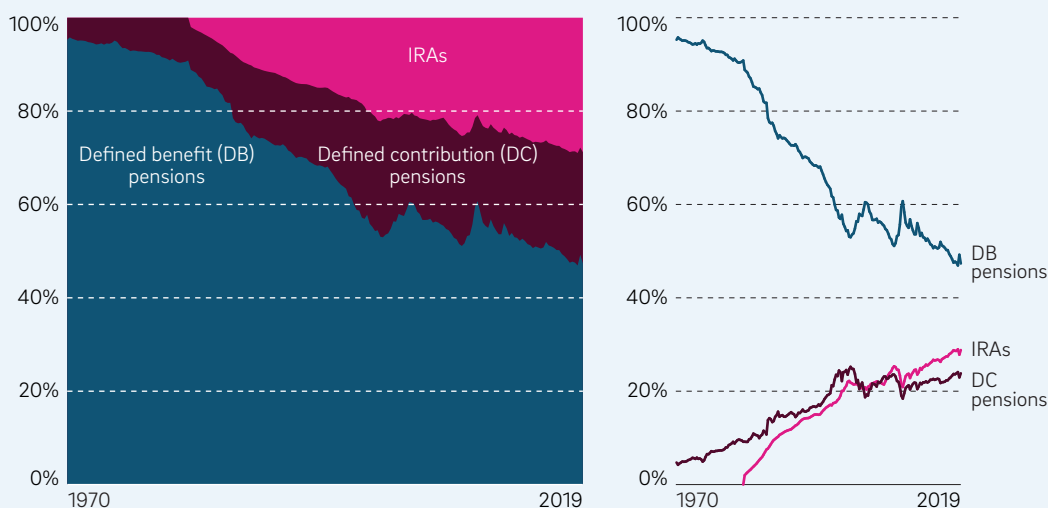
are still prevalent in the public sector. This implies that older households could be more exposed to asset price risks, especially when

they invest in riskier assets under a DC pension plan or an IRA.

Taking Stock

Let's review the differences across age groups discussed so far in this article. Young households are affected by monetary policy mainly through its effect on the labor market and wage income, since they do not own much wealth. They could particularly benefit from a monetary stimulus in a downturn because they are more likely to live hand to mouth.

Because most middle-aged individuals are homeowners with mortgages, a monetary policy action will have an important effect on them. A policy rate cut could allow them to refinance at a lower rate and then use the savings to support higher spending. Empirical research finds that spending by mortgage holders

responds strongly to rate cuts, indicating that these households are likely to be wealthy hand-to-mouth. If they are not, a change in the interest rate is not likely to affect the spending behavior of mortgage holders.

Finally, retired households have a shorter time horizon and are typically dissaving their wealth. Therefore, they respond to changes in the value of their houses more strongly than other age groups. On the other hand, the effect of monetary policy through retirement savings depends on the type of retirement savings, the composition of which has been changing over time, and on the portfolio choice decision of each retiree.

8   Federal Reserve Bank of Philadelphia
Research Department

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Aging and Monetary Policy

As a population ages, more households are retired.[19] Even though the two goals of monetary policy remain intact, as long as the monetary authority aims to take care of households in different stages of life equally, monetary policymakers might want to pay more attention to older retired households as the population ages. And retired households are affected differently by monetary policy. This has three implications for monetary policy.

First, since older households are mostly affected by the prices of the assets they hold, especially housing, more attention needs to be paid to the effect of monetary policy on the price of housing and financial assets. In other words, even though maximum employment remains one of the Federal Reserve's two goals, a shift of emphasis from the labor market (which is important for younger households) to the asset market (which is important for older households) might be necessary as the population ages.

Will this shift how monetary policy is conducted? Not necessarily. If older retired households benefit from the effects of monetary policy on asset markets, exactly when younger working households benefit from the effects on the labor market, shifting some of the emphasis from the labor market to the asset market does not imply a drastic change in the way monetary policy is conducted.

Second, this fortunate coincidence might not always be the case. When a monetary authority is worried about the economy overheating and inflation, it might want to increase its policy rate. But it might want to be more cautious in an aging society, because a rate increase may lower the prices of retired households' houses and financial assets, thus hurting a large number of retirees. Also, if a monetary policy action affects the asset market more strongly than the labor market, it could benefit older households, who are owners of assets, at the expense of young households, who are future buyers of assets.

Third, how monetary policy affects retired households depends on the composition of their assets. For retirees with housing and equity, monetary accommodation benefits them as well through its effects on the prices of housing and equity. On the other hand, for retirees investing in savings accounts, a lower interest rate hurts their income.

Broader Implications

In this article, I focused on how differences in income and wealth across age groups affect monetary policy in an aging economy. However, aging has other, broader implications for monetary policy. For one, as documented in Lukasz Drozd's 2018 *Economic Insights* article, aging seems to lower interest rates. Because middle-aged and older households hold more savings, and people save more when faced with longer life expectancy and rising health expenditures, total savings in a society increases as the population ages. When there is more savings available, the price of savings–that is, the interest rate–goes down.[20] This is one reason why interest rates have trended down in most rich countries, including the U.S. So long as inflation remains low, the nominal policy rate could stay close to zero, leaving a central bank less room to lower its policy interest rate even if it wants to stimulate the economy.[21]

Another, related implication is that aging might lower the interest rate of safer assets such as government bonds, relative to riskier assets such as stocks. This could cause a shift in portfolio allocation, most notably for older asset holders, and affect monetary policy indirectly, since the monetary authority needs to take into account such a shift in portfolios.

Finally, monetary policy in the U.S. could be affected indirectly. First, the aging of a population may also affect fiscal policy–via a public pension system or subsidies to private retirement savings, for example–and how the fiscal authority responds to aging affects monetary policymaking as well. Second, the whole world, including China, is rapidly aging. Because financial markets are globally connected, this could affect how monetary policy affects people through financial markets.

The U.S. and other high-income countries are aging, and an aging population could affect monetary policy in many ways. This aging's potential impact on monetary policymaking has been recognized by central bankers such as Bank of England Chief Economist Charles R. Bean, who made a speech on this topic at the Jackson Hole Symposium in 2004. One of the things Bean emphasized is that the effects of aging, including its effects on monetary policy, are gradual. Moreover, the U.S. is aging more slowly than other high-income countries, such as Japan and Italy. Maybe the U.S. has a bit more breathing room. However, because of these indirect channels, the breathing room could be smaller than it seems. The whole world is aging, and many countries are aging more rapidly than the U.S. Since we live in an interconnected world, the effects of aging in other countries could force U.S. monetary policy to respond even if the aging process in the U.S. is more gradual. ◫

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Federal Reserve Bank of Philadelphia
Research Department

9

Notes

1 The source for these figures is OECD.Stat, population projections.

2 The Federal Reserve Act states that the Federal Reserve "promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." This is commonly referred to as the Federal Reserve's dual mandate of maximum employment and price stability.

3 I look at households instead of individuals because it is difficult to measure wealth for each individual within a household. To calculate the income of a household, I sum the incomes of all members within the household.

4 Income here includes all kinds of income, such as wage income, financial income, rent income, income from business, and transfers from the government. The data are from the Survey of Consumer Finances, which is compiled by the Federal Reserve Board of Governors.

5 My Philadelphia Fed *Business Review* article "The Redistributive Consequences of Monetary Policy" looks at how monetary policy causes redistribution among different income groups, especially when there is a large dispersion in income.

6 In computing the composition of income, I take the 40th–60th percentiles of households in each income group and calculate the average amount for each of the income categories. This is to avoid looking at the income composition of only one household with the median income.

7 Wealth includes both financial wealth (such as bank account balances, stocks, bonds, mutual funds, and retirement accounts) and nonfinancial wealth (such as housing, businesses, and cars), net of all kinds of debt (including mortgages, credit card balances, college loans, and car loans).

8 See footnote 6 for how this figure is constructed. Debt is represented with negative values.

9 Government changes its transfer policy often in sync with monetary policy action, since both are used to cope with a recession, but this is different from the government responding to a monetary policy action.

10 In my *Business Review* article "The Diverse Impacts of the Great Recession," I make a similar argument about the Great Recession, namely, that the large decline in house prices during the recession made housing affordable for young households. Of course, young households might have suffered in terms of income as well, so the recession's overall effect on the young is ambiguous.

11 But note that losing a job has more serious income-related consequences for middle-aged workers. Johnson and Monnaerts (2011) find that when older workers lose their jobs, they take longer than their younger counterparts to become reemployed, and when they do find work, they generally experience a decline in wages.

12 Eichenbaum, Rebelo, and Wong (2019), among others, make this point.

13 The data series was discontinued in 2008.

14 See their 2014 article.

15 The contrast between homeowners with mortgages, homeowners without, and renters is stronger with durable-goods expenditures. After an unanticipated cut in the policy rate, homeowners with a mortgage increase their purchases of durable goods by up to 1.2 percent, while homeowners without debt do not change their expenditures. Renters' maximum response is 0.8 percent. With nondurable goods and services, homeowners with mortgages increase their expenditures by up to 0.4 percent, while the response of homeowners without mortgages is negligible. Renters respond like mortgage holders in terms of nondurable goods and services. Wong (2015) confirms this finding: Middle-aged home-owning households with mortgages increase their expenditures significantly when the policy rate is lowered.

16 While the policy rate was near zero (the "zero-lower-bound" period), the FRB used so-called unconventional monetary policies, such as asset purchases ("quantitative easing"), and communication to affect expectations of future interest rate policy ("forward guidance"). Their policies could, and perhaps did, work as a substitute for policy rate adjustments used in normal times, but there is no consensus about the strength of their impacts, or about how to convert the impacts into changes in policy rates, which makes it difficult to use the data during the zero-lower-bound period together with the data from the normal period. See, for example, Rudebusch (2018).

17 The desire of older households to leave bequests could weaken this argument.

18 See Berg, Curtis, Lugauer, and Mark (2019), who stress the importance of the shorter time horizon and strong wealth effect for older households.

19 As individuals live longer, the typical retirement age has been raised in many rich (and older) countries, but this increase in the retirement age has not kept pace with the increase in life expectancy.

20 To be more precise, the real (controlled for inflation) interest rate declines.

21 Rudebusch (2018) discusses the Fed's so-called unconventional monetary policy during the period when the nominal policy rate is close to zero.

References

Bean, Charles R. "Global Demographic Change: Some Implications for Central Banks," Speech at Jackson Hole Symposium, Jackson Hole, WY, August 26–28, 2004.

Berg, Kimberly A., Chadwick C. Curtis, Steven Lugauer, and Nelson C. Mark. "Demographics and Monetary Policy Shocks," NBER Working Paper No. w25970 (2019), https://doi.org/10.3386/w25970.

Cloyne, James, Clodomiro Ferreira, and Paolo Surico. "Monetary Policy When Households Have Debt: New Evidence on the Transmission Mechanism," *Review of Economic Studies*, 87:1 (2020), pp. 102–129, https://doi.org/10.1093/restud/rdy074.

Drozd, Lukasz. "The Policy Perils of Low Interest Rates," Federal Reserve Bank of Philadelphia *Economic Insights* (First Quarter 2018), pp. 1–10, https://www.philadelphiafed.org/the-economy/monetary-policy/the-policy-perils-of-low-interest-rates.

Eichenbaum, Martin, Sergio Rebelo, and Arlene Wong. "State Dependent Effects of Monetary Policy: The Refinancing Channel," NBER Working Paper No. w25152 (2019), https://doi.org/10.3386/w25152.

Johnson, Richard W., and Corina Mommaerts. "Age Differences in Job Loss, Job Search, and Reemployment," The Program on Retirement Policy Discussion Paper 11-01, The Urban Institute (2011).

Kaplan, Greg, Giovanni L. Violante, and Justin Weidner. "The Wealthy Hand-to-Mouth," Brookings Papers on Economic Activity (2014).

Moench, Emanuel, James I. Vickery, and Diego Aragon. "Why Is the Market Share of Adjustable Rate Mortgages So Low?" Federal Reserve Bank of New York *Current Issues in Economics and Finance*, 16:8 (2010), pp. 1–11.

Nakajima, Makoto. "The Diverse Impacts of the Great Recession," Federal Reserve Bank of Philadelphia *Business Review* (Second Quarter 2013), pp. 17–29.

Nakajima, Makoto. "The Redistributive Consequences of Monetary Policy," Federal Reserve Bank of Philadelphia *Business Review* (Second Quarter 2015), pp. 9–16, https://www.philadelphiafed.org/the-economy/monetary-policy/the-redistributive-consequences-of-monetary-policy.

Rudebusch, Glenn D. "A Review of the Fed's Unconventional Monetary Policy," Federal Reserve Bank of San Francisco *Economic Letter*, 2018-27 (2018).

Wong, Arlene. "Population Aging and the Transmission of Monetary Policy to Consumption," Working Paper (2015).

Baby Boomers vs. Millennials Through Monetary Policy
2020 Q4

Federal Reserve Bank of Philadelphia
Research Department

11

Photo: iStock/Tom Kelley Archive

How Accurate Are Long-Run Employment Projections?

The occupational mix has been changing for decades. Planners and decision makers need to know how it will continue to change, and why.

Enghin Atalay is a senior economist at the Federal Reserve Bank of Philadelphia. The views expressed in this article are not necessarily those of the Federal Reserve.

BY ENGHIN ATALAY

Projecting the future is immensely challenging. In October 1929, eight days before the stock market crash, economist Irving Fisher said that "stock prices have reached what looks like a permanently high plateau."[1] In a 2012 statement, Google cofounder Sergey Brin predicted that autonomous cars would be widely available within five years.[2] Closer to the focus of this article, although the U.S. Bureau of Labor Statistics' (BLS's) long-run projections of the labor market generally perform well, certain projections have not come to pass. In 2010, the BLS projected that the number of telemarketers would grow slightly, by 7 percent, over the next decade. Instead, the number of telemarketers has fallen by almost half.

None of us is Nostradamus. Yet, planners and decision-makers depend on projections of future conditions. Projections of financial market conditions and technology adoption shape individuals' and firms' investment decisions. BLS projections of future employment patterns guide career counseling for students, educational policy (for example, designing appropriate curricula), and state and local governments' planning for fiscal and regulatory policy.

In this article, I discuss long-run projections—looking 10 or more years ahead—of employment in different occupations.[3] I address three questions. First, why do some occupations tend to grow faster than others? Understanding the forces that have led workers to move out of certain occupations and into others will set the foundation for addressing our second question: How have economists, both those in governmental agencies and those in universities, developed projections for occupations' employment growth? And third, are their projections accurate, or is there room for improvement?

To preview the answers to these three questions: Computerization, globalization, and the declining importance of manufacturing are primary factors shaping the evolving occupational mix. Academic projections usually focus on individual factors, while the BLS approach is more comprehensive. Although BLS projections perform well, there may be room for improvement via incorporating certain projections from academic articles.

Why Some Occupations Grow Faster than Others

The share of workers in different occupations has changed dramatically in recent decades. Between 2000 and 2019 the share of production workers–including assemblers, machinists, and welders–within the workforce declined from 8.2 to 6.1 percent, a decrease of 25 percent (Figure 1).[4] The share of workers in office and administrative support occupations has also declined considerably. On the flip side, business and financial, computer and mathematical, and personal care and service occupations have all increased their share of the workforce by at least 25 percent since the turn of the century.

Economists have identified three phenomena that may account for these changes: computerization, offshoring, and the declining importance of manufacturing.

First, information technologies have proliferated in the American workplace. Since 1960 investment in information-processing equipment and software has increased nearly 25-fold, from $33 billion to $806 billion, in 2019 dollars (Figure 2).[5] These investments have reduced demand for worker-performed, "routine" tasks–such as conducting simple calculations, organizing records of office activities, and operating and monitoring production processes–that can now be performed automatically by computer-controlled systems.

Other, "nonroutine" tasks, such as providing companionship as part of convalescent care, meeting with customers or suppliers, and conducting original research, are difficult if not impossible to computerize. Human labor is increasingly in demand for these nonroutine tasks relative to routine tasks.
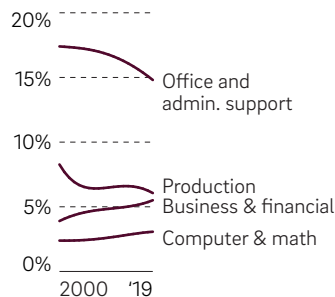
As a result of increasing computerization, employers' demand for workers in occupations rich in nonroutine tasks (such as the business and financial, computer, and personal care occupations mentioned above) is increasing relative to the demand for occupations rich in routine tasks (such as production and clerical occupations).

Second, facilitated by lower trade costs, easier communication between countries, and productivity gains abroad, trade

between countries has grown considerably (Figure 3). For the U.S., the ratio of imports to GDP more than tripled between 1960 and 2019, increasing from 4 percent to 15 percent.[6] Over the same period, exports have also increased, though not as strongly, from 5 percent of GDP to 12 percent.[7]

Globalization has had two countervailing effects on the labor market. On the one hand, increased competition from more-recently industrializing countries like China, Mexico, and South Korea has reduced the share of U.S. workers in manufacturing,[8] lessening the demand for production workers. On the other hand, both trade policy and improvements in information technology have lowered the cost of transmitting services across national boundaries. Although certain services have moved offshore, the U.S. is a global leader in high-skill, high-technology service industries and so may gain from globalization. Globalization likely reduces the demand for certain types of workers–mainly those in manufacturing, like production occupation workers–but may increase the demand for workers in other occupations.

Third, as a country develops, its share of workers within the manufacturing sector declines. This occurs for two reasons. First, richer households consume more services–including education, restaurant services, and domestic services–in relation to goods. So, over time, as a country's households become richer, on average, the manufacturing sector's share of that country's economy shrinks.[9] In addition, productivity growth in the manufacturing sector has been faster than in the service sector. Because an increase in productivity enables firms to produce more with less labor, this differential in productivity growth rates has further reduced demand for labor in manufacturing relative to services.[10] Because certain types of jobs (mainly in production occupations) are concentrated in manufacturing, the decline of manufacturing relative to services also alters the occupational mix.

These three trends have transpired over the last several decades, are likely to persist for decades more, and underpin projections on the future of work.

How Projections Are Made

Economists tend to take two complementary approaches for determining which occupations are likely to grow or shrink. Academic studies focus on individual explanations for occupations' differential growth rates, whereas the BLS occupational employment projections are comprehensive, encompassing multiple explanations for shifts in the relative size of occupations.

The BLS follows a multistep procedure to ensure that its employment projections are consistent with its other projections of economic activity. First, using its macroeconomic model, the BLS develops projections for three aggregate variables: population growth, GDP growth, and the aggregate labor force participation rate.[11] Then, the BLS projects future exports, imports, and consumers' final demand for each industry. To calculate future labor demand within each industry, the BLS combines its projections of the output that will be produced by each industry with estimates of how much labor is required to produce each unit of output. In the final step, the BLS uses its National Employment Matrix, which describes the share of each industry's workers who come from each occupation. This matrix gives, for example, the fraction of workers in the scheduled air transportation industry who are flight attendants (25.8 percent as of 2019); airline pilots, copilots, and flight engineers (16.1 percent); and reservation and transportation ticket agents (13.9 percent).[12] Knowing how much each industry's employment is likely to grow, and knowing each occupation's employment share within each industry, the BLS can thus compute the projected economy-wide size of each occupation.[13]

In contrast to the BLS projections, academic projections focus on individual sources of occupational change.

When academic economists Blinder (2009) and Jentsen and Kletzer (2010) estimate individual occupations' risk of being offshored, their main input is the Occupational Information Network (O*NET) database. Developed by the U.S. Department of Labor (DOL), this database provides detailed information on each occupation's skill and knowledge requirements, main work activities, required tools and technologies, and other job characteristics. The DOL bases its measurements on extensive interviews with workers in each of more than 700 occupations. Both Blinder and Jentsen and Kletzer postulate that jobs that rely on face-to-face contact (for example, in child care) or where the work is done on site (for example, short-order cooking) are less likely to be offshored. (In addition, Jentsen and Kletzer's offshorability index is high for occupations with a high concentration of routine tasks and low for jobs that involve analyzing or processing information that is easily transmittable across space.) By applying these hypotheses and using different combinations of O*NET survey questions, Blinder and Jentsen and Kletzer each constructs an index of occupations' risk of being offshored. The two indices are not identical, but they strongly correlate with each another.

Another pair of academic economists, Frey and Osborne (2017), uses information from O*NET to assess the probability that jobs within each occupation will be lost due to automation within the next decade or two. (Although their paper was published in 2017, they made their main projections at the start of that decade.) As advised by machine learning experts, they began their procedure by hand-labeling 70 occupations as either automatable or not. Then they identified the characteristics of occupations at low risk of being lost to automation: They tend to require high levels of social perceptiveness, caring for others, originality, negotiation skills, and persuasion skills. Conversely, the occupations labeled as likely to be automated involve high levels of manual and finger dexterity.[14] Then, for each of the 702 occupations in their sample, Frey and Osborne used the occupation's measured social perceptiveness, originality, and so on to provide a summary measure of its risk of automation. They found that occupations in production, office and administrative support, and transportation and material moving are at high risk for automation, while education and healthcare occupations are among those at low risk of automation.

Before assessing the accuracy of different projections, it helps to examine whether they are correlated with one another. In other words, are the occupations that the BLS projects to shrink merely the ones that Frey and Osborne have identified as susceptible to automation, or that Blinder and Jentsen and Kletzer have identified as likely to be offshored? Table 1 presents the correlations[15] between the BLS 2010-2020 projections of employment growth, Frey and Osborne's measure of the probability of loss to automation, and the average of Blinder's and Jentsen and Kletzer's measures of offshoring.[16] In addition, I include in these correlations a measure of each occupation's routineness.[17] As this table makes clear, the BLS projections are correlated with each of the three occupational measures. Furthermore, Frey and Osborne's measure is highly correlated with each occupation's routine task intensity. Overall, the different measures–while applying different methods and emphasizing different factors contributing to changes in the occupational mix–yield similar but distinct projections of which occupations are likely to grow or shrink in the future.

TABLE 1

Correlations Among Projections

	Automation	Offshorability	Routineness	BLS Projection
Automation	1			
Offshorability	0.10	1		
Routineness	0.79	0.21	1	
BLS 2010–2020 Projection	−0.31	−0.30	−0.42	1

Sources: U.S. Bureau of Labor Statistics, Frey and Osborne (2017), Blinder (2009), Jentsen and Kletzer (2010), author's calculations.

The Accuracy of Employment Projections

To gauge the accuracy of the BLS projections (as of 2010), I compared them to the actual growth rates in the share of workers in each occupation (as a share of the overall workforce) between 2010 and 2019 (Figure 4, left panel). The BLS projections did a good job indicating which occupations were likely to grow or shrink over the following decade. They accurately predicted growth in many medical occupations (for example, occupational/physical therapy aides) and a decline in production-related occupations (for example, production workers in textile, apparel, and furnishings). But there are also some substantial misses. The BLS projections underpredicted the decline in statistical assistants and communications-equipment operators, and the growth of animal care and service providers and mathematical science workers. Overall, the BLS projections captured 25.6 percent–using an R^2 measure–of the variation in occupations' actual growth rates.[18,19] I also compared the BLS projections to actual growth rates for the 2000s (Figure 4, right panel). Here, BLS projections performed almost as well, capturing 16.3 percent of the variation in the employment growth rates in each occupation.

Next, I assessed the accuracy of projections from academic studies. Occupations that Frey and Osborne have identified as susceptible to automation grew significantly more slowly than average between 2010 and 2019 (Figure 5, left panel). This one variable captured 18.5 percent of the variation in occupations' employment growth rates, smaller than the R^2 using BLS projections from the same period. The offshorability index captured only 6.5 percent of the variation in their 2010-2019 growth rates (Figure 5, right panel).
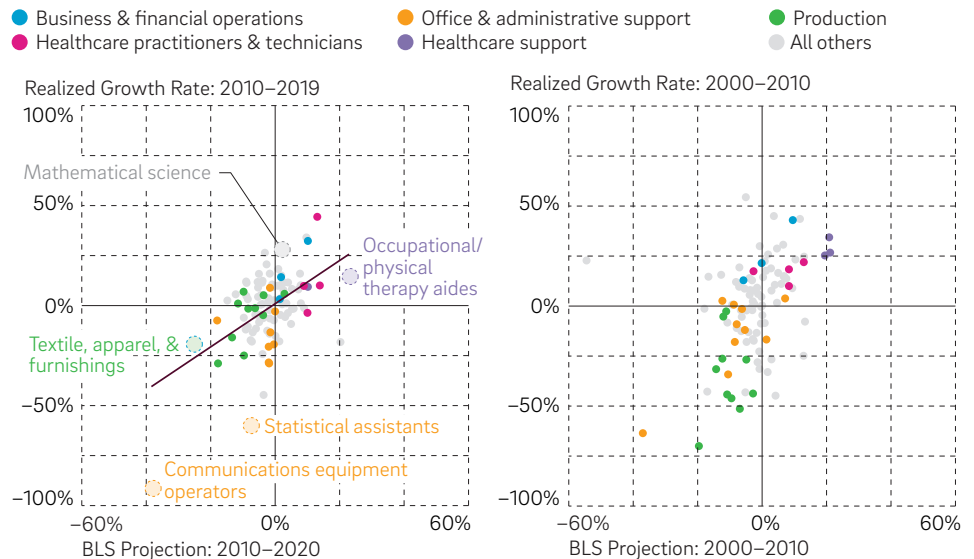
The BLS projections and the measures of occupations' susceptibility to automation both predict future employment growth rates, though neither is perfectly accurate. Can anything be gained by using information from both projections jointly?

To find out, I plotted the relationship between the probability of automation measure and the BLS-projected employment growth rates, along with the best fit regression line (Figure 6, left panel).[20]

BLS Accurately Predicted Changes in Many Occupations

BLS projections and realized growth rates, 2000–2010 and 2010–2019

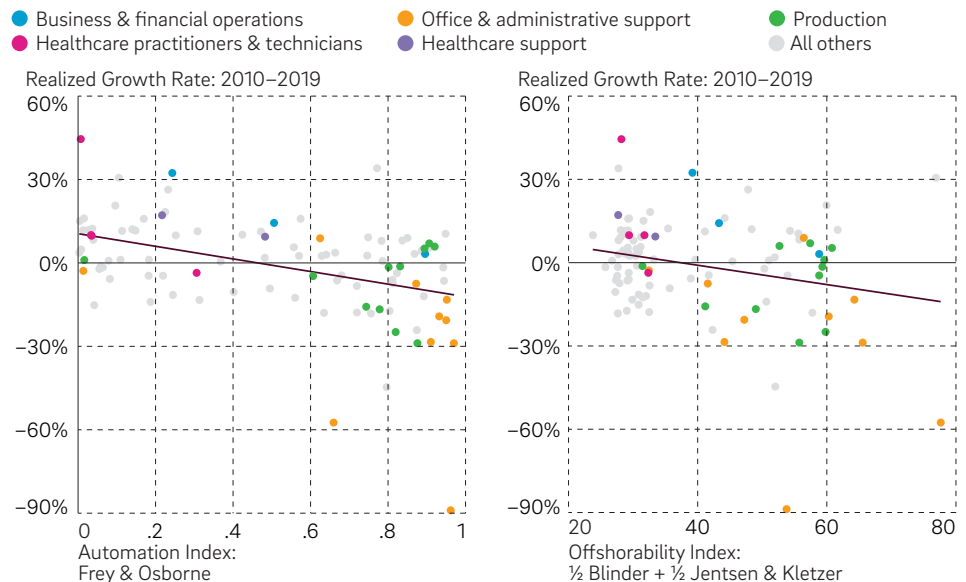**Source:** U.S. Bureau of Labor Statistics; author's calculations.

Note: Each panel presents BLS projections of the succeeding decade's growth rate for each occupation (measured as a share of the workforce) on the horizontal axis, and the realized growth rate on the vertical axis. The left panel applies the realized growth rate to 2019, as this is the most recent year for which we have data available.

Academic Projections Predict Some Occupational Change

Academic projections and realized growth rates, 2010–2019

Source: Author's calculations based on Frey and Osborne (2017), Blinder (2009), and Jentsen and Kletzer (2010); U.S. Bureau of Labor Statistics.

Note: Each panel presents projections of the succeeding decade's growth rate for each occupation (measured as a share of the workforce) on the horizontal axis, and the realized growth rate on the vertical axis. Both panels apply the realized growth rate to 2019, as this is the most recent year for which we have data available. The left panel applies the Frey and Osborne probability of automation measure; the right panel blends offshorability measures from Blinder and Jentsen and Kletzer.

The differences between the Frey and Osborne measure and the regression line ("the residuals") represent variation within the Frey and Osborne measure left unexplained by the BLS projections. I used these residuals to measure the explanatory power of the Frey and Osborne measure on top of the BLS projections (Figure 6, right panel). That is, I compared the Frey and Osborne measure with the component of realized employment growth rates that the BLS projections couldn't predict. The strength of the relationship captures the extent to which the measure of the probability of automation provides extra explanatory power (on top of the BLS projection) in employment growth rates. The main result of this exercise is that, starting with information from the BLS projections, an extra 8.3 percent of the variation in occupations' growth rates can be explained using the Frey and Osborne measure. This means that the BLS and academic measures, together, combined account for more than a third of the variation in occupations' growth rates.

What the Future Holds

Figure 7 lists the occupations that the BLS has projected to grow or shrink most quickly between 2019–the year with the most recent projections–and 2029. (I exclude every occupation that comprises less than 0.2 percent of total employment as of 2019.) The BLS projects that the decline of production and office clerical occupations will continue in the 2020s. As a share of the workforce, secretaries and administrative assistants; other production occupations; textile, apparel, and furnishings workers; supervisors of sales workers; and financial clerks are each projected to shrink by at least 10 percent, while other personal care and service occupations; animal care and service workers; and therapists, nurses, and veterinarians will each grow by 10 percent.

Also I incorporate information from Frey and Osborne's measure of the probability of automation, which I have shown in the previous section to be useful in constructing projections of employment growth. (I assume that the relationships– among realized occupational growth, BLS projections, and the Frey and Osborne measure–that I had estimated using

FIGURE 6

An Extra 8.3 Percent of the Variation in Occupations' Growth Rates Can Be Explained Using the Frey and Osborne Measure

Frey and Osborne automation index, BLS projected growth rate, realized growth rate, 2010–2019
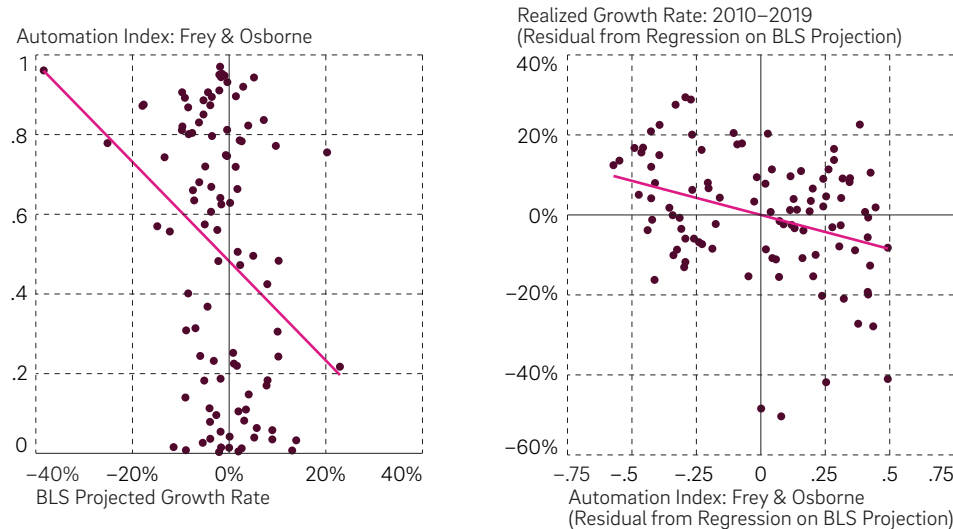
Source: U.S. Bureau of Labor Statistics; author's calculations based on Frey and Osborne (2017).

Note: The left panel presents the relationship between BLS projections of 2010–2020 occupations' growth rates and the Frey and Osborne probability of auto-mation measure. For the right panel, the vertical axis presents the residual of the realized growth rate (taking the difference between circles and the best-fit line from the left panel of Figure 4); the horizontal axis presents the residual from the left panel of this figure. The relationship between the two residuals thus gives the extra variation in the realized growth rate explained by the Frey and Osborne automation index.

FIGURE 7

Top 5 Shrinking & Growing Occupations, 2019–2029
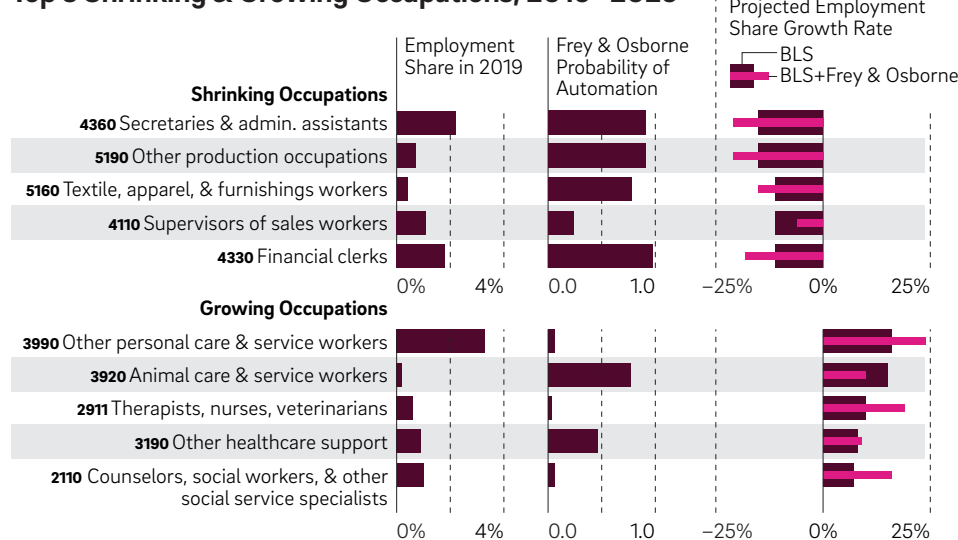
Sources: U.S. Bureau of Labor Statistics, Frey and Osborne (2017), author's calculations.

Notes: Occupations are sorted according to their BLS projected growth rates. The bold numbers before each occupation title refer to SOC occupation codes. The first column gives each occupation's employment share, according to the BLS. The second column presents the Frey and Osborne probability of automation. The third column compares the BLS projected growth rate to 2029 with information from the Frey and Osborne probability of automation measure—specifically, the value equals 10/9 × (0.087 + 0.880 × BLS Projection − 0.160 × Automation Probability). The values 0.087, 0.880, and −0.160 come from a regression of actual 2010–2019 occupation growth rates on the 2010–2020 BLS projection and the Frey and Osborne automation probability. The 10/9 scaling factor is necessary, as the regression coefficients were generated from a regression of nine years of employment growth, while I am projecting 10 years of employment growth, from 2019 to 2029.

data from the 2010s will apply as well over the next 10 years.) Incorporating information from the Frey and Osborne measure modestly alters projections of employment growth to 2029. According to BLS projections and projections that incorporate Frey and Osborne's measure, office clerical and production occupations are likely to shrink, while health and service-related occupations are likely to grow. However, there are interesting differences: The BLS projects financial clerks and supervisors of sales operations to shrink at a similar rate, while Frey and Osborne conclude that the former occupation is substantially more likely to be lost to automation. Projections incorporating Frey and Osborne's measure suggest that financial clerks will shrink 12 percent faster than supervisors of sales operations.

Caveats abound. Even under normal circumstances, projections of the future are inherently difficult: Each of the trends highlighted in this paper–computerization, globalization, and the shift toward services–could accelerate or decelerate in the coming decades, and each trend may shape labor demand in the future somewhat differently than in the past. Moreover, the projections that form the basis for Figure 7 preceded the COVID-19 pandemic. The pandemic and its aftermath will shape the labor market profoundly in some predictable ways–in the future, more people may be working from home, and fewer people may be working in occupations that involve high levels of human-to-human physical contact–and in some ways that are currently beyond our collective imagination.

Conclusion

Work changes over time for many reasons, including improvements in technology, increasing globalization, and the declining importance of manufacturing relative to services. Existing projections focus on different combinations of these reasons. Projections by the BLS perform well in predicting the shares of workers in each occupation a decade into the future. However, information from academic articles could improve the accuracy of these projections. ▣

Notes

1 See New York Times (1929).

2 See Tam (2012).

3 I thank Roc Armenter, Mike Dotsey, Makoto Nakajima, and Dave Terkanian for helpful comments during the early stages of this project, and Ryan Kobler for excellent research assistance. The replication materials for this note can be found at https://enghinatalay.github.io.

4 These figures come from the BLS Occupational Employment Statistics program; see https://www.bls.gov/oes/tables.htm. Data from 2019 are the most recently available.

5 See FRED, Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/series/A679RC1Q027SBEA and https://fred.stlouisfed.org/series/DPCERD3Q086SBEA, accessed September 1, 2020).

6 See FRED, Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/series/B021RE1A156NBEA, accessed September 1, 2020).

7 See FRED, Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/series/B020RE1A156NBEA, accessed September 1, 2020).

8 See Autor, Dorn, and Hanson (2013).

9 See Aguiar and Bils (2015).

10 Whether employment grows more quickly in industries with relatively fast or relatively slow productivity growth depends on the substitutability between different industries' products. The empirically relevant case is one in which manufactured products and services complement each other. In this case, industries with faster productivity growth employ a decreasing share of the labor force. See Ngai and Pissarides (2007).

11 BLS employment projections assume "full employment"—in other words, that the 10-year-ahead unemployment rate will be at the rate consistent with nonaccelerating inflation. See Dubina (2017).

12 See https://data.bls.gov/projections/nationalMatrix?queryParams=481100&ioType=i . Accessed September 1, 2020.

13 To see how the National Employment Matrix and projections of industries' labor demand interact, consider a hypothetical economy with two occupations ("production" and "nonproduction") and two industries ("manufacturing" and "services"). Suppose that, initially, manufacturing and services each employs half of the workers in the economy, and that our hypothetical National Employment Matrix indicates that manufacturing employs production and nonproduction workers in equal share, while services employs only nonproduction workers. If we project that manufacturing will shrink from 50 percent to 20 percent of labor demand over the next decade, and that the mix of workers within each sector will remain constant, then we would project that the share of workers in production occupations will shrink from 25 percent (0.5 × 0.5) to 10 percent (0.5 × 0.2). Within this example, each occupation's employment share within each industry is assumed to be fixed. In practice, the BLS allows for the importance of different occupations within each industry to change over time.

14 "Finger dexterity" and "manual dexterity" may—in certain circumstances—protect workers from automation. In Table 1 of their paper, Frey and Osborne refer to these skills as "automation bottlenecks." However, among all 702 occupations in their analysis, these two skills are positively correlated with their automation index.

15 The (Pearson) correlation coefficient summarizes the strength of the linear relationship between any two variables, and can take any value between −1 and 1. With a value of 1 (or −1) a scatterplot between the two variables would take the form of a positively (or

negatively) sloped line. Values strictly between 0 and 1, as in most of Table 1, indicate that the measures are positively related with one another, but that the relationship is far from perfect.

16 Although the different projections are constructed for each individual 6-digit Standard Occupational Classification (SOC), I aggregate to the 4-digit level. Under the finer 6-digit level of aggregation, the correlations across different occupational measures are weaker. So, too, is the ability of any occupation measure to predict future employment growth.

17 See page 1163 of Acemoglu and Autor (2011) for the O*NET elements that correspond to nonroutine analytic, nonroutine cognitive, nonroutine manual, routine cognitive, and routine manual tasks. For each occupation, the Acemoglu and Autor routineness index subtracts the sum of the three nonroutine task measures from the sum of the two routine task measures.

18 R^2 measures the fraction of the variability in a variable—in this case, realized growth rates in occupations' employment shares—that is predictable using information from another variable or set of variables—in this case, projections of employment growth rates.

19 For each of the regressions discussed in this section, I present the coefficient estimates in the appendix to this article.

20 This line represents what the data plot would look like if the measure of the probability of automation and the BLS-projected employment growth rates were perfectly identical. The more dispersed the data points are around this line, the less the two measures agree as to what will happen in the future.

References

Acemoglu, Daron, and David Autor. "Skills, Tasks and Technologies: Implications for Employment and Earnings," in *Handbook of Labor Economics*, vol. 4 (2011), pp. 1043–1171, https://doi.org/10.1016/S0169-7218(11)02410-5.

Aguiar, Mark, and Mark Bils. "Has Consumption Inequality Mirrored Income Inequality?" *American Economic Review*, 105:9 (2015), pp. 2725–2756, https://doi.org/10.1257/aer.20120599.

Autor, David H., David Dorn, and Gordon H. Hanson. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, 103:6 (2013), pp. 2121–2168, https://doi.org/10.1257/aer.103.6.2121.

Blinder, Alan S. "How Many U.S. Jobs Might be Offshorable?" *World Economics*, 10:2 (2009), pp. 41–78.

Dubina, Kevin S. "Full Employment: An Assumption Within BLS Projections," *Monthly Labor Review*, 140 (2017), pp. 1–10.

Frey, Carl Benedikt, and Michael A. Osborne. "The Future of Employment: How Susceptible Are Jobs to Computerisation?" *Technological Forecasting and Social Change*, 114 (2017), pp. 254–280, https://doi.org/10.1016/j.techfore.2016.08.019.

Jentsen, J. Bradford, and Lori G. Kletzer. "Measuring Tradable Services and the Task Content of Offshorable Services Jobs," in Katharine G. Abraham, James R. Spletzer, and Michael Harper, eds., *Labor in the New Economy*. Chicago: University of Chicago Press, 2010, pp. 309–335.

New York Times. "Fisher Sees Stocks Permanently High," October 16, 1929, p. 8.

Ngai, L. Rachel, and Christopher A. Pissarides. "Structural Change in a Multisector Model of Growth," *American Economic Review*, 97:1 (2007), pp. 429–443, https://doi.org/10.1257/aer.97.1.429.

Tam, Donna. "Google's Sergey Brin: You'll Ride in Robot Cars Within 5 Years," CNET, September 25, 2012.

Appendix: Regression Results

In this short appendix, I present the results of the regressions underlying the discussion in the section titled "The Accuracy of Employment Projections."

	(1)	(2)	(3)	(4)	(5)
BLS 2010–2020 Projection	1.079 (0.186)				0.880 (0.185)
BLS 2000–2010 Projection		0.937 (0.216)			
Frey and Osborne Prob. of Automation			−0.227 (0.048)		−0.160 (0.046)
Offshorability Index				−0.003 (0.001)	
Constant	0.009 (0.016)	0.014 (0.023)	0.105 (0.029)	0.130 (0.056)	0.087 (0.027)
R^2	0.256	0.163	0.185	0.065	0.339
Number of Occupations	100	99	100	100	100
Period	2010–2019	2000–2010	2010–2019	2010–2019	2010–2019

Notes: Each observation corresponds to a 4-digit SOC code occupation. Except for column (2), the dependent variable is the occupation's growth—as a share of the workforce—between 2010 and 2019. In column (2), the dependent variable is the occupation's growth between 2000 and 2010. Standard errors are in parentheses.

Photo: iStock/gsheldon

Elif Sen is a senior economic analyst at the Federal Reserve Bank of Philadelphia. The views expressed in this article are not necessarily those of the Federal Reserve.

Regional Spotlight

How Third District Firms Were Impacted by COVID-19

The first few weeks of our special COVID Survey tell us a lot about how businesses fared during unprecedented times.

BY ELIF SEN

The Philadelphia Fed's Research Department has long conducted monthly and quarterly Business Outlook Surveys, which help us assess economic conditions in our region. The speed and severity of the COVID-19 crisis, however, prompted us to create a new Special Weekly Business Outlook Survey on the COVID-19 Outbreak (COVID Survey). This new survey focused on questions specific to COVID-19 and related issues and policies. This article describes the construction of our COVID Survey and identifies the weekly survey's main finding: Business conditions deteriorated in April and somewhat stabilized in May, and firms applying for funds through the Paycheck Protection Program (PPP) experienced delays. However, these were largely resolved within a few weeks.

Background

As March began, it was still business as usual for the Business Outlook Surveys. We had just finalized questions for our monthly March surveys, and the main virus-related concern was supply chain disruptions in the manufacturing sector.

But by the time we closed the survey and processed the responses during the week of March 16, the U.S. had declared a national emergency and several states, including Pennsylvania, New Jersey, and Delaware, had shut down or issued stay-at-home orders. Given how quickly COVID-19 was changing the economy and our everyday lives, we knew we needed a weekly survey to understand how our region's firms were affected by and responding to the pandemic. Our new COVID Survey allowed us to focus on actual and realized impacts and avoid forward-looking or speculative questions. We avoided those questions partly because the pandemic created so much uncertainty about the future.

In each weekly COVID Survey, we asked respondents in the region to compare the previous week's new orders or sales with what they expected prior to the pandemic. For the first 12 weeks, we also asked them what actions they had taken in response to the pandemic and its associated effects. In weeks 13 through 16, we asked about specific changes they made to their labor force, and about impediments to hiring or recalling workers.

We asked some additional questions on a rotating four-week basis over the first 12 weeks. These questions addressed a range of topics, including the influence of different factors on new orders or sales, concerns about credit issues, and sources and utilization of financial assistance, including the PPP loans from the Small Business Administration (SBA).

We conducted the weekly survey for the week ending March 22 through the week ending July 5.[1] This article focuses on results from those 16 weeks.

Headline Impacts Question

In each week's survey, responding firms selected one of the following options to describe the impact of the pandemic on the past week's new orders or sales relative to what they had expected prior to the outbreak:

■ Increase of 15% or more

■ Increase of 5% to 15%

■ Roughly little to no change, between −5% and 5%

■ Decrease of −15% to −5%

■ Decrease of −30% to −15%

■ Decrease of −60% to −30%

■ Decrease of −60% or below

■ We shut down temporarily (or remained shut down)

■ We closed permanently (or remained closed)

During these weeks,[2] a majority of firms (67 percent) reported a decrease in new orders or sales on average, far exceeding the 9 percent of firms reporting an increase. Conditions improved over the 16 weeks, with an average of 15 percent of firms reporting growth in new orders or sales in June and early July, following the easing of stay-at-home-orders in the states of the Third District in late May and June.

It's difficult to compare over time all firms' reported changes in new orders or sales, so we quantified the responses by using the midpoint of each answer option range as an average change for each group.[3] We then compared these averages from week to week.[4]

The average percent change in new orders or sales suggests that Third District firms continued to experience fairly large declines in new orders or sales of around −15 percent as of early July (Figure 1). However, these declines are an improvement on the average of −34 percent in mid-April.[5] Nonmanufacturing firms

Firms Experienced Declines in New Orders or Sales

Percent of responses and average percent change, firms reporting in 11 of 16 weeks
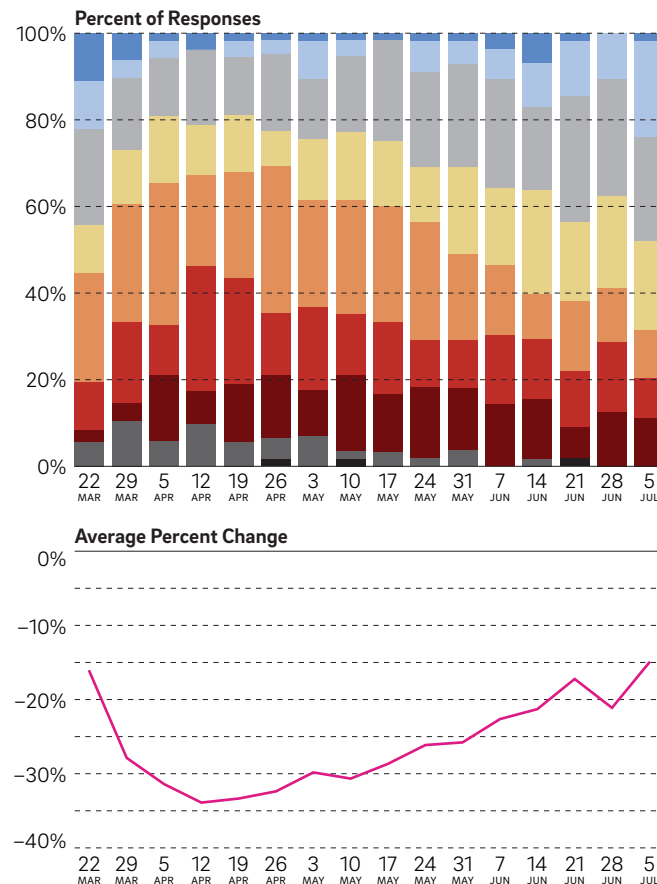
Source: Federal Reserve Bank of Philadelphia, COVID-19 Business Outlook Survey.

Nonmanufacturing Firms Experienced Sharper Declines in New Orders or Sales

Stay-at-home orders dramatically affected certain nonmanufacturing sectors, such as retail and leisure and hospitality. Average change in new orders or sales by firm type, firms reporting in 11 of 16 weeks
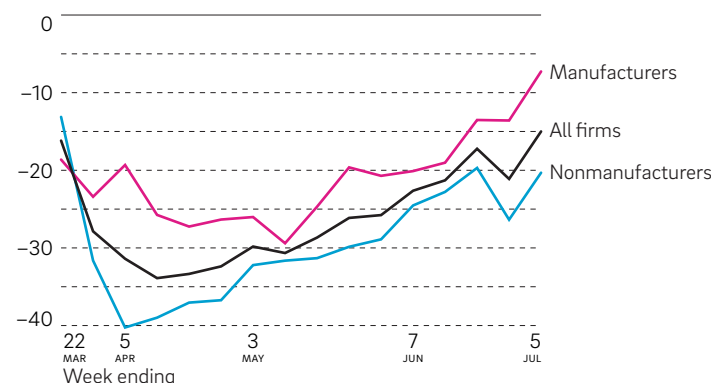
Source: Federal Reserve Bank of Philadelphia, COVID-19 Business Outlook Survey.

experienced sharper declines in new orders or sales than manufacturing firms, as stay-at-home orders dramatically affected certain nonmanufacturing sectors, such as retail and leisure and hospitality (Figure 2).

PPP Loans Helped Third District Firms in April and May

With most business activity halted or constrained, small businesses and the self-employed across the country and in our District were relying on the PPP, which was established in March under the Coronavirus Aid, Relief, and Economic Security (CARES) Act, to fund payroll costs. An average of 84 percent of firms responding to our weekly survey reported applying for a PPP loan from the SBA. Some firms in our District said they were confused by the application process and terms, and frustrated by long wait times to receive approval or funding.

PPP funds were exhausted two weeks after loan applications were first released on April 3. When we surveyed firms on April 14 (for the week ending April 12), 87 percent indicated they had applied for a PPP loan. However, of those firms, only 6 percent had received the funds (Figure 3). Slightly more than a quarter had been approved but had not yet received funds, and 67 percent were still awaiting approval.

When we surveyed firms on May 12 (for the week ending May 10)—after Congress had allocated more funds to the PPP—of the firms that had applied for a PPP loan, 90 percent had received the funds and 8 percent were waiting to receive either the funds or approval.

By early June–days after enactment of the Paycheck Protection Program Flexibility Act of 2020, which eased some loan forgiveness terms–nearly all of the responding firms that had applied for a PPP loan had received the funds, and 70 percent of firms indicated that the loans prevented layoffs or furloughs and helped them pay bills or rent.

Less Concern About Credit

In some surveys, we asked firms to indicate whether they were not at all concerned, somewhat concerned, or very concerned about their ability to deal with various credit issues, such as maintaining adequate cash flow or solvency, incurring excessive debt, and collecting payables from customers over the next month. The responses suggest that firms were less concerned after the beginning of April, particularly about the issues a firm could address with PPP funding.

For all categories and over each subsequent survey period, the share of firms reporting that they were not at all concerned increased, and the share reporting that they were very concerned decreased (Figure 4).[6] For example, for the week ending April 5, 30 percent of responding firms stated they were very concerned about maintaining solvency over the next month; by the week ending May 31, that share had fallen to 17 percent. Similarly, at the beginning of April, more than half of responding firms reported that they were very concerned about maintaining adequate cash flow, but that share had fallen to 21 percent by the end of May. Collecting payables from customers over the next

Many Firms Had to Wait to Receive Funds
But nearly all who reported applying eventually received funds.
Percent of respondents
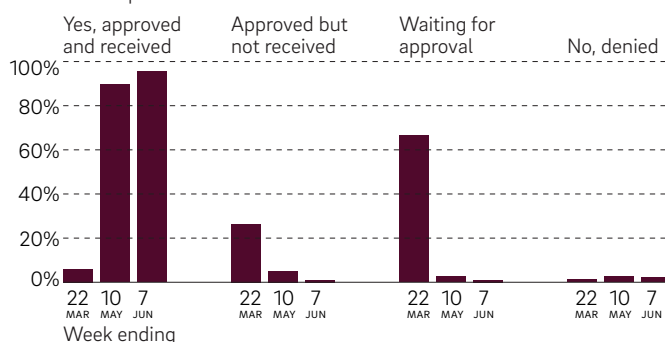
Source: Federal Reserve Bank of Philadelphia, COVID-19 Business Outlook Survey.

month, however, remained the most frequently cited concern: Seventy-seven percent of the firms indicated they were somewhat or very concerned at the end of May, down from 84 percent at the beginning of April.

Conclusion

Third District firms experienced strong declines in new orders and sales throughout the spring, but survey results suggest some stabilization and a slight improvement going into the summer. In the survey's earliest weeks, respondents commented on the extreme uncertainty of the situation. They said they were making important business decisions daily, and sometimes even hourly. One respondent even stated that it was "too chaotic at this time to comment." Firms also expressed frustration about mandated

closures, lack of guidance on the standards or timing of reopening, and confusion and delays surrounding PPP funding. In later weeks, results and comments indicated that firms were on firmer footing, partly because of PPP funding and the recent gradual reopening and easing of restrictions.

However, respondents continued to note difficulties, confusion, and uncertainty. Although firms had begun to report that the economy's slow reopening was having positive results, one manufacturer said that they struggled to keep employees safe while the pandemic continued. Furthermore, although firms in our region received and benefited from PPP funding, it is too early to assess the efficacy of the PPP program, particularly in the long term. As late as June, some firms still spoke of the possibility of layoffs in later months, depending on how quickly activity picked up once the shutdown ended. The pandemic's impact will be felt for some time to come. ◨

Concern Among Firms Subsides Somewhat
The share of firms reporting they were not at all concerned increased, and the share reporting they were very concerned decreased.
Percent of respondents
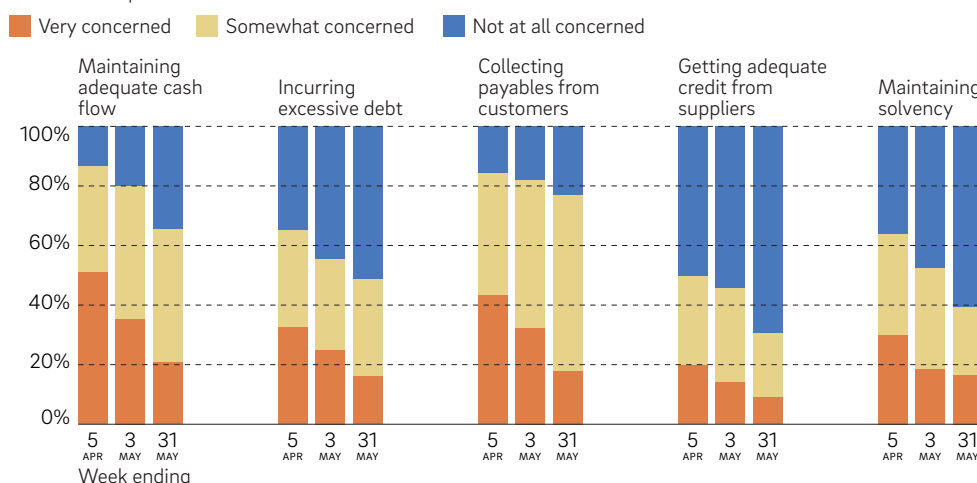
Source: Federal Reserve Bank of Philadelphia, COVID-19 Business Outlook Survey.

Our Sample

We conducted our first COVID Survey for the week ending March 22. During the survey's first two weeks, we increased our respondent pool significantly, but our potential respondent pool remained stable after the week ending April 5. The number of respondents peaked that week and decreased thereafter, averaging around 130 respondents in the last four to five weeks (Figure 5).

Most responses came from smaller firms: About 11 percent of responding firms had 500 or more employees; most had 250 or fewer.
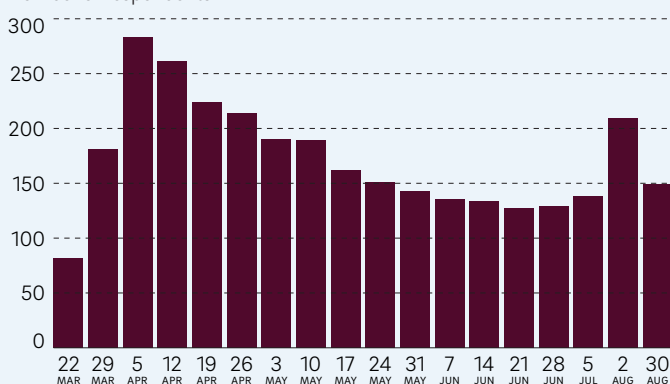
The expansion of the respondent pool also significantly affected the sectoral representation of responding firms. Although firms from all sectors participated in the survey, manufacturing firms were heavily overrepresented in the first week, accounting for more than 47 percent of responses. Beginning the week ending April 5,

nonmanufacturing firms were roughly three-quarters of respondents each week. During the survey's first 12 weeks, the most heavily represented sectors were professional and business services and manufacturers, making up an average of 25 percent and 23 percent of responses, respectively, each week. Most other sectors represented between 5 and 10 percent of responses. Relative to the three-state region, our survey sample significantly overrepresented the manufacturing sector and underrepresented the trade, transportation, and utilities and education and health services sectors (Figure 6).

Number of Respondents Peaked the Week of April 5
Average dropped to 130 in last month of survey.

Number of respondents

Source: Federal Reserve Bank of Philadelphia, COVID-19 Business Outlook Survey.

Survey Sectoral Representation Differs from Three-State Region
Relative to the three-state region, our survey sample overrepresented the manufacturing sector and underrepresented the trade, transportation, and utilities and education and health services sectors.

Average sector representation of respondents relative to 2019 average of three-state establishment data from QCEW

● Survey average   ● QCEW industry data
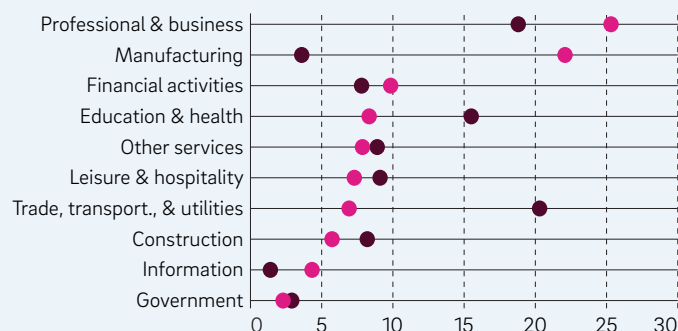
Source: Federal Reserve Bank of Philadelphia, COVID-19 Business Outlook Survey; Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

Notes

1 After collecting 16 weeks of survey data, we replaced the weekly survey with a monthly survey through early October, then replaced that with a recurring special question in our regular monthly surveys. Readers can find the survey results online at https://www.philadelphiafed.org/surveys-and-data/regional-economic-analysis/covid-19-business-outlook-survey.

2 Although we collected 16 weeks' worth of data, beginning for the week ending March 22, our sample size changed significantly over the first two weeks. Therefore this article's analysis covers only 14 weeks of data, from the week ending April 5 through the week ending July 5.

3 We used these values: 20% for 15% or above; 10% for 5% to 15%; 0% for −5% to 5%; −10%

for −15% to −5%; −22.5% for −30% to −15%; −45% for −60% to −30%; −80% for −60% or below; −100% for temporary or permanent shutdown.

4 To mitigate the effect of sample composition changes from week to week, we used responses from respondents who participated in at least 11 of the 16 weeks in these calculations.

5 This metric reflects a snapshot and does not incorporate a firm's response for a prior week. Therefore, it may underestimate the average change in new orders or sales. Some firms that reported a shutdown one week reported non-shutdown changes in later weeks, suggesting they had reopened. However, other firms that had reported a shutdown stopped responding.

6 With two exceptions, we obtain comparable results if we sample only those firms that responded to this set of credit questions in each of the three weeks we asked them. The two exceptions: The share of firms reporting they were very concerned about getting adequate credit from suppliers held steady between the May 3 and May 31 surveys (although the share reporting they were not at all concerned did decrease), and the share of firms reporting they were very concerned or not at all concerned about maintaining solvency held mostly steady between May 3 and May 31, after decreasing and increasing, respectively, between April 5 and May 3.

Research Update

These papers by Philadelphia Fed economists, analysts, and visiting scholars represent preliminary research that is being circulated for discussion purposes.

High-Dimensional DSGE Models: Pointers on Prior, Estimation, Comparison, and Prediction

Presently there is growing interest in DSGE models that have more parameters, endogenous variables, exogenous shocks, and observables than the Smets and Wouters (2007) model, and substantial additional complexities from non-Gaussian distributions and the incorporation of time-varying volatility. The popular DYNARE software package, which has proved useful for small- and medium-scale models, is, however, not capable of handling such models, thus inhibiting the formulation and estimation of more realistic DSGE models. A primary goal of this paper is to introduce a user-friendly MATLAB software program designed to reliably estimate high-dimensional DSGE models. It simulates the posterior distribution by the tailored random block Metropolis-Hastings (TaRB-MH) algorithm of Chib and Ramamurthy (2010), calculates the marginal likelihood by the method of Chib (1995) and Chib and Jeliazkov (2001), and includes various post-estimation tools that are important for policy analysis, for example, functions for conducting impulse response and variance decomposition analyses, and point and density forecasts. Another goal is to provide pointers on the fitting of these DSGE models. An extended version of the new Keynesian model of Leeper, Traum and Walker (2017) that has 51 parameters, 21 endogenous variables, 8 exogenous shocks, 8 observables, and 1,494 non-Gaussian and nonlinear latent variables is considered in detail.

WP 20-35. Siddhartha Chib, Olin Business School, Washington University in St. Louis; Minchul Shin, Federal Reserve Bank of Philadelphia Research Department; Fei Tan, Chaifetz School of Business, Saint Louis University.

Post-Merger Product Repositioning: An Empirical Analysis

This paper investigates firms' post-merger product repositioning. We compile information on conglomerate forms' additions and removals of products for a sample of 61 mergers and acquisitions across a wide variety of consumer-packaged goods markets. We find that mergers lead to a net reduction in the number of products offered by the merging firms, and the products that are dropped tend to be particularly dissimilar to the firms' existing products. These results are consistent with theories of the firm that emphasize core competencies linked to particular segments of the product market.

WP 20-36. Enghin Atalay, Federal Reserve Bank of Philadelphia Research Department; Alan Sorensen, University of Wisconsin–Madison; Christopher Sullivan, University of Wisconsin–Madison; Wanjia Zhu, University of Wisconsin–Madison.

Mortgage Loss Severities: What Keeps Them So High?

Mortgage loss-given-default (LGD) increased significantly when house prices plummeted during the financial crisis, but it has remained over 40 percent in recent years, despite a strong housing recovery. Our results indicate that the sustained high LGDs post-crisis is due to a combination of an overhang of crisis-era foreclosures and prolonged liquidation timelines, which have offset higher sales recoveries. Simulations show that cutting foreclosure timelines by one year would cause LGD to decrease by 5 to 8 percentage points, depending on the tradeoff between lower liquidation expenses and lower sales recoveries. Using difference-in-differences tests, we also find that recent consumer protection programs have extended foreclosure timelines and increased loss severities despite their potential benefits of increasing loan modifications and enhancing consumer protections.

WP 20-37. Xudong An, Federal Reserve Bank of Philadelphia Supervision, Regulation, and Credit Department; Larry Cordell, Federal Reserve Bank of Philadelphia Supervision, Regulation, and Credit Department.

The Geography of Travel Behavior in the Early Phase of the COVID-19 Pandemic

We use a panel of county-level location data derived from cellular devices in the U.S. to track travel behavior and its relationship with COVID-19 cases in the early stages of the outbreak. We find that travel activity dropped significantly as case counts rose locally. People traveled less overall, and they specifically avoided areas with relatively larger outbreaks, independent of government restrictions on mobility. The drop in activity limited exposure to out-of-county virus cases, which we show was important because such case exposure generated new cases inside a county. This suggests the outbreak would have spread faster and to a greater degree had travel activity not dropped accordingly. Our findings imply that the scale and geographic network of travel activity and the travel response of individuals are important for understanding the spread of COVID-19 and for policies that seek to control it.

WP 20-38. Jeffrey C. Brinkman, Federal Reserve Bank of Philadelphia Research Department; Kyle Mangum, Federal Reserve Bank of Philadelphia Research Department.

A Quantitative Theory of the Credit Score

What is the role of credit scores in credit markets? We argue that it is a stand-in for a market assessment of a person's unobservable type (which here we take to be patience). We pose a model of persistent hidden types where observable actions shape the public assessment of a person's type via Bayesian updating. We show how dynamic reputation can incentivize repayment without monetary costs of default beyond the administrative cost of filing for bankruptcy. Importantly, we show how an economy with credit scores implements the same equilibrium allocation. We estimate the model using both credit market data and the evolution of individuals' credit scores. We find a 3 percent difference in patience in almost equally sized groups in the population with significant turnover and a shift toward becoming more patient with age. If tracking of individual credit actions is outlawed, the benefits of bankruptcy forgiveness are outweighed by the higher interest rates associated with lower incentives to repay.

WP 20-39. Satyajit Chatterjee, Federal Reserve Bank of Philadelphia Research Department; Dean Corbae, University of Wisconsin–Madison and Visiting Scholar, Federal Reserve Bank of Philadelphia Research Department; Kyle Dempsey, Ohio State University; José-Víctor Ríos-Rull, University of Pennsylvania and Visiting Scholar, Federal Reserve Bank of Philadelphia Research Department.

The Role of Government and Private Institutions in Credit Cycles in the U.S. Mortgage Market

The distribution of combined loan-to-value ratios (CLTVs) for purchase mortgages has been remarkably stable in the U.S. over the last 25 years. But the source of high-CLTV loans changed during the housing boom of the 2000s, with private securitization replacing FHA and VA loans directly guaranteed by the government. This substitution holds within ZIP codes, properties, and borrower types. Furthermore, the two groups exhibit similar delinquency rates. These findings suggest credit expanded predominantly through the increase in asset values rather than a relaxation of CLTV constraints, which supports models of the collateral channel or broad changes in house price expectations.

WP 20-40. Manuel Adelino, Duke University; W. Ben McCartney, Purdue University and Federal Reserve Bank of Philadelphia Consumer Finance Institute Visiting Scholar; Antoinette Schoar, Massachusetts Institute of Technology.

Inference in Bayesian Proxy-SVARs

Motivated by the increasing use of external instruments to identify structural vector autoregressions (SVARs), we develop an algorithm for exact finite sample inference in this class of time series models, commonly known as Proxy-SVARs. Our algorithm makes independent draws from any posterior distribution over the structural parameterization of a Proxy-SVAR. Our approach allows researchers to simultaneously use proxies and traditional zero and sign restrictions to identify structural shocks. We illustrate our methods with two applications. In particular, we show how to generalize the counterfactual analysis in Mertens and Montiel-Olea (2018) to identified structural shocks.

WP 18-25 Revised. Jonas E. Arias, Federal Reserve Bank of Philadelphia Research Department; Juan F. Rubio-Ramírez, Emory University and Visiting Scholar, Federal Reserve Bank of Philadelphia Research Department; Daniel F. Waggoner, Federal Reserve Bank of Atlanta.

Evidence of Accelerating Mismeasurement of Growth and Inflation in the U.S. in the 21st Century

Corporate equity market values, profitability, and intangible investment have reached high proportions of income. Are these investments and their outcomes evidence of a well-functioning society? We do not see the rapid growth in aggregate measures of output that would justify these investments and rewards. And why did the yield curve invert as the U.S. federal funds rate reached 2⅜ percent in early 2019, if the inflation rate was near 2 percent? We present the broad case that mismeasurement of growth and prices accelerated in the U.S. during the 21st century and may be responsible for the appearance of secular stagnation in the U.S. We argue that it is possible that productivity growth has accelerated and that prices have been deflating during much of the 21st century. The evidence is very incomplete; large uncertainties surround these estimates. Indeed, the main message of this paper is that uncertainty in economic measurement has risen substantially.

WP 20-41. Leonard I. Nakamura, Emeritus Economist, Federal Reserve Bank of Philadelphia Research Department.

The Firm Size-Leverage Relationship and Its Implications for Entry and Business Concentration

Larger firms (by sales or employment) have higher leverage. This pattern is explained using a model in which firms produce multiple varieties and borrow with the option to default against their future cash flow. A variety can die with a constant probability, implying that bigger firms (those with more varieties) have a lower coefficient of variation of sales and higher leverage. A lower risk-free rate benefits bigger firms more, as they are able to lever more, and existing firms buy more of the new varieties arriving into the economy. This leads to lower startup rates and greater concentration of sales.

WP 20-29 Revised. Satyajit Chatterjee, Federal Reserve Bank of Philadelphia Research Department; Burcu Eyigungor, Federal Reserve Bank of Philadelphia Research Department.

Missouri's Medicaid Contraction and Consumer Financial Outcomes

In July 2005, a set of cuts to Medicaid eligibility and coverage went into effect in the state of Missouri. These cuts resulted in the elimination of the Medical Assistance for Workers with Disabilities program, more stringent eligibility requirements, and less generous Medicaid coverage for those who retained their eligibility. Overall, these cuts removed about 100,000 Missourians from the program and reduced the value of the insurance for the remaining enrollees. Using data from the Medical Expenditure Panel Survey, we show how these cuts increased out-of-pocket medical spending for individuals living in Missouri. Using data from the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (CCP) and employing a border discontinuity differences-in-differences empirical strategy, we show that the Medicaid reform led to increases in both credit card borrowing and debt in third-party collections. When comparing our results with the broader literature on Medicaid and consumer finance, which has generally measured the effects of Medicaid expansions rather than cuts, our results suggest there are important asymmetries in the financial effects of shrinking a public health insurance program when compared with a public health insurance expansion.

WP 20-42. James Bailey, Providence College and Federal Reserve Bank of Philadelphia Consumer Finance Institute Visiting Scholar; Nathan Blascak, Federal Reserve Bank of Philadelphia Consumer Finance Institute; Vyacheslav Mikhed, Federal Reserve Bank of Philadelphia Consumer Finance Institute.

Corporate Bond Liquidity During the COVID-19 Crisis

We study liquidity conditions in the corporate bond market during the COVID-19 pandemic, and the effects of the unprecedented interventions by the Federal Reserve. We find that, at the height of the crisis, liquidity conditions deteriorated substantially, as dealers appeared unwilling to absorb corporate debt onto their balance sheets. In particular, we document that the cost of risky-principal trades increased by a factor of five, forcing traders to shift to slower, agency trades. The announcements of the Federal Reserve's interventions coincided with substantial improvements in trading conditions: dealers began to "lean against the wind" and bid-ask spreads declined. To study the causal impact of the interventions on market liquidity, we exploit eligibility requirements for bonds to be purchased through the Fed's corporate credit facilities. We find that, immediately after the facilities were announced, trading costs for eligible bonds improved significantly while those for ineligible bonds did not. Later, when the facilities were expanded, liquidity conditions improved for a wide range of bonds. We develop a simple theoretical framework to interpret our findings, and to estimate how the COVID-19 shock and subsequent interventions affected consumer surplus and dealer profits.

WP 20-43. Mahyar Kargar, University of Illinois at Urbana–Champaign; Benjamin Lester, Federal Reserve Bank of Philadelphia Research Department; David Lindsay, University of California, Los Angeles; Shuo Liu, Tsinghua University, School of Economics and Management; Pierre-Olivier Weill, University of California, Los Angeles and Visiting Scholar, Federal Reserve Bank of Philadelphia Research Department; Diego Zúñiga, University of California, Los Angeles.

Firm Technology Upgrading Through Emerging Work

We propose a new measure of firms' technology adoption, based on the types of employees they seek. We construct firm-year level measures of emerging and disappearing work using ads posted between 1940 and 2000 in *The Boston Globe*, *The New York Times*, and *The Wall Street Journal*. Among the set of publicly listed firms, those that post ads for emerging work tend to be younger, be more R&D intensive, and have higher future sales and productivity growth. Among all firms, those that post ads for emerging work are more likely to survive and, for privately held firms, are more likely to go public in the future. We develop a model—consistent with the described patterns—with incumbent job vintage upgrading and firm entry and exit. Our estimated model indicates that 55 percent of upgrading occurs through the entry margin, with incumbents accounting for the remaining 45 percent.

WP 20-44. Enghin Atalay, Federal Reserve Bank of Philadelphia Research Department; Sarada, University of Wisconsin-Madison.

Financial Instability with Circulating Debt Claims and Endogenous Debt Limits

This paper develops a banking model in which intermediaries issue liabilities that circulate as a medium of exchange to finance loans to entrepreneurs, who use the proceeds to fund the accumulation of capital goods. The issuance of circulating liabilities, together with endogenous debt limits, gives rise to a franchise value for intermediaries. A competitive equilibrium with endogenous debt limits admits allocations that are characterized by a funding crisis and a self-fulfilling collapse of the banking system, with the intermediary's franchise value eroding over time. In view of these difficulties, I construct a sophisticated fiscal policy that provides a government guarantee for the franchise value, which results in the determinacy of equilibrium, with the constrained efficient allocation emerging as the unique outcome.

WP 20-45. Daniel Sanches, Federal Reserve Bank of Philadelphia Research Department.

Lockdowns and Innovation: Evidence from the 1918 Flu Pandemic

Does social distancing harm innovation? We estimate the effect of non-pharmaceutical interventions (NPIs)—policies that restrict interactions in an attempt to slow the spread of disease—on local invention. We construct a panel of issued patents and NPIs adopted by 50 large U.S. cities during the 1918 flu pandemic. Difference-in-differences estimates show that cities adopting longer NPIs did not experience a decline in patenting during the pandemic relative to short-NPI cities, and they recorded higher patenting afterward. Rather than reduce local invention by restricting localized knowledge spillovers, NPIs adopted during the pandemic may have better preserved other inventive factors.

Q&A...

with Enghin Atalay,
a senior economist here
at the Philadelphia Fed.

Enghin Atalay

Enghin Atalay grew up in the San Francisco Bay area and studied mathematics at the University of California, Berkeley. After earning his doctorate in economics from the University of Chicago in 2014, he headed to the University of Wisconsin, Madison, to teach macroeconomics and industrial organization. In 2019, Enghin joined the Federal Reserve Bank of Philadelphia, where he continues to focus on economic networks, how firms are organized, and long-run changes in the labor market.

What led you to study economics?
Mainly, being a research assistant at the Federal Reserve Bank of New York. I helped the economists there with their policy and research projects, and they were nice enough to let me coauthor some of their papers. It was a great experience, seeing a research project go from the initial stage up through putting together an initial draft. I got a sense of what grad school would be like, and that this is something I really wanted to do.

How did you decide on the University of Chicago?
As part of my graduate school application, my writing sample included a paper I wrote with Morten Bech, one of my supervisors at the New York Fed. We were trying to describe the federal funds market using statistics developed by people who study financial, economic, and physical networks. This topic was something Ali Hortaçsu, a professor at the University Chicago, had been interested in, and is still interested in. He reached out to me as I was deciding between schools. That meant a lot, to have Ali reach out. He later supervised my dissertation. I was very, very lucky to work with him in grad school.

In your article in this issue, you compare the academic approach to explaining different occupations' growth rates to the approach of the BLS [Bureau of Labor Statistics]. Was this topic inspired by your personal experience of having been an academic economist and then a central bank economist?
It's more from my academic experience. I had been reading academic research that uses lessons from the past to predict the future, and I noticed some anxiety about new automation technologies making certain types of work obsolete. My initial idea was to check the accuracy of projections from academics, to get a sense of whether this anxiety is well-founded. But then you want to compare that to what the BLS has done, since they spend so much time and effort constructing projections of the labor market's future.

And because you were seeing these projections coming from both academic and BLS economists, you wanted to know, what are the benefits of each of these and can they be combined?
Right. They have different goals. Typically, an academic paper aims primarily to analyze something that other researchers haven't looked at yet. So, in this area, each academic article focuses on a different source of change in the occupational mix. The goal is to say something new. The BLS isn't trying to say something new, but rather to use all available information to make the best projection possible. For that reason, you might expect the BLS to have a more accurate projection, which turned out to be the case. But there's always the possibility that information from academic research can be better incorporated into the BLS' projections. And that also seems to be the case.

One of the biggest industries affected by COVID-19 has been bars and restaurants. How might the effects of COVID-19 on just that one industry affect the entire economy, and by what route might that happen?
There's a rule of thumb that, if you want to know the aggregate effect of events in a certain industry, you start with that industry's total sales relative to GDP [gross domestic product]. For bars and restaurants, this figure is roughly 4 percent. But other factors may lead this industry to have an outsized effect. Workers in the food service sector—who tend to make less than other types of workers—might have less savings to buffer income declines, so having bars and restaurants shut down could lead to a bigger knock-on decline in consumption. And maybe firms in other industries can survive periods of low demand for longer than bars and restaurants, to the extent that they might have easier access to credit.

You have to look at sales, at how indebted that industry is, how concentrated it is—there are all sorts of factors, but when you study all of them, you see the route by which that knock can affect the entire economy.
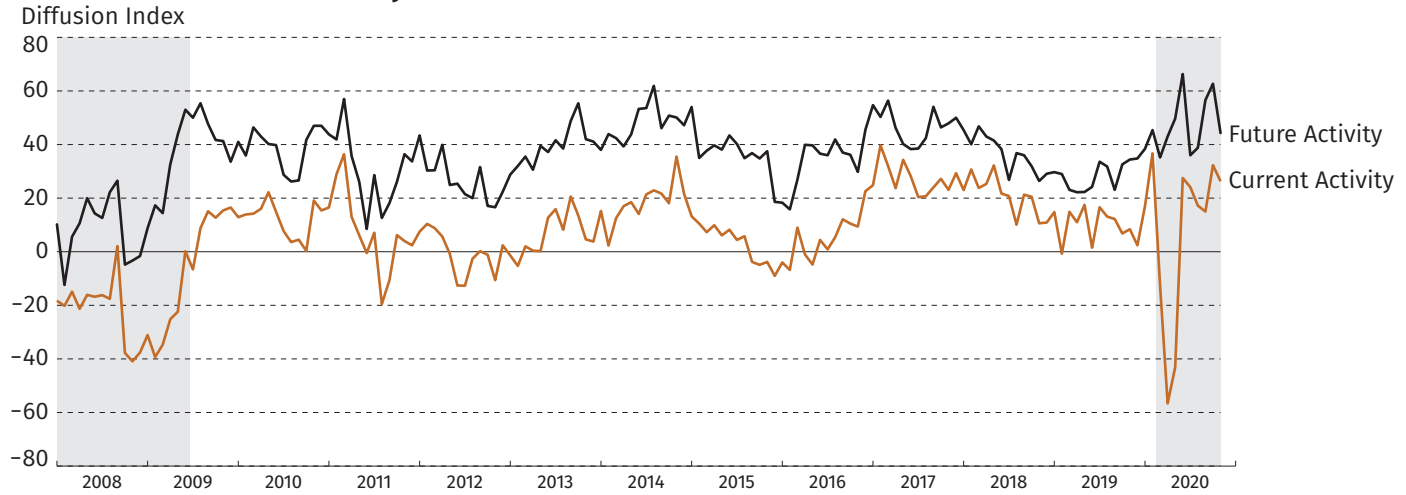Exactly right. ▣

Data in Focus

MBOS/General Activity

The Philadelphia Fed collects, analyzes, and shares useful data about the Third District and beyond. Here's one example.

Current and Future General Activity Indexes
Diffusion Index

Note: The diffusion index is computed as the percentage of respondents indicating an increase minus the percentage indicating a decrease; the data are seasonally adjusted.

Source: Federal Reserve Bank of Philadelphia Manufacturing Business Outlook Survey.

Each month, we ask manufacturing business executives in the Third District about their business activity. We compile and publish their answers as the Manufacturing Business Outlook Survey (MBOS). The MBOS provides regional data that is often helpful in forecasting U.S. economic indicators for manufacturing before official quantitative statistics are published. The MBOS's timeliness gives it an edge over many other indicators. "This is hugely important," says Tom Porcelli, managing director and chief U.S. economist at RBC Capital Markets. "It is a 'live' index. You can look at what's going on in the month you are trying to analyze."

This issue's Data in Focus highlights the MBOS's Current and Future General Activity Indexes, which chart business executives' answers to the survey's two broadest questions: "What is your evaluation of the level of general business activity," both currently and in six months? We compute each index by subtracting the percentage of respondents who indicate a decrease from the percentage who indicate an increase. According to these indexes, respondents reported a significant decline in current activity during the worst months of the COVID-19 pandemic, and more recently a majority were predicting growth in future activity. As bad as things were in 2020, manufacturers in the Third District are optimistic about 2021. ⧉

Connect with Us

Explore a New Philadelphia Fed Website User Experience

The Philadelphia Fed launched its new website. Visit www.philadelphiafed.org to see how our improved user-centric navigation and content gives you an easier way to find the data and information you want—current bookmarks will need to be reset under the new navigation system—and explore everything the Philadelphia Fed has to offer to help communities thrive.

Economic Insights

THE 2020 ANNUAL INDEX