ECONOMIC REVIEW

Did the Federal Reserve Anchor Inflation Expectations Too Low?

By Brent Bundick and A. Lee Smith

In 2012, the Federal Reserve adopted a 2 percent target for inflation to firmly anchor longer-term inflation expectations. Since then, inflation has averaged about 1.4 percent. Modern theories suggest that inflation should eventually gravitate toward measures of longer-run inflation expectations. The tendency for inflation to reside below the Federal Reserve's 2 percent inflation target over much of the past decade raises questions of whether longer-run inflation expectations are anchored—and, if so, whether they are anchored below 2 percent.

Brent Bundick and A. Lee Smith argue that the Federal Reserve's communication of a numerical objective for inflation better anchored longer-term inflation expectations; however, Federal Open Market Committee (FOMC) projections for longer-run inflation from 2009–11 may have anchored them below 2 percent. The authors present evidence that the 2009 addition of longer-run inflation to the FOMC's Summary of Economic Projections (SEP), together with the eventual adoption of a longer-run 2 percent inflation objective in 2012, made investors' inflation expectations more stable. At the same time, SEP projections for longer-run inflation from 2009 to 2011 generally resided below 2 percent, which may have led inflation expectations to anchor below 2 percent.

How You Say It Matters: Text Analysis of FOMC Statements Using Natural Language Processing

By Taeyoung Doh, Sungil Kim, and Shu-Kuei Yang

The Federal Reserve has increasingly used public statements to shape expectations about future policy actions. After the Great Recession, when the nominal short-term interest rate reached its effective lower bound, the Federal Open Market Committee turned toward explicit forward guidance about the future path of the policy rate as well as the amount and composition of large-scale asset purchases in their post-meeting statements. Although these statements sometimes included quantitative information, they also included more nuanced, qualitative descriptions of economic conditions. However, measuring the effects of these qualitative communications is not straightforward.

Taeyoung Doh, Sungil Kim, and Shu-Kuei Yang use a natural language processing tool to provide a new measure of how changes in qualitative descriptions of the economy in post-meeting statements affect bond prices. They find that qualitative descriptions of economic conditions and

the balance of risk can have as much of an effect on bond prices as quantitative information about the target policy rate. In some cases, the tone of the Committee's statement can affect financial market conditions even if no policy action is taken. Their new measure is generally correlated with alternative measures in prior research based solely on bond price data, and particularly well correlated with medium-term policy expectations.

The Evolving Link between Oil Prices and U.S. Consumer Spending

By Nida Çakır Melek and Robert J. Vigfusson

Oil prices have fluctuated widely since the 1970s. Historically, consumers have tended to increase spending on non-oil goods and services when oil prices decline and cut back on such spending when oil prices rise. However, this relationship may have changed more recently. The U.S. oil sector has increased in importance in the last decade, and consequently the United States has become less reliant on oil imports. Moreover, gasoline expenditures have fallen as a share of households' budgets. As a result, price swings may no longer have the same effect on U.S. consumption.

Nida Çakır Melek and Robert J. Vigfusson look at two channels through which oil price changes affect consumption—the discretionary income channel and the oil producer channel—and provide evidence that the effect of oil price changes on consumption has become more muted. Their analysis suggests changes in oil prices are less likely to yield major changes in consumption, even among lower-income households.

Did the Federal Reserve Anchor Inflation Expectations Too Low?

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I n 2012, the Federal Reserve adopted a 2 percent target for infla-tion to firmly anchor longer-term inflation expectations. Through 2019, inflation, as measured by the annual change in the price index for personal consumption expenditures (PCE), averaged about 1.4 percent. Many factors have contributed to this shortfall, including the protracted labor market recovery from the Great Recession and, at times, large declines in energy and import prices. Nevertheless, modern theories of inflation suggest that inflation should eventually gravitate toward measures of longer-run inflation expectations. The tendency for inflation to reside below the Federal Reserve's 2 percent inflation target over much of the past decade therefore raises questions of whether lon-ger-run inflation expectations are anchored—and, if so, whether they are anchored below 2 percent.

In this article, we argue that the Federal Reserve's communica-tion of a numerical objective for inflation better anchored longer-term inflation expectations; however, Federal Open Market Committee (FOMC) projections for longer-run inflation from 2009–11 may have anchored them below 2 percent. Drawing on our recent research, we present evidence that the 2009 addition of longer-run inflation to the

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FOMC's Summary of Economic Projections (SEP), together with the eventual adoption of a longer-run 2 percent inflation objective in 2012, made investors' inflation expectations more stable (Bundick and Smith 2020). At the same time, SEP projections for longer-run inflation from 2009 to 2011 generally resided below 2 percent, which may have led inflation expectations to anchor below 2 percent. The prospect that inflation expectations are anchored below 2 percent helps to explain the persistently low rates of inflation in the recent era. Moreover, this result underscores the rationale behind the FOMC's recent shift to a new framework that conveys a clear preference for inflation that averages 2 percent over time in an effort to anchor longer-run inflation expectations at 2 percent.

Section I describes how the FOMC's communication about its longer-run inflation objective has evolved in recent decades. Section II estimates whether these changes in FOMC communication better anchored longer-run inflation expectations. Building on this analysis, Section III argues that the distribution of FOMC projections for longer-run inflation from 2009 to 2011 conveyed a preference for inflation below 2 percent, underscoring the need to shift long-run inflation expectations to sustainably achieve 2 percent inflation.

I.   The Federal Reserve's Shift to Communicating a Numerical Inflation Target

With the passage of the Federal Reserve Reform Act in 1977, Congress tasked the Federal Reserve with promoting maximum employment, moderate long-term interest rates, and stable prices. Taken literally, long-run price stability would necessitate inflation averaging zero over time. However, pursuing a zero inflation rate is problematic for several reasons. For instance, any measure of inflation is imperfectly calculated, owing to biases that tend to overstate the true rate of inflation. Based on the estimate of this bias from Boskin and others (1996), targeting a measured rate of zero would likely yield a rate of true inflation around −1 percent (that is, deflation), which would be inconsistent with price stability.[1] Another issue with targeting a zero rate of inflation is that zero or very low rates of inflation may themselves impede the Federal Reserve's pursuit of its maximum employment objective. In particular, given the reluctance of workers to accept nominal wage

cuts during economic downturns, some positive rate of inflation helps to "grease the wheels" of labor markets by allowing real (inflation-adjusted) wages to vary more freely in line with labor market conditions.

In recent decades, the effective lower bound on interest rates has provided a more salient rationale for pursuing positive rates of inflation. One component of every nominal interest rate, including the federal funds rate—the primary monetary policy instrument of the Federal Reserve—is expected inflation. Persistently low inflation and correspondingly low rates of expected inflation can depress nominal interest rates. Therefore, targeting a very low or zero rate of inflation may limit the amount by which policymakers can reduce the federal funds rate during a recession due to the challenges associated with setting interest rates below zero. Conversely, persistently higher rates of inflation generally lead to higher levels of nominal interest rates, allowing policymakers more space to reduce the federal funds rate in an economic downturn.

Instead of identifying a numerical objective for inflation consistent with price stability, for some time Federal Reserve officials interpreted price stability as summarized by former Federal Reserve Chair Paul Volcker: "A workable definition of reasonable 'price stability' would seem to me to be a situation in which expectations of generally rising (or falling) prices over a considerable period are not a pervasive influence on economic and financial behavior" (Volcker 1983). While the high rates of inflation in the late 1970s and 1980s clearly did not meet this general notion of price stability, Federal Reserve officials began to consider a more precise notion of the rate of inflation that they deemed to be consistent with price stability as inflation trended lower into the 1990s.

Given the shortcomings of targeting a zero inflation rate, the FOMC broadly agreed during internal policy deliberations in 1996 that a measured rate of inflation around 2 percent over the long run is most consistent with its congressional mandates (Board of Governors 1996). However, the Committee stopped short of communicating this 2 percent inflation objective to the public. Instead, Committee members continued to deliberate issues surrounding the formal adoption of an inflation objective, such as which measure of inflation to target, over which horizon policymakers should seek 2 percent inflation, and whether to specify a single target rate or a target range for inflation outcomes.

At the same time, many other central banks around the world moved forward with adopting and communicating formal inflation targets. Research prior to the FOMC's decision to adopt a numerical inflation target suggests that in the United Kingdom, the euro area, and Sweden, communicating a numerical inflation target provided a nominal guidepost for the public and led to better-anchored inflation expectations compared with the United States (Gürkaynak, Levin, and Swanson 2010; Beechey, Johannsen, and Levin 2011). This research concludes that before the global financial crisis, the FOMC had the scope to better anchor U.S. inflation expectations by adopting and communicating a numerical inflation target like many central banks around the world.

Better-anchored inflation expectations enhance the ability of central banks to achieve their government mandates. Because inflation expectations are thought to be a key determinant of realized inflation, central banks tasked solely with price stability mandates can better stabilize inflation when inflation expectations are well anchored. However, even central banks with multiple mandates, such as the Federal Reserve, can better achieve their desired outcomes with well-anchored inflation expectations. For instance, anchored inflation expectations enable policymakers to respond aggressively to cyclical swings in the real economy, such as rising unemployment, without unseating inflation expectations and threatening price stability.

The global financial crisis and ensuing Great Recession elicited such an aggressive policy response from the Federal Reserve. Beginning in 2008, as financial markets seized, the Federal Reserve rapidly expanded its balance sheet to provide liquidity and support to credit markets. These actions resulted in a corresponding surge in the monetary base that sparked concerns inflation might accelerate in the future. At the same time, the severe deterioration of the economic outlook led the FOMC to successively reduce the target federal funds rate until it reached its effective lower bound in December 2008. The exhaustion of conventional monetary policy led to greater concern around the possibility of deflation. Threats had emerged on both sides of the Federal Reserve's price stability mandate, underscoring the need to better anchor inflation expectations.

In an attempt to stabilize inflation expectations, the FOMC added numerical projections for longer-run inflation to its quarterly Summary of Economic Projections (SEP) in 2009.[2] In a January 2009 conference call, Janet Yellen, then president of the Federal Reserve Bank of San Francisco, argued that such projections could convey the Committee's commitment to low but positive rates of inflation and thereby better anchor inflation expectations: "Greater transparency about how we think the future will likely unfold could help anchor inflationary expectations … But our existing FOMC projections, which have the three-year forecast horizon, obviously aren't up to the task … The obvious solution to this problem is to provide economic projections with a longer horizon" (Board of Governors 2009, p. 19). Despite dispersion across participants' initial projections for longer-run inflation, which ranged from 1.5 to 2.0 percent, the SEP projections marked an early step in the FOMC's evolution toward adopting and communicating a formal inflation target.

In January 2012, the FOMC formalized its inflation target in a consensus statement on longer-run goals and strategies for monetary policy. This statement communicated, for the first time, the Committee's adoption of a numerical, longer-run goal for inflation—2 percent as measured by annual changes in the PCE price index. The statement also articulated a clear rationale for adopting such a target: "Communicating this inflation goal clearly to the public helps keep longer-term inflation expectations firmly anchored, thereby fostering price stability and moderate long-term interest rates and enhancing the Committee's ability to promote maximum employment in the face of significant economic disturbances" (Board of Governors 2012).

The FOMC has continued to refine its Statement on Longer-Run Goals and Monetary Policy Strategy since 2012. In January 2016, the Committee clarified that the 2 percent inflation target is symmetric, meaning policymakers would be "concerned if inflation were running persistently above or below this objective" (Board of Governors 2016). The Committee further modified the consensus statement in August 2020 to specify that to anchor longer-term inflation expectations at 2 percent, "the Committee seeks to achieve inflation that averages 2 percent over time, and therefore judges that, following periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above

2 percent for some time" (Board of Governors 2020). Despite these qualitative adjustments, each iteration of the consensus statement has reaffirmed the 2 percent inflation target over the longer run. Whether communicating this target has actually anchored inflation expectations, and whether these expectations are anchored at 2 percent, remain empirical questions.

II.   Did FOMC Communication Better Anchor Inflation Expectations?

Economists often measure the degree to which inflation expectations are anchored by analyzing how financial markets respond to incoming economic news. Inflation expectations are considered to be well anchored if investors do not adjust their expectations for longer-run inflation in response to new information about inflation today. In this way, anchored inflation expectations can be seen as a sign of confidence that the central bank will adjust monetary policy to prevent unexpected fluctuations in inflation from persisting far into the future.[3] For example, Gürkaynak, Levin, and Swanson (2010) and Beechey, Johannsen, and Levin (2011) collectively show that following the announcement of a numerical inflation target, investors in the United Kingdom, the euro area, and Sweden stopped incorporating recent inflation developments into their expectations for future inflation, suggesting inflation expectations became better anchored in those countries. In contrast, the same authors find that, before 2008, investors in the United States did adjust their expectations for future inflation in response to news about current inflation, suggesting the Federal Reserve had some scope to better anchor inflation expectations before the global financial crisis.

In light of this previous research, we examine whether investors ceased to incorporate news on realized inflation into their expectations for future inflation after the FOMC adopted a formal inflation objective in 2012. Specifically, we study whether investors' expectations for future inflation changed on days the Bureau of Labor Statistics (BLS) released its monthly reports on the Consumer Price Index (CPI), which measures the change in the price of a bundle of consumer goods and services over the previous month. Although the Federal Reserve formally targets the PCE measure of inflation, investors in the U.S. government bond market pay close attention to CPI reports because

interest payments on a class of U.S. government debt called Treasury Inflation-Protected Securities (TIPS) are indexed to the CPI. As a result, the nominal interest payments on TIPS automatically adjust in response to CPI inflation. In contrast, interest payments on nominal government debt instruments are fixed at issuance and do not adjust in response to CPI inflation. Thus, the spread between yields on nominal government debt securities and TIPS provides a measure of the compensation investors require to be exposed to inflation, which we use to proxy for investors' inflation expectations.

To capture changes in inflation expectations far into the future, we focus on how yields on nominal Treasury notes maturing five to 10 years into the future behave relative to TIPS notes maturing five to 10 years into the future. The spread between these two forward yields is referred to as the five-year, five-year forward inflation compensation. By studying the change in this forward rate of expected inflation, we can isolate changes in long-run inflation expectations from movements in near-term inflation expectations that occur on CPI release days irrespective of the degree to which long-run inflation expectations are anchored.
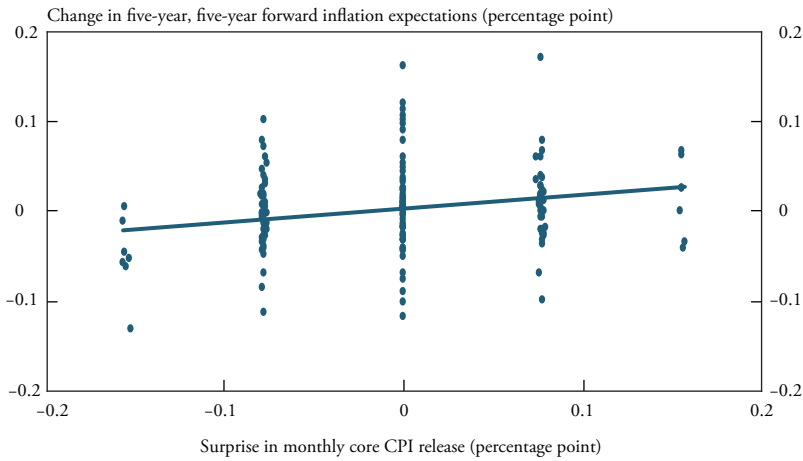
Although the CPI report contains information on many price aggregates, we focus on the month-over-month change in core CPI, which strips out changes in more volatile food and energy prices.[4] To isolate the surprise or unexpected movement in core CPI inflation, we compare the actual monthly rise or fall in core CPI to the median forecast from Bloomberg's panel of about 60 financial market participants, who submit their forecast for the CPI shortly before the report's release. Although these forecasts have been available since 1997, we start our sample in 1999, the year the TIPS market was created. We end our sample in 2019, prior to the onset of the COVID-19 pandemic.

A visual inspection of the data suggests a meaningful change in the way that investors revise their inflation expectations in response to inflation news after 2012. Chart 1 presents a scatter plot of the surprise or unexpected component of the monthly core CPI inflation rate (horizontal axis) versus the daily change in five-year, five-year forward inflation expectations on release days of the monthly CPI report (vertical axis). Each dot in the chart represents these measures on the day of a CPI release. Panel A shows that from 1999 to 2011, prior to the adoption of a formal 2 percent inflation target, changes in inflation
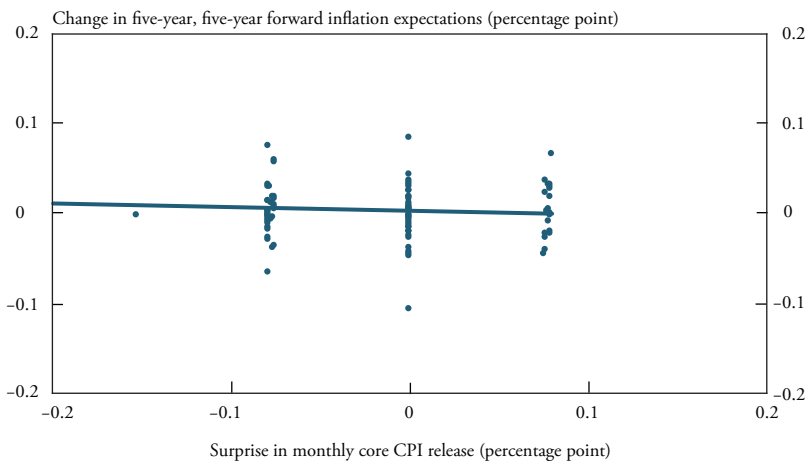
Chart 1

Long-Run Inflation Expectations and Core CPI Surprises

Panel A: 1999–2011

Change in five-year, five-year forward inflation expectations (percentage point)

Panel B: 2012–19

Change in five-year, five-year forward inflation expectations (percentage point)

Surprise in monthly core CPI release (percentage point)

Notes: Each dot represents the surprise in monthly core CPI and the change in five-year, five-year forward inflation expectations on the day of a CPI release. Bloomberg's survey asks for CPI release predictions rounded to the nearest tenth. Surprises are calculated to the nearest tenth, then scaled by the share of core CPI in overall CPI (around 0.75). Therefore, most core CPI surprises are concentrated at 0, +/− 0.075 and +/− 0.15.
Sources: Bloomberg LP, Board of Governors of the Federal Reserve System (Haver Analytics), BLS (Haver Analytics), and authors' calculations.

expectations appeared to be positively correlated with inflation surprises. However, Panel B shows that from 2012 to 2019, inflation expectations appear to have become more stable in the face of unexpected fluctuations in inflation.[5]

To more formally examine the changing relationship between inflation expectations and inflation news, we use three alternative statistical approaches. We begin by regressing the change in five-year, five-year forward inflation expectations on the days of CPI releases against the surprise component of monthly core CPI inflation over the sample periods 1999–2011 and 2012–19. These two regressions help us measure the extent to which inflation expectations have become less sensitive to unexpected changes in core CPI since 2012. Table 1 shows the relevant coefficient estimates from these regressions. The first column of Table 1 shows that, prior to 2012, an unexpected 10 basis point change in monthly core CPI typically led investors to revise their five-year, five-year forward inflation expectations by about 1.5 basis points in the same direction as the change. The positive and statistically significant coefficient suggests that from 1999 to 2011, inflation expectations were not well anchored in the sense that they drifted in the direction of the CPI surprise. However, the second column of Table 1 shows that since 2012, that responsiveness has declined to essentially zero (–0.04), suggesting longer-term inflation expectations became better anchored. Finally, the second row of the third column of Table 1 formally tests for a change in the sensitivity of inflation expectations to core CPI surprises between periods. The negative, statistically significant coefficient indicates that inflation expectations became less sensitive to CPI surprises after 2012.

Although these regressions demonstrate a change in sensitivity after 2012, they do not necessarily demonstrate that the FOMC's adoption of the numerical target led to the change. To more precisely estimate the date on which the relationship between inflation expectations and CPI surprises changed, we next produce a time series that does not impose a break in January 2012 but instead estimates the date when the regression coefficient most likely changed. If a change in the behavior of inflation expectations reflected better anchoring, we would expect the estimated date to follow a change in Federal Reserve policy. Chart 2 shows the time series of the statistic,

Table 1
Regression Model of Inflation Expectations on Core CPI Surprises

|	Five-year, five-year forward inflation expectations		
Independent variable	1999–2011	2012–19	1999–2019
Core CPI surprise	0.15* (0.07)	–0.04 (0.06)	0.15* (0.07)
Core CPI surprise with post-2012 interaction			–0.20* (0.09)
Regression R²	0.04	0.01	0.03
Observations	155	94	249

* Statistically significant at the 5 percent level.

Note: Eicker-White standard errors are in parentheses.
Sources: Bloomberg LP, Board of Governors of the Federal Reserve System (Haver Analytics), BLS (Haver Analytics), and authors' calculations. See Bundick and Smith (2020) for the full regression model.

Chart 2
Estimated Break Date of Core CPI Inflation Coefficient
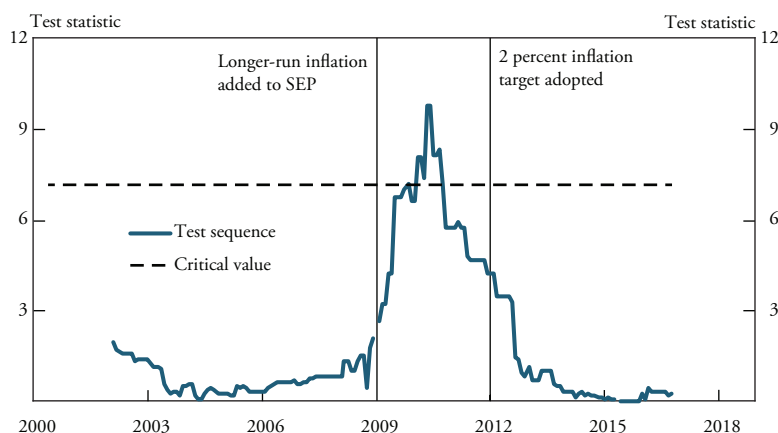
Notes: Chart shows the sequence of Chow test statistics as a function of candidate break dates. The 10 percent critical value is obtained from Andrews (1993). See Bundick and Smith (2020) for more details.
Sources: Bloomberg LP, Board of Governors of the Federal Reserve System (Haver Analytics), FOMC, BLS (Haver Analytics), and authors' calculations.

which measures how much better the regression model fits the observed data when a change in the regression coefficient on core CPI inflation is permitted at the date shown. Larger values of this statistic indicate larger improvements in the regression model's fit. The dashed line represents the critical value for this test statistic: values of the test statistic above this critical value indicate strong evidence of a change in the sensitivity of inflation expectations to core CPI surprises at the corresponding date. The vertical lines

denote meaningful changes in FOMC communication around its inflation objective, either communicated through the consensus statement or the SEP.

The test statistic (blue line) in Chart 2 peaks above the critical value (dashed line) in May 2010, indicating a structural change in the behavior of inflation expectations is most likely to have occurred on that date. Notably, this date precedes the 2012 adoption of the formal 2 percent target. However, it follows the 2009 SEP enhancement in which FOMC participants began to provide their projections for longer-run inflation. Therefore, Chart 2 suggests that this 2009 shift in SEP communication—rather than the formal adoption of the 2 percent inflation target in 2012—may have been instrumental in anchoring inflation expectations.

The time lag between the January 2009 introduction of longer-run inflation projections to the SEP and the mid-2010 estimated date of change in the relationship between inflation surprises and inflation expectations in Chart 2 suggests that the anchoring process may have been gradual. However, the two preceding statistical approaches both isolate a specific month in which the relationship between unexpected inflation data and inflation expectations abruptly changed. To model the potentially gradual change in the sensitivity of inflation expectations to unexpected inflation data, we now turn to a rolling-window regression. Chart 3 shows the sensitivity of longer-term inflation expectations to core CPI releases over the 10-year window ending at the date shown. The solid blue line shows the point estimate, and the gray shaded region shows 90 percent confidence intervals. Periods with a positive estimate suggest that inflation expectations are unanchored in the sense that they drift in the direction of the core CPI surprise. This was the case dating back to 2008. Thereafter, the estimated sensitivity of inflation expectations gradually declines. By 2012, the point estimate is no longer statistically significant, suggesting inflation expectations ceased to meaningfully vary in response to recent inflation data. These estimates offer further evidence that providing longer-run inflation projections through the SEP may have served as a catalyst for anchoring inflation expectations.

All three statistical approaches used to detect a change in the sensitivity of long-term inflation expectations to unexpected movements in inflation direct us to the same conclusion: financial market measures of inflation expectations became better anchored after the FOMC

Chart 3

Rolling Window Regression Estimates of the Response of Inflation Expectations to Core CPI Surprises
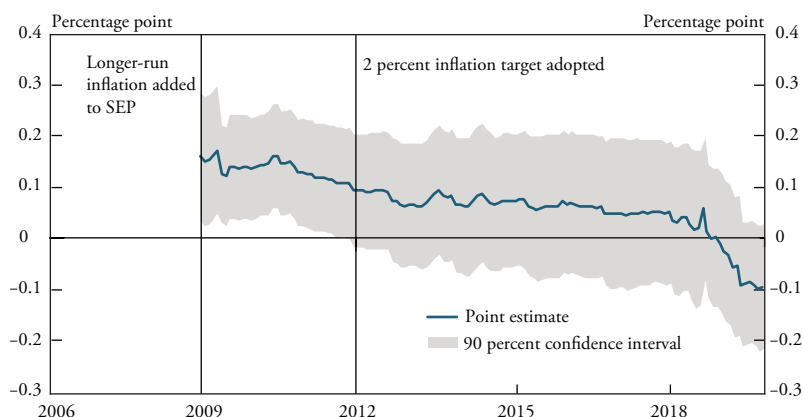
Notes: Dates indicate the end point of a 10-year rolling sample with estimates shown from December 2008 through December 2019. The 90 percent confidence intervals are computed as the point estimate plus or minus 1.645 times the Eicker-White standard error.
Sources: Bloomberg LP, Board of Governors of the Federal Reserve System (Haver Analytics), FOMC, BLS (Haver Analytics), and authors' calculations.

began communicating a numerical target for inflation. The latter two approaches underscore the perhaps underappreciated role as a catalyst for this anchoring played by the FOMC's 2009–11 SEP projections for longer-run inflation.[6] However, the approaches do not reveal at what level inflation expectations were anchored, leaving open the possibility that Federal Reserve communications anchored inflation expectations at too low a level.

III. Could Inflation Expectations Be Anchored below 2 Percent?

Although the FOMC established an explicit longer-run target of 2 percent inflation in 2012, annual inflation since then has persisted below 2 percent. Chart 4 shows the PCE price index—the inflation measure formally targeted by the FOMC—along with a horizontal line representing its sample average. From 2012 through 2019, annual PCE inflation averaged about 1.4 percent. Absent any disturbances, inflation would be expected to eventually converge to the FOMC's 2 percent target if inflation expectations were well anchored at 2 percent. Of course, the economy is constantly being buffeted by disturbances,

Chart 4
PCE and Core PCE Inflation over the Formal Inflation Targeting Era

Note: Dashed lines represent average annual inflation for each measure over the 2012–19 period.
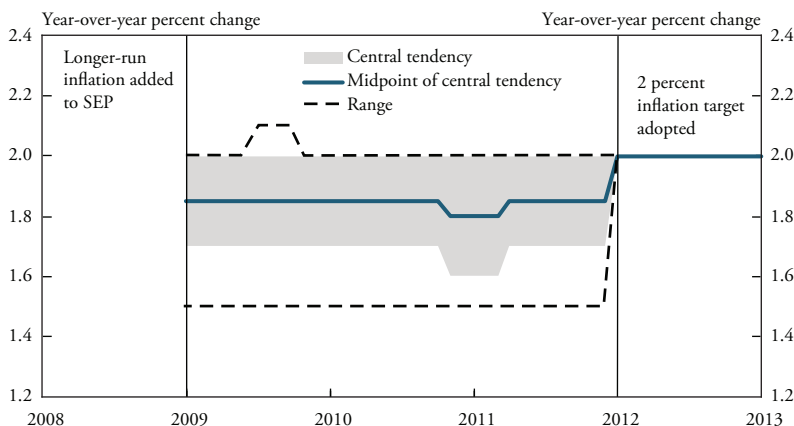Source: Bureau of Economic Analysis (Haver Analytics).

including deflationary forces that could help explain the recent period of low inflation.

Several explanations other than the level of inflation expectations have been proposed for the persistent inflation shortfall. For instance, U.S. prices are exposed to foreign developments through global trade and supply chain linkages. Since 2012, global disinflationary forces have put downward pressure on U.S. inflation. Indeed, Federal Reserve Chair Jerome Powell highlighted that "there are significant disinflationary pressures around the world, and there have been for a while" (Powell 2020b). As an example, from 2014 to 2016, large declines in energy prices visibly weighed on inflation measures. Chart 4 illustrates these forces by comparing core PCE inflation, which removes the direct effect of food and energy prices, to total PCE inflation. From 2012 through 2019, core PCE inflation has averaged about 1.6 percent, above the 1.4 percent average for PCE inflation. This gap between PCE inflation and core PCE inflation suggests that global forces, such as energy prices, have directly restrained U.S. inflation over the past decade.[7] However, the fact that even core PCE inflation has failed to sustainably converge to 2 percent suggests that other factors are at play.

Another possible explanation for the recent period of low inflation is that longer-run inflation expectations are anchored below 2

Chart 5

FOMC Summary of Economic Projections for Longer-Run PCE Inflation

Year-over-year percent change   Year-over-year percent change

Longer-run inflation added to SEP

Central tendency
Midpoint of central tendency
Range

2 percent inflation target adopted

Notes: Longer-run projections represent each FOMC participant's assessment of the rate to which inflation would be expected to converge under appropriate monetary policy and in the absence of further shocks to the economy. The central tendency discards the three highest and three lowest projections.
Source: FOMC SEP (Haver Analytics).

percent. Given our evidence that the 2009–11 SEP projections for longer-run inflation helped anchor inflation expectations, low SEP projections could conceivably have anchored expectations at a lower level. To test this possibility, Chart 5 shows the range, central tendency, and midpoint of the FOMC's SEP projections for longer-run PCE inflation from January 2009 through January 2013. From 2009 through 2011, the period preceding the adoption of a formal 2 percent inflation target, FOMC projections were centered below 2 percent. Specifically, SEP projections from this period communicated that the Federal Reserve's longer-run goal for inflation was between 1.5 and 2 percent, with a central tendency ranging from 1.6 to 2 percent. Although the FOMC's projections for longer-run inflation have been entirely concentrated at 2 percent since 2012, the earlier projections may have led the public to perceive the 2 percent target announced in 2012 as a "ceiling" on inflation rather than a symmetric target.[8] In other words, the FOMC's implicit target for inflation may have been perceived as near but below 2 percent.

A December 2011 speech by former Federal Reserve Chair Ben Bernanke may have bolstered this public perception of 2 percent as a ceiling

rather than a symmetric target. Just prior to the January 2012 formal adoption of a 2 percent target, then-Chair Bernanke summarized Committee projections by stating (emphasis added), "My colleagues and I on the Federal Reserve's monetary policymaking committee equate price stability with inflation being at 2 percent *or a little less*" (Bernanke 2011). Therefore, perhaps complemented by non-monetary explanations, low inflation over the 2012–19 period may have its origins in the FOMC's early SEP projections that indicated a preference for longer-run inflation somewhat below 2 percent.[9] To the extent these projections helped anchor longer-run inflation expectations, they may well have anchored them below 2 percent.

Long-run inflation expectations anchored below 2 percent can pose a challenge to the successful conduct of monetary policy. Although short periods of low inflation do not pose any harm to the economy, persistently low inflation stemming from low levels of inflation expectations tend to be associated with persistently low nominal interest rates. Therefore, an economy beset by persistently low inflation is likely to also be perpetually mired with low interest rates, leaving little room for monetary policymakers to maneuver in a downturn. With longer-term real interest rates also trending lower in recent years, the cost of low inflation appears to have risen, as, holding inflation expectations fixed, lower real interest rates increase the odds that monetary policy will be constrained by the effective lower bound. In this sense, inflation expectations anchored below 2 percent may be "too low" for the Federal Reserve to effectively achieve its mandates of maximum employment, moderate long-term interest rates, and stable prices.

Conclusion

Shifts toward greater transparency and clarity in how the Federal Reserve interprets its price stability mandate have accompanied marked changes in the behavior of inflation and inflation expectations. Most notably, in 2012, the FOMC adopted a formal 2 percent longer-run target for inflation in its first-ever Statement on Longer-Run Goals and Monetary Policy Strategy. Since 2012, U.S. inflation has been low, and inflation expectations have been more stable than in previous decades. Our research shows that, to a large extent, these changes in inflation and inflation expectations can be linked to changes in FOMC

communication. However, we also find some evidence from the 2009–11 SEP projections that the FOMC conveyed a preference for inflation near but below 2 percent for several years, perhaps leading longer-run inflation expectations to anchor at a level below 2 percent.

The prospect that inflation expectations are anchored below 2 percent—and the challenges posed by low levels of inflation expectations—underscores the rationale for the FOMC's recent decision to adopt a revised Statement on Longer-Run Goals and Monetary Policy Strategy that codifies a new framework for achieving 2 percent inflation. As outlined by Chair Powell at the Federal Reserve Bank of Kansas City's 2020 Economic Policy Symposium, this new consensus statement expresses a clear preference to anchor longer-run inflation expectations at 2 percent, stressing that merely achieving 2 percent inflation over the longer run may lead inflation expectations to settle below 2 percent if inflation runs below target for a prolonged period (Powell 2020a). While it is far too soon to evaluate the effectiveness of this new strategy, our research provides some support for the idea that by clearly communicating its preferences for longer-run inflation, the FOMC has the potential to shape longer-term inflation expectations.

Endnotes

[1] While this bias is unobservable and time-varying, more recent estimates from Gordon (2006) and Groshen and others (2017) conclude that a similar magnitude of bias remains in annual measures of inflation.

[2] See Kahn and Palmer (2016) for a detailed review of the SEP.

[3] This notion of anchored expectations also applies to households and firms, not just investors. However, as previous research has stressed, the high-frequency nature of asset prices allows us to more directly test whether realized inflation causes investors to change their longer-run inflation expectations than is possible with lower-frequency household or firm surveys. Because changing prices can be costly—firms may need to reprint catalogues, change signs, and communicate new prices to consumers—firms try to avoid frequent price adjustments. As a result, most firms consider how prices are expected to evolve into the future when setting prices. This forward-looking nature of price setting creates a direct link from inflation expectations to realized inflation. Without high-frequency data, observed changes in inflation and inflation expectations could either reflect this forward-looking nature of price setting or evidence of unanchored inflation expectations shifting in response to a change in realized inflation.

[4] We also include a constant and the unexpected component of food and energy price inflation in the regression and we weight the core and food and energy components by their respective weights in the CPI. In our research working paper, "Did the Federal Reserve Break the Phillips Curve? Theory and Evidence of Anchoring Inflation Expectations," we show robustness to several variants on this regression model (Bundick and Smith 2020).

[5] This period also had fewer large inflation surprises, and these surprises may drive the positive relationship in Panel A. In Bundick and Smith (2020) we address this concern in two ways. First, we show that the distribution of CPI releases did not significantly change between the two samples. Second, we show that the positive correlation in the 1999–2011 sample and the reduction in that correlation from 2012–19 is robust to controlling for outliers.

[6] Using a different approach, Doh and Oksol (2018) also find evidence that long-term inflation expectations became better anchored after 2010.

[7] Forbes (2019) more formally analyzes the role that global forces have played in shaping recent U.S. inflation dynamics. Smith (2016) also presents evidence that oil and import prices have weighed on core measures of inflation over this time.

[8] In support of this interpretation, the FOMC amended its statement of longer-run goals and policy strategy in 2016 to specify that 2 percent inflation is "symmetric" and therefore not a ceiling.

[9] Shapiro and Wilson (2019) take an entirely different approach and analyze text from internal FOMC discussions. They argue similarly that the FOMC's implicit inflation target from 2000 to 2013 was closer to 1.5 percent.

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How You Say It Matters: Text Analysis of FOMC Statements Using Natural Language Processing

By Taeyoung Doh, Sungil Kim, and Shu-Kuei Yang

The Federal Reserve has increasingly used public statements to shape expectations about future policy actions. This practice has become more prevalent since the Great Recession, when the nominal short-term interest rate reached its effective lower bound. To provide further policy easing, the Federal Open Market Committee (FOMC) turned toward explicit forward guidance about the future path of the policy rate as well as the amount and composition of large-scale asset purchases in their post-meeting statements. Although these statements sometimes included quantitative information, such as a specific threshold for the unemployment rate that would make an increase in the federal funds rate appropriate, they also included more nuanced, qualitative descriptions of economic conditions.

Measuring the effects of these qualitative communications is not straightforward. Previous research has found that public communications by policymakers can affect financial market conditions (Eberly, Stock, and Wright 2019). However, most of these studies identify the effects of central bank communications through changes in bond prices during short windows around policy announcements. Although changes in quantitative information such as the policy rate and the pace of

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asset purchases can be more directly translated into bond prices, it is often difficult to determine the effect of changes in qualitative descriptions of economic conditions. For example, when the FOMC communicates a "subdued outlook for inflation" in its post-meeting statement, it is not immediately clear how market participants might adjust their expectations of future monetary policy actions.

In this article, we use a natural language processing tool to provide a new measure of how changes in qualitative descriptions of the economy in post-meeting statements affect bond prices. These changes may or may not be communicated jointly with changes in quantitative information. Our measure yields two key findings: First, qualitative descriptions of economic conditions and the balance of risk can have as much of an effect on bond prices as quantitative information about the target policy rate. In some cases, information about the factors that played into the Committee's assessment of economic conditions makes a substantial difference in our measure of the overall tone of the statement—that is, whether it connotes policy easing or tightening relative to the previous statement—and that tone can affect financial market conditions even if no policy action is taken. Second, our new measure of the effects of central bank communications is generally correlated with alternative measures in prior research based solely on bond price data. Our measure is particularly well correlated with medium-term policy expectations.

Section I describes how we assess the tone in FOMC statements using information that staff of the Board of Governors of the Federal Reserve System prepares for the FOMC before each meeting. Section II explains how we quantify the overall tone of the post-meeting statements using a natural language processing tool. Section III shows that qualitative information contained in FOMC statements has significant effects on financial market conditions from March 2004 to December 2014.

I.   Assessing the Tone of FOMC Statements

Because FOMC statements can signal the future path of interest rates or plans for large-scale asset purchases, financial market participants watch these statements closely and react to any unexpected information contained in them. This unexpected information is not necessarily quantitative, such as the size of a policy rate change or the

value of intended asset purchases; the overall "tone" of the statement, which does not have a numeric value by itself, can influence market participants as well. For example, market participants might interpret the tone of a statement as optimistic or pessimistic about the future irrespective of the quantitative information it contains and behave accordingly. As a result, identifying the tone of new qualitative information in a monetary policy announcement is critical to anticipating how markets will react to it.

Since March 2004, staff at the Board of Governors of the Federal Reserve System, in consultation with the Chair, has prepared drafts of typically three (but occasionally four) alternative versions of the Committee's post-meeting statement along with the rationale for each alternative.[1] These alternative statements, referred to as Alt. A, Alt. B, Alt. C, and Alt. D, serve as a basis for the discussion of policy options at FOMC meetings and help the Committee formulate its policy stance. In addition to proposing possible policy actions, the alternative statements describe the economic and financial conditions that might motivate them. Although the official FOMC statement describing the actual policy decision is released at the conclusion of each FOMC meeting, the draft alternatives are released to the public only after five years, along with the meeting transcripts. Documents released with the alternative statements contain additional information about their rationale and possible implications for financial market conditions.[2]

Each alternative statement has a somewhat different tone and is written to capture a range of possible Committee views on the proper stance of policy. In general, Board staff writes Alt. B as representative of the likely consensus of the Committee, Alt. A as suggestive of an easier policy stance than Alt. B, and Alt. C (or Alt. D, which suggests a tighter policy stance than Alt. C when it is prepared) as suggestive of a tighter policy stance than Alt. B.

The official FOMC statement is not necessarily identical to any of the three draft alternatives. Committee members may interpret the incoming data and appropriate policy stance differently, and they discuss and negotiate the wording in the released statement before and during FOMC meetings. As a result, the official statement may not be exactly the same as any of the three alternative statements.

These semantic differences make alternative statements almost ideal for identifying the tone of the official post-meeting FOMC statement. Because alternative statements intentionally signal "more" or "less"

monetary policy accommodation to financial markets, we can compare the semantic similarity of the official statement with alternative statements to identify its tone. In addition, the detailed discussion of the rationale for the policy positions in alternative statements can help us easily map the semantic differences across statements to differences in the degree of policy accommodation signaled by each statement.

II.   Using a Natural Language Processing Model to Quantify the Tone of FOMC Statements

Identifying the tone of FOMC statements requires a model that can capture both quantitative and qualitative information on the policy stance. Although many statistical models can easily classify the policy implications of quantitative information such as a change in the policy rate, classifying qualitative descriptions is not straightforward.

A class of models that uses natural language processing (NLP) can help overcome this challenge by highlighting certain patterns in the distribution of words in a given text or speech to learn the sentiment of those words. The patterns the NLP model highlights can then be used to determine the overall tone of a text. One common strategy is to assess the overall tone of a document by counting the frequency with which words classified as having a positive or negative tone appear in the document. For example, many researchers have classified the tone of documents using a list of words with negative implications in financial contexts developed by Loughran and McDonald (2011).

However, this classification strategy alone may not be useful for FOMC statements. Figures 1 and 2 show word clouds of the most commonly used words in statements that announced policy tightening (Alt. C and Alt. D) versus statements that announced policy easing (Alt. A), respectively, from March 2004 to December 2014.[3] Together, the word clouds suggest that FOMC statements may not have sufficient word variation, making it difficult to construct a dictionary of words classified as having specific tones. For example, "inflation" is the second most frequently used word in all the alternative statements, though the contextual meaning of inflation likely differs across these statements.

Instead, classifying the tone of a word used in an FOMC statement may require a method that can account for the context in which the word is used. Such a method would be consistent with the

Figure 1

Cloud of Frequently Used Words in Alternative Statements that Suggest Policy Easing

Notes: More frequently used words are represented by larger text size. We count the frequency of words only in Alt. A.
Source: Authors' calculations.

Figure 2

Cloud of Frequently Used Words in Alternative Statements that Suggest Policy Tightening

Notes: More frequently used words are represented by larger text size. We count the frequency of words only in Alt. C and Alt. D.
Source: Authors' calculations.

"distributional representation hypothesis" in linguistics, which suggests that the meaning of a particular word is clarified by the words surrounding it. For example, "broke" in "he broke the law" represents a different, negative sentiment from "broke" in "he broke the world record," which has a positive sentiment. Simply examining the frequency with which the word "broke" appears in a document would not be sufficient to classify the document's tone.

Fortunately, recent developments in NLP models allow us to build rich features that can detect the contextual meaning of words above and beyond simple frequency patterns. One such model is the Universal Sentence Encoder (USE) developed by Google researchers, in which a computer algorithm generates a numerical representation of a text document (Cer and others 2018). Specifically, the USE converts any given input document into a numerical vector. Because the USE algorithm is trained to model the meaning of sequences of words, rather than just individual words, its numeric representations are "context-aware"—that is, even the same word can be represented by different numeric values depending on the context in which it is used. Hence, the distance between the numerical representations of two sentences can capture semantic differences between them even if they contain many overlapping words. For example, consider the following three sentences:

S1) How old are you?
S2) What is your age?
S3) How are you?

S1) and S3) have similar words but ask very different questions. In contrast, S1) and S2) have no overlapping words but ask essentially the same question. A model trained to compare the meaning of two sentences based only on the frequency with which similar words appear would erroneously suggest S1) is most similar to S3). However, when the USE is tasked with scoring the similarity of the three sentences, it correctly identifies that S1) is more similar to S2) than S3).

The ability of the USE to discriminate the contextual semantic meaning of words makes it particularly useful for identifying the overall tone of a FOMC statement. Although "inflation" is one of the most frequently used words in all of the alternative statements, its

sentiment—whether it connotes an increase or decrease in the outlook for inflation—changes depending on the words around it or its order in the sentence. As an example, Table 1 compares a sentence from the FOMC statement released after the November 2005 meeting with a counterfactual sentence in which the order of two clauses describing the development in the inflation outlook is swapped. The released version discounts the rise in energy and other costs and ends by emphasizing the stability of core inflation and longer-term inflation expectations. However, the counterfactual version reverses the order, beginning with the stability of core inflation and then tempering that stability with the rise in energy costs. By changing the order of the clauses, the counterfactual paragraph emphasizes the rise in energy and other costs over the stability of core inflation and longer-term inflation expectations. Although humans can recognize these semantic differences qualitatively, they may not agree on the magnitude of the semantic difference across different descriptions of economic conditions. The USE provides an automatic way to quantify such a semantic difference.[4]

As a result, we follow the method detailed in Doh, Song, and Yang (2020) and identify the tone of a post-meeting FOMC statement by comparing its numeric representation from the USE algorithm to the numeric representations of the alternative statements. We classify the tone of the post-meeting statement as less accommodative if it is semantically more similar to Alt. C (or Alt. D if available) than Alt. A. As a first step, we calculate the "similarity score" between the numeric representations of two texts generated by the USE algorithm. The similarity score lies between 0 and 1, where a value of 1 indicates that the two documents are identical. Because we are interested in new information from one FOMC statement relative to another, the *dissimilarity* between documents is more informative for our purpose. Thus, we subtract the similarity score from 1 to yield the "semantic distance" between the documents, which measures how dissimilar they are.

As a second step, we use this measure of semantic distance to, in turn, construct a measure of tone that is bounded between –1 and 1. If the released statement is indistinguishable from the alternative statement suggesting policy easing based on the numeric representation generated by the USE algorithm, our tone measure takes the value of –1; if the released statement is indistinguishable from the alternative statement suggesting policy tightening, our measure takes the value of 1. In

Table 1
Inflation Language in the November 2005 FOMC Statement

Released version	Counterfactual version
The cumulative rise in energy and other costs has the potential to add to inflation pressures; however, core inflation has been relatively low in recent months and longer-term inflation expectations remain contained.	Core inflation has been relatively low in recent months and longer-term inflation expectations remain contained; however, the cumulative rise in energy and other costs has the potential to add to inflation pressures.

Source: Board of Governors of the Federal Reserve System.

addition, we measure the semantic distance between each post-meeting FOMC statement and the previous post-meeting FOMC statement to capture new information in the more recent statement. We then follow Ke, Kelly, and Xiu (2019) and multiply this measure of new information by our measure of tone to generate a measure of the change in the policy stance from the previous FOMC meeting.

Because monetary policy actions are transmitted through financial markets to the real economy, policymakers are interested in assessing the effect of central bank communications on financial markets. Economic theory suggests financial markets respond only to unexpected information—also known as the "surprise component" of a statement. As a result, we need a measure of the surprise component of the tone of a statement to isolate the change in bond prices that occurred in response to the released statement. Unfortunately, we do not have a measure of the market's expectation of the tone of the upcoming FOMC statement comparable to asset price data. However, we can reasonably assume that the market expectation of the statement's tone will lie somewhere between the tone of the less accommodative and more accommodative statements. Thus, some weighted average of the tones in these two statements will provide the market expectation of the tone in the upcoming post-meeting statement. We can then subtract this measure from the estimated tone of the official statement to get a measure of the surprise component of the statement.

Although these weights are unknown, they can be estimated by examining how bond yields change during a narrow event window around a policy announcement (10 minutes before and after the announcement). When the tone of a released FOMC statement is unexpectedly less accommodative, bond yields increase; when the tone is unexpectedly more accommodative, bond yields decline. If FOMC

statements with similar tones induce different market responses, we attribute the difference to a difference in market expectations. Although this method looks similar to the method in Swanson (2020) and Nakamura and Steinsson (2018) of identifying policy surprises based purely on the high-frequency responses of bond markets around policy announcements, we can measure the magnitude of surprises not just by the size of bond market responses but also by information in FOMC statements. For example, we can study what part of the statement can make it more or less accommodative in tone, which drives the market's reaction to FOMC announcements.

III. Empirical Analysis of FOMC Statements (March 2004–December 2014)

Using the USE algorithm and following the methods detailed in Doh, Song, and Yang (2020), we find that the overall tone of a statement has as least as much of an effect on financial market conditions as quantitative information such as the size of the rate cut. This analysis is based on a sample of publicly available alternative versions of FOMC statements for 87 scheduled FOMC meetings from March 2004 through December 2014. When multiple versions of alternative statements that suggest policy tightening or policy easing exist, we use the most extreme version (for example, Alt. D instead of Alt. C) to identify the tone of the released statement.

To illustrate our results in more detail, we consider two examples in which the NLP model provides additional insights on the policy stance. Our first example is from September 2007, when alternative FOMC statements differed not only in the size of the rate cut suggested but also in their characterizations of the balance of risk. Table 2 shows a summary of the policy decisions, stated rationale, and risk assessment of all four alternative statements. Based only on the decision for the target policy rate, the alternative statements appear to get progressively less accommodative as they move from A to D: Alt. A and B suggest a 50 basis point cut in the federal funds rate target, Alt. C suggests a 25 basis point cut, and Alt. D suggests no change to the federal funds rate target at all. However, the statements also differ meaningfully in later paragraphs that describe the outlook and the balance of risk: first, Alt. B and Alt. C provide the same description of the outlook, while Alt.

Table 2
Alternative Language for the September 2007 FOMC Statement

Component	Alternative A	Alternative B	Alternative C	Alternative D
Policy decision	Lower the federal funds rate target by 50 basis points	Lower the federal funds rate target by 50 basis points	Lower the federal funds rate target by 25 basis points	Keep the federal funds rate target
Rationale	Tighter credit conditions and the intensification of the housing correction appear likely to exert appreciable restraint on economic growth. Moreover, the potential for significant spillovers from credit market disruptions to business and household spending poses a risk to the outlook.	Economic growth was moderate during the first half of the year, but the tightening of credit conditions has the potential to intensify the housing correction and to restrain economic growth more generally.	Economic growth was moderate during the first half of the year, but the tightening of credit conditions has the potential to intensify the housing correction and to restrain economic growth more generally.	Economic growth was moderate during the first half of the year. Financial market conditions have deteriorated in recent weeks, leading to tighter credit and an intensification of the housing correction. These developments have the potential to restrain growth in economic activity. Nonetheless, the economy seems likely to continue to expand in a moderate pace over coming quarters, supported by solid growth outside the housing sector and a robust global economy.
Assessment of risk	Even after today's action, the Committee judges that the downside risks to economic growth outweigh the upside risks to inflation.	The Committee will continue to closely follow timely indicators of economic prospects and will act as needed to foster price stability and sustainable economic growth.	Even after today's action, the Committee judges that the downside risks to economic growth outweigh the upside risks to inflation.	In the current circumstances, the Committee judges that the downside risks to economic growth are now roughly balanced by the upside risks to inflation.

Source: Board of Governors of the Federal Reserve System.

A (Alt. D) provides a more pessimistic (optimistic) outlook; second, Alt. A and Alt. C acknowledge that "the downside risks to economic growth outweigh the upside risks to inflation," while Alt. B and Alt. D sound neutral regarding the risk assessment. Thus, even though Alt. C suggests a smaller rate cut than Alt. B, it may not necessarily be less accommodative in tone overall.

To assess how this qualitative risk assessment affects the tone of the released FOMC statement, we compare the similarity scores among alternative statements based on their USE representations. Importantly, the released FOMC statement adopted the rate cut and risk assessment language from Alt. B, so we compare the similarity scores of the released statement with the other alternatives. Table 3 shows that the released statement was semantically more similar to Alt. C than Alt. A, even though the released statement and Alt. A cut the rate by 50 basis points, while Alt. C cut the rate by 25 basis points. This result suggests the qualitative description of the outlook matters as much as quantitative decisions on the rate cut in determining the overall tone of the statement.

In addition, Table 3 shows that the stated rationale for the rate decision generates semantic differences across alternative statements even when the rate decision itself is the same. Although Alt. A and Alt. B both cut the rate by 50 basis points, Alt. A points to significant spillovers from credit markets to business and household spending and emphasizes downside risks. In doing so, Alt. A describes an outlook consistent with additional easing in the future relative to Alt. B, generating significant semantic differences between the two alternative statements. In this sense, how the Committee signals future policy actions matters as much as its current policy action.[5]

Our second example is from October 2013, when alternative statements differed in their interpretations of the strength in incoming data. As Table 4 shows, Alt. A downplays the signal from strong incoming data by describing the effect of the temporary government shutdown on the interpretation of the data; other versions do not have that sentence. The paragraphs describing incoming data are otherwise similar across alternative statements. Accordingly, Table 5 shows that when we apply similarity scoring based only on the frequency of words used in the text, the sentiment of the alternative statements does not appear to differ much. However, their USE representations are quite different,

Table 3

Similarity Scoring of Alternative Statements for the September 2007 FOMC Meeting

Similarity (A, C)	Similarity (A, FOMC)	Similarity (C, D)	Similarity (C, FOMC)
0.990	0.968	0.897	0.983

Note: FOMC denotes the post-meeting statement, and A, C, and D denote alternative statements.
Source: Doh, Song, and Yang (2020).

Table 4

Alternative Language Describing Outlook for the October 2013 FOMC Meeting

Alternative A	FOMC	Alternative C
The effects of the temporary shutdown of the federal government have made the evolution of economic conditions during the intermeeting period somewhat more difficult to assess. However, information received since the Federal Open Market Committee met in September generally suggests that economic activity has been expanding at a modest pace. Indicators of labor market conditions have shown some further improvement but the unemployment rate remains elevated. Available data suggest that household spending and business fixed investment advanced, but that the recovery in the housing sector has slowed in response to higher mortgage rate. Fiscal policy is restraining economic growth. Apart from fluctuations due to changes in energy prices, inflation has been running below the Committee's longer-run objective, even though longer-term inflation expectations have remained stable.	Information received since the Federal Open Market Committee met in September generally suggests that economic activity has continued to expand at a moderate pace. Indicators of labor market conditions have shown some further improvement, but the unemployment rate remains elevated. Available data suggest that household spending and business fixed investment advanced, while recovery in the housing sector slowed somewhat in recent months. Fiscal policy is restraining economic growth. Apart from fluctuations due to changes in energy prices, inflation has been running below the Committee's longer-run objective, but longer-term inflation expectations have remained stable.	Information received since the Federal Open Market Committee met in September generally suggests that economic activity has continued to expand at a moderate pace. Indicators of labor market conditions have shown some further improvement; in particular, the unemployment rate, though still elevated, has continued to decline. Household spending and business fixed investment advanced, and the housing sector has continued to strengthen, even though mortgage rates have risen on balance in recent months and fiscal policy is restraining economic growth. Apart from fluctuations due to changes in energy prices, inflation has been running somewhat below the Committee's longer-run objective, but longer-term inflation expectations have remained stable.

Note: FOMC denotes the post-meeting statement, and alternatives A and C denote alternative statements.
Source: Board of Governors of the Federal Reserve System.

Table 5

Similarity Scoring of Alternative Statements for the October 2013 FOMC Meeting

Algorithm	Similarity (A, FOMC)	Similarity (C, FOMC)
USE	0.895	0.990
Word frequency	0.975	0.972

Note: FOMC denotes the post-meeting statement, and A and C denote alternative statements.
Source: Doh, Song, and Yang (2020).

Table 6

Correlation with Policy Surprise Measures from Swanson (2020)

Policy instrument	Correlation of surprise in Doh, Song, and Yang (2020) and Swanson (2020)
Federal funds rate	0.20
Forward guidance	0.52
Asset purchases	–0.12

Notes: Asset purchase shocks in Swanson (2020) are normalized to associate a negative number with policy tightening comparable to the increase in the interest rate, so the sign is flipped even though the underlying relation should be similar.
Sources: Swanson (2020) and Doh, Song, and Yang (2020).

as the sentence on the effect of the temporary government shutdown changes the contextual meaning of the first paragraph substantially.[6] This example shows once again that changing qualitative descriptions of the outlook can materially change the tone of the FOMC statement.

Because monetary policy influences the real economy through financial markets, it is important to know how the tone we identify using text analysis is transmitted to asset prices, including stock returns and bond returns. To answer this question, we compare our measure of the tone of FOMC statements with measures from previous research based on high-frequency asset price data only. In these measures, an upward jump in Treasury yields during a narrow window around an announcement is associated with a surprisingly less accommodative tone, and a downward movement in Treasury yields is associated with a surprisingly more accommodative tone. Our measure of tone is highly correlated with these other measures, suggesting the tone we identify using alternative statements matches the tone financial markets perceive (Doh, Song, and Yang 2020).

In addition to incorporating qualitative information, our measure has another advantage over measures in previous research. When bond yields with different maturities respond differently to FOMC

announcements, we can use this cross-sectional difference to decompose policy surprises along multiple dimensions. For example, we can assess how announcements related to asset purchases influence longer-term (10-year and longer) bond yields and how forward guidance about the future path of interest rates influences near- to medium-term (two- to five-year) bond yields. We compare our text-based policy surprise measure with multiple dimensions of monetary policy surprises in Swanson (2020) constructed in this way. Table 6 shows that our measure is highly correlated with forward guidance on the future path of the interest rate, and modestly correlated with large-scale asset purchases. Given that our measure is sensitive to alternative descriptions of the outlook, this finding suggests that market participants associate changes in the outlook mostly with medium-term policy expectations.

Conclusion

Central bank communications about current and future policy actions have increasingly received attention as a policy tool. Many studies evaluate the effects of quantitative information from policy statements based on the response of bond prices during narrow event windows around the release of FOMC statements. However, this approach may not fully capture the potential effect of qualitative descriptions of the economy or the rationale for a policy decision contained in these statements.

We overcome the limitation of event studies based on asset price responses by using a natural language processing tool to directly quantify the policy stance from texts. Specifically, we identify the tone of a post-meeting statement by quantifying how close it is semantically to alternative versions of statements, whose more or less accommodative tones can be determined based on the rationale given for each alternative in FOMC documents. Our analysis of post-meeting FOMC statements illustrates an important role for qualitative statement language. In particular, we find that information about the Committee's assessment of risk is as important as a quantitative decision on the target policy rate. In addition, we find that including information about how the Committee interprets incoming data in a statement can substantially influence a statement's tone. Our results suggest that *how* the Committee describes its rationale for the policy action may matter as much as the policy action itself.

Endnotes

[1]Before 2004, the Board staff prepared alternative draft language for some parts of the statement (such as "maintaining [increasing/reducing] the federal funds rate") but did not provide alternative versions of the full statement. See Board of Governors of the Federal Reserve System (2004).

[2]The Board declassifies documents after five years and publicly releases them each January. Thus, as of November 2020, the latest available alternative statements were those prepared for the December 2014 meeting and included in a document called "Tealbook," which had a "Part A" and a "Part B." Tealbook Part A was formerly called "Greenbook," while Part B was called "Bluebook." Occasionally, Board staff provides a fourth policy alternative, Alt. D. In these cases, Alt. D is intended to be less accommodative than Alt. C. When available, we use Alt. D instead of Alt. C to identify the tone of the post-meeting statement.

[3]Lucca and Trebbi (2009) classify the tone of words used in the post-meeting FOMC statement by the systematic co-frequency of those words with "hawkish" (associated with policy tightening) or "dovish" (associated with policy easing) in documents found by the Google search engine. However, the contextual meaning of words depends on word ordering and various qualifiers not easily detected by this method.

[4]The similarity scoring is 1 based on word frequency but 0.991 in the USE. Although the difference does not seem to be material even in the USE, the similarity score is generally high and less variable in the USE. For example, the average similarity score between the released post-meeting statement and Alt. A is 0.977, and the standard deviation is 0.022. Hence, the difference between 1 and 0.991 can still make a meaningful difference once we construct our measure of the tone based on the counterfactual paraphrase.

[5]Gürkaynak, Sack, and Swanson (2005) highlight this point using high-frequency bond price changes as instruments for the effect of changing language in FOMC statements.

[6]The alternative statements have other slight differences—for instance, Alt. A adds a more dovish tone to the threshold of forward guidance on the duration of the effective lower bound. However, when we calculate the semantic differences paragraph by paragraph, we find that the first paragraph is most critical in generating the semantic difference between alternative statements.

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The Evolving Link between Oil Prices and U.S. Consumer Spending

By Nida Çakır Melek and Robert J. Vigfusson

O il prices have fluctuated widely since the 1970s. Starting around 2000, oil prices began a steady rise, reaching historic highs in the mid-2000s. Then, in the wake of the 2007–09 global financial crisis, oil prices plummeted, before rebounding sharply in the early stages of the subsequent economic recovery. This rebound in prices helped fuel investment in the U.S. oil sector and propelled the fracking revolution. As the fracking revolution took hold and U.S. oil production ramped up, prices again fell sharply in 2014. Although oil prices began to recover again in recent years, they took yet another sharp hit in the economic shutdown precipitated by the COVID-19 pandemic.

Historically, consumers have tended to increase spending on non-oil goods and services when oil prices decline and cut back on such spending when oil prices rise. This response is due, in part, to the United States being a major oil importer and the demand for oil being relatively price-inelastic—that is, slow to adjust to price changes (see, for example, Hamilton 2009; Edelstein and Kilian 2009; Yellen 2011; Ramey 2016). However, this relationship may have changed more

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recently. In particular, the domestic oil sector has grown strongly in the last decade, increasing its importance to overall U.S. economic activity, and consequently the United States has become less reliant on oil imports. In addition, oil expenditures have fallen as a share of households' budgets. As a result, price swings may no longer have the same effect on household consumption as they did in the past.

In this article, we look at two channels through which oil price changes affect consumption—the (direct) discretionary income channel and the (indirect) oil producer channel—and describe how the net oil import position influences these channels. We then provide evidence that the effect of oil price changes on consumption has become more muted. Our analysis suggests changes in oil prices are less likely to yield major changes in consumption, even among lower-income households.

In describing the channels through which oil price changes affect consumption, we limit our focus to how oil prices can affect consumer spending holding other influences fixed. In particular, we abstract from how changes in consumption might affect oil prices. For example, during the global financial crisis and Great Recession, both consumption and oil prices fell sharply, likely due to a steep decline in aggregate demand. Although the factors affecting consumption and oil prices are wide-ranging, we concentrate our discussion on how an independent change in oil prices might affect consumption through these channels.

Section I describes and discusses the channels through which oil prices can affect consumption. Section II presents evidence that these channels on net have likely reduced the sensitivity of consumer spending to oil price changes. Section III explores the distributional effects of oil price changes.

I.   Channels through Which Oil Prices Affect Consumption

We focus on two main channels through which oil price changes affect consumer spending. Through the first channel—the discretionary income channel—changes in oil (specifically, gasoline) prices directly affect consumers' spending on other goods and services as consumers' discretionary income changes. Through the second channel—the oil producer channel—oil price changes indirectly affect consumption through their effects on oil sector revenues and the costs associated with

reallocating labor and capital from the oil sector to other sectors of the economy. The overall effect of these two channels is determined by the degree to which a country relies on oil imports to meet its energy needs.

Discretionary income channel

Changes in oil prices can affect consumption directly through the discretionary income channel (Edelstein and Kilian 2009). Specifically, consumers can benefit from lower oil prices that pass through to lower gasoline prices by redirecting their spending on gasoline toward non-energy-related items. Assuming the demand for gasoline is price-inelastic, consumers can purchase the same volume of gasoline for less when oil prices fall, freeing up cash for them to spend on other goods and services (Edelstein and Kilian 2009; Hamilton 2009; Blanchard and Galí 2010; Baumeister and Kilian 2016).

Oil producer channel

In addition to the previous direct channel, which implies that lower oil prices boost consumption, changes in oil prices may also affect consumption through an indirect channel: the oil producer channel. This channel captures the effect of oil price changes on oil producer income as well as the costs associated with the reallocation of labor and capital across sectors (Hamilton 1988; Davis and Haltiwanger 2001). Importantly, this channel operates in the opposite direction of the discretionary income channel in that it implies that a contraction in the oil sector resulting from lower revenues in response to an unexpected drop in oil prices may result in *lower* consumer spending. For example, workers in the energy sector may not be able to easily translate their specialized skills for use in other sectors should low oil prices lead to layoffs, which in turn, could reduce consumption. In this way, frictions in the reallocation of sector-specific labor (or capital) can affect consumption beyond the direct effect of oil price changes.

The role of net oil imports

In addition to these two channels, a country's net oil import status—that is, whether it is a net importer or a net exporter—also matters for the overall effect on consumption of a given change in oil prices. Although some researchers consider the net oil import status a separate

channel, we argue that a country's net import status instead determines the relative importance of the direct and indirect consumption channels. Lower oil prices benefit some consumers through the discretionary income channel, but negatively affect domestic oil producers' income and hence their consumption; the net oil import status affects the balance between the two.

The effect of a change in the relative price of a good in an economy open to trade works through a change in its domestic income. For a net oil importer, this means a decline in oil prices would reduce the domestic income spent on oil imports.[1] As less income is transferred abroad to pay for the same amount of oil consumed, the resulting increase in domestic income should boost (non-oil) consumption. This benefit to a country's consumption of spending less on oil imports has been frequently cited in discussions of oil price effects on consumption in the United States, which has been a major net oil importer for decades (see, for example, Yellen 2011; Ramey 2016).

Ramey (2016) questions whether the discretionary income channel exists independent of this import status effect. She argues that absent the import status effect, changes in relative prices should not boost aggregate consumption, because independent of their effect on income, a decrease in the relative price of one good means a corresponding increase in the relative price of another good. Baumeister, Kilian, and Zhou (2018) emphasize that the discretionary income channel comes through gasoline price changes, and that the discretionary income channel is closely related to the import status effect. One may indeed resolve this debate by interpreting a country's net oil import status as what determines the relative importance of the direct benefits to consumers of lower gasoline prices versus the indirect harm done to the consumption of oil producers. The weaker the net oil importer status, the more the burden of lower oil prices is borne by domestic rather than foreign oil producers. The balance between the two, hence, would likely determine the overall effect of oil price changes on consumption, which would also depend on the more immediate effects.

Although the role of imports is important, a change in oil prices could still affect consumption without involving income transfers abroad. For example, one could see a boost to consumption from an oil price decline if the oil price decline benefited consumers who spend a

larger share of their household budgets on gasoline and who are more likely than average to spend rather than save a windfall from lower gasoline prices. Hamilton (2016) makes a related distributional argument that lower gasoline prices boost some consumers' discretionary income more immediately than lower gasoline spending lowers the incomes of others. Because of this distributional effect, a decline in the relative price of oil could still support aggregate spending even if none of the oil was imported.

II. Why the Effect of Oil Price Changes on Consumption Has Likely Diminished

Recent developments may have altered the channels through which oil price changes affect consumption. On net, we argue that the response of consumption to oil price changes has become more muted.

First, the empirical importance of the discretionary income channel is likely lower now than in the past. Chart 1 shows how the share of gasoline expenditures in total personal consumption expenditures has evolved since 1985. After fluctuating from about 2 to 4 percent of spending since the mid-1980s, the share fell below its long-run average value of 3 percent in late 2014 and has remained below this value since then. Notably, the share has declined even more since the onset of the pandemic, suggesting a more muted effect of lower oil prices on consumption.

However, the decline in the expenditure share since the onset of the pandemic highlights an additional channel that might help boost consumption in the near term: increased work from home. Restrictions to slow the spread of COVID-19 forced many U.S. businesses to close their offices and allow their employees to work from home. To the extent that this experiment encourages more work from home going forward, changes in gasoline prices may lead workers to adjust their commuting rather than divert income toward gasoline expenditures. Based on a survey of working-age adults, Bick, Blandin, and Mertens (2020) document that 35 percent of the workforce worked entirely from home in May 2020, up from 8 percent in February. According to Barrero, Bloom, and Davis (2020), from May to October 2020, about half of all paid hours were worked from home. Bartik and others (2020) suggest that at least 16 percent of American workers in professional offices will switch to working at home at least two days per week post-pandemic.

Chart 1

Share of Gasoline Spending in Total Personal Consumption Expenditures
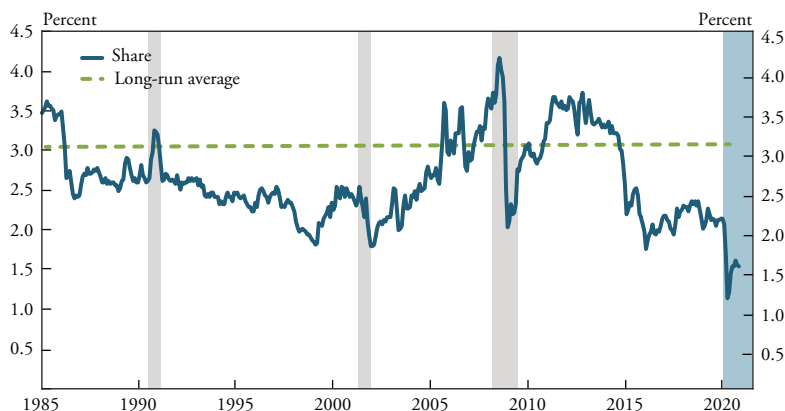
Note: Gray bars denote National Bureau of Economic Research (NBER)-defined recessions; blue bar indicates the pandemic recession.
Sources: Bureau of Economic Analysis (BEA) and NBER. Both data sources accessed through Haver Analytics.

Reflecting both less-frequent commutes and other associated declines in mobility, gasoline consumption per household fell during the pandemic. Chart 2 shows that after fluctuating narrowly around the 1990s' average since 2000, gasoline consumption per household dropped by more than one-third from February to April 2020. Although mobility has increased with the lifting of stay-at-home restrictions, gasoline consumption remains well below pre-pandemic levels and is unlikely to fully recover due in part to the potential for greater workplace flexibility in the future. This reduction in gasoline consumption may boost non-oil consumption in the near term, but going forward, increased ability to work from home will likely dampen the effect of oil price changes on consumption. If more consumers have the ability to work from home, higher gasoline prices could cause them to reduce their commuting rather than spend more of their income on gasoline. In this way, gasoline demand is likely to become more responsive to price changes, while total consumption becomes less responsive to changes in gasoline prices.

The oil producer channel is also likely less important for the U.S. economy today than it was the last time oil prices declined substantially. During the 2014–16 oil price slump, some researchers attributed the

Chart 2
Gasoline Consumption per Household
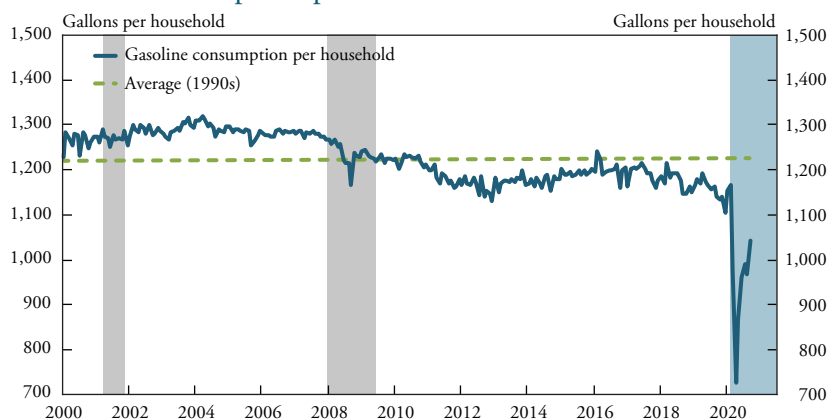
Note: Gray bars denote NBER-defined recessions; blue bar indicates the pandemic recession.
Sources: U.S. Census Bureau (Haver Analytics), U.S. Energy Information Administration, and NBER (Haver Analytics).

muted economic benefits of lower oil prices to the oil industry's increased importance to the U.S. economy (see, for example, Baumeister and Kilian 2016). The resulting plunge in U.S. oil investment took about 2 percentage points off U.S. nonresidential business investment growth in 2015 and 2016. However, the oil industry's importance to the overall economy has waned somewhat more recently. For example, Chart 3 shows that while U.S. oil production has continued to increase since 2016, neither the employment share (Panel A) nor the investment share (Panel B) of the oil industry is as high as it was in 2014. As such, the losses realized by oil producers from lower oil prices will be relatively smaller compared with the overall economy, resulting in a more muted negative effect on consumption from this channel now than in the recent past.

In addition to the weakening of the discretionary income and oil producer channels, the share of net oil imports in U.S. GDP has declined considerably over the past decade due to the shale oil revolution and associated growth in U.S. oil production. Accordingly, the import share of oil in GDP has declined. Chart 4 shows that the share of net imports of petroleum and petroleum products in U.S. GDP fell close to zero in 2019, well below the long-run average of 1 percent. The United States moved slightly into net exporter territory in 2020, when oil prices and U.S. demand fell precipitously in response to the economic

Chart 3
Importance of the Oil Industry in the Overall Economy

Panel A: Share of Oil Employment in Total Employment
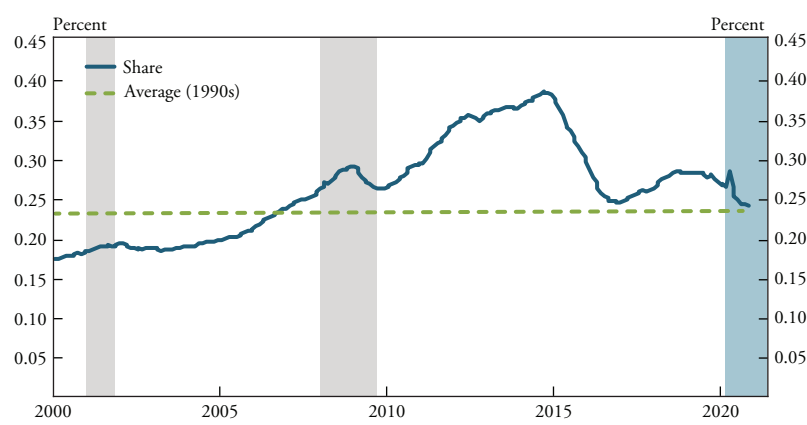
Panel B: Share of Oil Investment in GDP
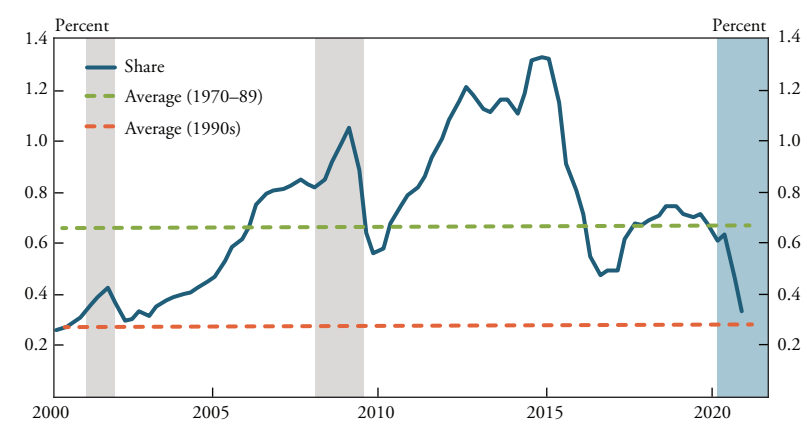
Note: Gray bars denote NBER-defined recessions; blue bar indicates the pandemic recession.
Sources: BEA, U.S. Bureau of Labor Statistics (BLS), and NBER. All data sources accessed through Haver Analytics.

Chart 4
Share of Net Petroleum and Petroleum Products Imports in GDP

Note: Gray bars denote National Bureau of Economic Research (NBER)-defined recessions; blue bar indicates the pandemic recession.
Sources: BEA and NBER (Haver Analytics).

slowdown caused by the COVID-19 pandemic. Overall, this decline in the net import share of oil in recent years has likely diminished the relative importance of the positive discretionary income channel relative to the negative oil producer channel, weakening the overall positive effect of lower oil prices on consumption.

III. Distributional Effects of Oil Price Changes

Although this reduced responsiveness is likely to hold in the aggregate, gasoline price changes could still affect the consumption of lower-income individuals, who spend a larger share of their income on gasoline and are less likely to work from home. To explore this possibility, Chart 5 presents the share of gasoline expenditures in total expenditures by income quantile. Consistent with Chart 1, across the income distribution, spending on gasoline accounted for a smaller share of total spending in 2019 (blue line) than in the past (green line). Thus, even low-income households affected disproportionately by the COVID-19 shock are likely to see a smaller boost to consumption from a drop in gasoline prices.[2] Moreover, Chart 5 shows that gasoline's expenditure share across the income distribution is relatively flat. Indeed, data show that the difference between the lowest-income and the highest-income quantiles' expenditure shares of gasoline has been about 1 percentage

Chart 5
Share of Spending on Gasoline by Income Quantile
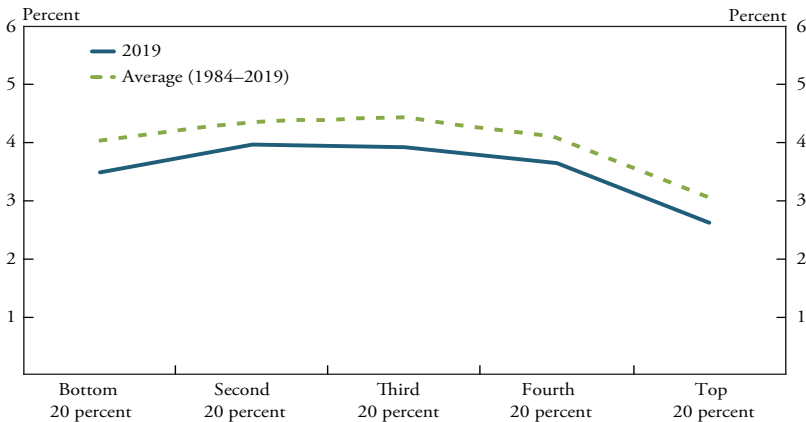
Note: 2019 is the latest year for which data are available.
Source: BLS (Haver Analytics).

point since 1984. As a result, gasoline price changes may have similar effects on consumption across different income groups.

However, results from previous studies have reached somewhat conflicting conclusions regarding differences across consumers. Macro-economic theory predicts that the responses of consumers to changes in income could vary depending on their asset holdings or access to credit. For example, Kaplan and Violante (2014) examine varying responses of consumers to changes in fiscal transfers and find that hand-to-mouth consumers—those who may be liquidity constrained and generally consume all their income to meet basic needs—exhibit a larger marginal propensity to consume (MPC) after transitory, anticipated income shocks than non-hand-to-mouth consumers. If hand-to-mouth consumers respond in a similar way to changes in discretionary income due to an oil price change, their behavior could lead to a relatively large response of consumption to oil price changes.

In this context, Gelman and others (2016) focus on the sudden, large drop in gasoline prices in 2014 and estimate the change in consumers' spending from the considerable income freed up by lower gasoline prices. Given a low elasticity of demand for gasoline, they interpret the MPC as measuring the response of spending to a permanent, unanticipated income shock. In contrast with Kaplan and

Violante, they show that consumers' liquidity constraints did not generally affect the strength of the spending response—that is, hand-to-mouth and non-hand-to-mouth consumers had similar MPCs out of savings generated by reduced gasoline prices. Gelman and others (2016) argue that this conflicting finding is likely driven by the more persistent and less anticipated gasoline price shocks over the 2013–16 period relative to the fiscal transfer shocks considered in Kaplan and Violante. Even so, the differences in results are puzzling.

Another underexplored question is how commuting costs interact with consumption. Ready, Roussanov, and Zurowska (2019) document that as oil prices increase, lower-paid workers or those who live in areas with lower population density work fewer hours. Although the authors do not document consumption effects, fewer hours worked would likely depress consumption for these low-income workers beyond the direct effect of gasoline prices, worsening the distributional consequences of an oil price change. In this context, the rise of work from home will also likely have distributional consequences, benefitting higher-income households more than lower-income households, who are less likely to work from home.[3]

Conclusion

The pandemic has created a global economic slowdown, resulting in a large decline in oil prices in early 2020. Historically, low oil prices have boosted consumption. However, we argue that the channels through which oil prices can affect U.S. consumption—the discretionary income channel and the oil producer channel—have likely weakened, and that any boost to consumption from a decline in oil prices is likely to be modest. In particular, the dramatic decline in the net oil import share has diminished the relative importance of the (positive) discretionary income channel relative to the (negative) oil producer channel, meaning consumers would likely experience less of a boost from lower oil prices now than in the past.

Nevertheless, the increase in work from home during the pandemic and potential workplace flexibility post-pandemic may lead individuals who can work from home to redirect their gasoline expenditures toward other categories of U.S consumption. Of course, this effect is distributional in that it would benefit only those who have the

flexibility to work from home and not those who are tied to their work-places. Therefore, a useful area of further research would be consumption behaviors across different groups, which may help us better understand the distributional effects of oil price changes in an evolving environment.

Endnotes

[1]For example, Backus and Crucini (2000) find that oil accounts for much of the variation in the terms of trade—the relative price of exports in terms of imports—in the 1970s and early 1980s.

[2]For example, Chetty and others (2020) investigate the economic effects of COVID-19 and show that low-wage workers experienced much larger job losses than high-wage workers, and these losses persisted for several months.

[3]Mongey, Pilossoph, and Weinberg (2020) study the characteristics of individuals who cannot work from home and find that they are more likely to be lower income, lack a college degree, rent their dwellings, be non-white, and lack employer-provided health insurance.

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