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Federal monetary policy: Is this time different?

Introduction

We just experienced the fastest recession and subsequent recovery in recorded economic history. In the depths of the Great Financial Crisis, the Federal Open Market Committee (FOMC) cut the federal funds rate by 325 basis points in just one year (2008).[1] It took seven years for the economy to dig itself out of that recession. However, during the prolonged recovery, inflation stayed largely subdued, averaging 1.8% year-on-year.

During the more recent, pandemic-induced recession, unemployment hit a high of 14.7% and a low of 3.9%, and inflation rose from 1.2% to 6.4% year-on-year, all in 20 months. The lightning-paced recovery of economic activity, combined with supply-chain issues, pushed prices to uncomfortable levels and risks unanchoring inflation expectations. This could lead to a policy shift away from accommodative and toward neutral—when the funds rate reaches r-star—and then to policy tightening when rates push above r-star post-recession.[2]

The Fed is navigating a long and difficult path to r-star. It will have to tighten policy, pushing well into positive real rates, as it balances the trade-off between inflation and employment. History tells us that market volatility plays a significant role in the Fed's decision making, and rightly so, since disregarding market volatility can come with a steep cost for policymakers. The most recent 50-basis-point rate hike was preceded by a 25-basis-point increase and a hawkish dot plot signaling a faster hike path; the Fed anticipates reaching 2% by the end of this year in its March 2022 survey of economic projections.

1 The FOMC is the body of the Federal Reserve System that sets national monetary policy. The FOMC consists of 12 voting members—the seven members of the Board of Governors; the president of the Federal Reserve Bank of New York; and four of the remaining 11 reserve bank presidents, who serve one-year terms on a rotating basis. For simplicity, we refer to the FOMC and its rotating members of the Federal Reserve System as the Fed.

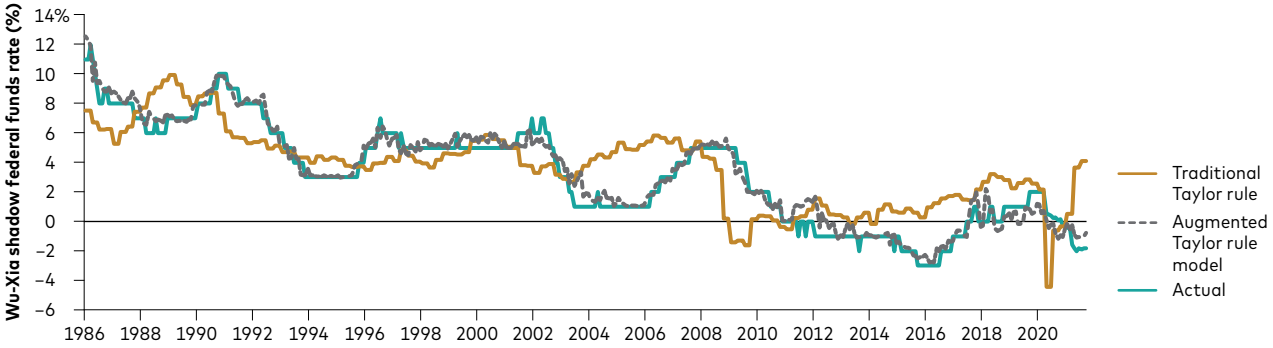
2 R-star is a theoretical concept that describes the funds rate at which the economy is at full employment with price stability. Estimates vary greatly; however, for the purposes of this paper we will assume an r-star rate of 2.5%.

While the market seemed unconvinced early on, in the weeks following the March meeting it slowly priced in the Fed's hike path. However, the Fed's work is far from finished. The risks of external supply shocks linger, and the Fed is aware of its limited influence on supply constraints. On the other hand, raising rates with limited information about the resilience of the economy raises the risk of overturning the recovery with an overly aggressive stance.

In this paper, we explore the influence of financial conditions and other macro fundamentals on the Fed's long-term policy path. We find that the traditional Taylor rule model has been a poor predictor of monetary policy action.[3] Adding more macro and market variables to a machine-learning-augmented Taylor rule model improves forecasting ability (**Figure 1**) and helps predict monetary policy actions under various simulated economic scenarios.

FIGURE 1.

The traditional Taylor rule has been a poor predictor of monetary policy action



Note: The figure shows the actual effective federal funds rate (EFFR) at a monthly frequency spliced with the Wu-Xia shadow federal funds rate for periods when rates hit the zero lower bound, along with the traditional Taylor rule estimate and our augmented Taylor rule model estimates of EFFR. Our augmented Taylor rule estimates are forecasted on a 12-month-ahead basis. The estimates are calculated using data from January 1980 to December 2021.

Sources: Vanguard model estimates based on data from Bloomberg and the Federal Reserve Board.

3 The Taylor rule is a proposed guideline for how central banks, such as the Federal Reserve, should alter interest rates in response to changes in economic conditions, specifically changes in unemployment and inflation.

Back to basics

We began our analysis with a standard Taylor rule framework. The Fed has a dual mandate of price stability and maximum sustainable employment; the goal of monetary policy is to foster economic conditions that help achieve these goals using the tools available.[4] The Taylor rule is a forecasting model that helps determine what interest rates should be to shift the economy toward these goals. Interest rates above r-star are considered restrictive, and those below, accommodative.

We used the Taylor rule framework to forecast Wu-Xia shadow federal funds rates using two modeling methods, ordinary least squares (OLS) and machine learning.[5,6] Using the two macro variables of inflation and unemployment rate in either model yielded unreliable estimates.[7] Changing strategy, we tested other macro and market variables and settled on a combination (see Appendix Figure A-1 for a detailed list) containing information about financial conditions, inflation, labor markets, and global conditions. In our analysis, all of these factors were significant in predicting interest rates (**Figure 2**).

FIGURE 2.

Old and new factors predicting monetary policy

Note: The figure shows the various factors that help predict monetary policy.
Source: Vanguard.

Since monetary policy actions consider the progression of and not just prevailing economic conditions, our model included lags of the variables to capture conditions in the medium and long term.

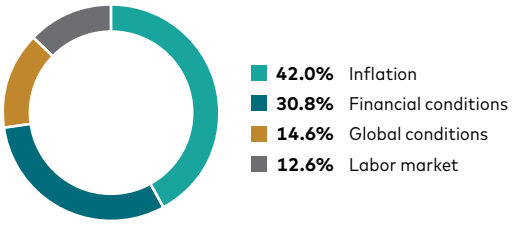
We used the aforementioned factors in a machine-learning, gradient-boosting regression model to predict future changes in Wu-Xia shadow federal funds rates. The data set was for the period January 1990 to September 2021. We used the initial 310 months as our training data set and the remaining 60 as our test set for an out-of-sample prediction result.

Results

Our findings reinforce the importance of inflation and unemployment rates in driving monetary policy but also highlight the significance of a range of additional indicators that capture the financial conditions of the economy. As shown in **Figure 3**, inflation had a significance of 42%, financial conditions about 31%, global conditions about 15%, and unemployment about 13% in explaining monetary policy decisions.

FIGURE 3.

Significance of additional indicators in the augmented Taylor rule model



Note: Training a random-forest decision-tree-based model on our data set gives the model the ability to tell us which indicators have the most influence on the target variable—in this case, the Wu-Xia shadow federal funds rates from January 1990 to September 2021.
Sources: Vanguard model estimates based on data from Refinitive, Moody's, and Bloomberg.

4 The Federal Reserve uses several tools to implement monetary policy that traditionally include reserve requirements, the discount rate, and open-market operations. In 2008, it added paying interest on balances held at reserve banks to its toolkit. More recently, it also added overnight reverse repurchase agreements to support the rate level.

5 OLS is a form of statistical regression used to predict unknown values from an existing set of data.

6 The Wu-Xia shadow federal funds rate is a model-derived rate used to measure the implied federal funds rate of the economy when nominal interest rates come close to the lower bound of zero. We splice the effective federal funds rate for periods in which Wu-Xia shadow federal funds rate data are unavailable. For more details on the model specification, please refer to the Appendix.

7 See Appendix Figure A-2 for detailed results of the Taylor rule with OLS and machine-learning.

Global conditions as proxied by commodity prices also play a significant role in predicting rates. We tested the model out of sample and found a significant improvement in estimates over the traditional Taylor rule.[8] An out-of-sample evaluation of the past five years returned a root-mean-square error of about 0.0078, implying a high degree of accuracy.[9]

This modeling framework also equips us with the ability to simulate certain macroeconomic scenarios that are quite likely this year given contemporary policy shifts and geopolitical events (**Figure 4**). The Fed's discontinuation of monetary policy accommodation has raised the debate over terminal rates, while the Russia-Ukraine crisis has led to a commodity price shock that might well translate into persistently higher inflation.

With current rates in the range of 0.75% to 1% and estimates of neutral rates at 2% to 2.5%, the Fed might have some way to go, especially for steering monetary policy from accommodative to neutral and eventually to tight.[10] Historically, hikes have never followed a recession this closely, and they could run the risk of being too aggressive. If enough of the market believes that will occur, we could very well see short rates rise even as long rates fall off, inverting the yield curve. The likelihood of a recession could also lead to bouts of volatility in the stock market.

FIGURE 4.

Simulation of likely economic scenarios' effect on monetary policy's path

Scenarios	Inflation at year-end 2022	Financial conditions	Global conditions	Labor market at year-end 2022
Inflation baseline	5%	—	—	—
Financial conditions shock	6%	(+) Commodity shock + yield curve inversion	—	—
Global oil shock	6%	—	(+) Commodity shock	—
Global recession	2%	—	(–) Commodity shock	>4%
Fed funds rate at 3%–4%	>7%	—	—	—

Notes: The table describes the underlying economic assumptions made for each scenario discussed. Column 1 names the scenario, and the subsequent columns indicate the assumptions imposed on various input variables. We posit 4 trajectories for inflation by 2023: baseline (5%), downside (close to 2%), upside (above 6%), and above 7%. Our downside scenario for the labor market shows unemployment rising well above 4%. Global conditions are described in two scenarios: a decline in commodity prices by 20% from their levels at year-end 2021 and an increase by the same amount over the course of the year.

Source: Vanguard.

8 The sample used in the analysis is based on data from January 1990 to September 2021. The out-of-sample prediction is based on data from September 2016 to September 2021.

9 The out-of-sample test indicated the robustness of machine-learning regression, which used actual underlying macroeconomic factors as inputs.

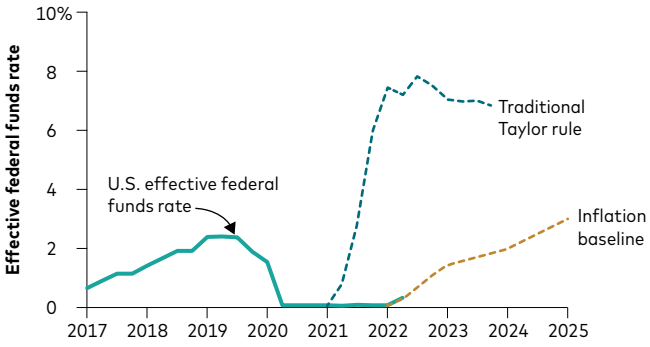
10 Data are from the Federal Reserve Board's FOMC statement issued May 4, 2022.

Is it likely that such events will cause the Fed to pause? In these scenarios, we find that under various conditions of market distress or runaway inflation, the hike path changes as predicted in the model by the estimated relationship between each of the factors and the Wu-Xia shadow federal funds rate. We then use the relationship between the Wu-Xia shadow federal funds rate and the effective federal funds rate to lay out the monetary policy path under various scenarios.[11]

In our inflation baseline scenario, inflation peaks in the first half of this year and thereafter trends lower. Despite its downward trajectory, it remains well above the Fed's target of 2% for this year and is expected to be driven by elevated wage inflation. Under these conditions, our model estimates a brisker tightening pace, with rates expected to rise to 1.5% by the end of this year (implying about six to eight hikes in total, including the one in March 2022). This rate path is much lower than what the traditional Taylor rule would predict, which could possibly be far too aggressive in the current uncertain economic environment (**Figure 5**).

FIGURE 5.

The traditional approach recommends a more aggressive and arguably unrealistic path



Notes: The line farthest to the right shows the estimated path of policy rates under our baseline inflation and labor market assumptions. The middle line shows the rate path as predicted by the traditional Taylor rule.

Sources: Vanguard model estimates based on data from Moody's and Refinitive.

As discussed earlier, the market has now come around to pricing the Fed's accelerated hike path. But the risk of the market perceiving it as too aggressive still lingers if future economic releases disappoint. Under the scenario of a financial conditions shock, the model estimates the Fed will raise rates to 0.8% to 0.9% (implying three or four hikes this year) and reach its terminal rate later.

Recently, the oil price shock has pushed energy prices and headline inflation higher and threatens to unanchor long-term inflation expectations. Even if growth holds up under these conditions (our global oil shock scenario), increased risks of inflation unanchoring could push the Fed to raise rates at a faster pace. In this case, our model estimates the Fed hiking rates aggressively to 2% this year and reaching close to or above the terminal rate of 3% by the end of 2023.

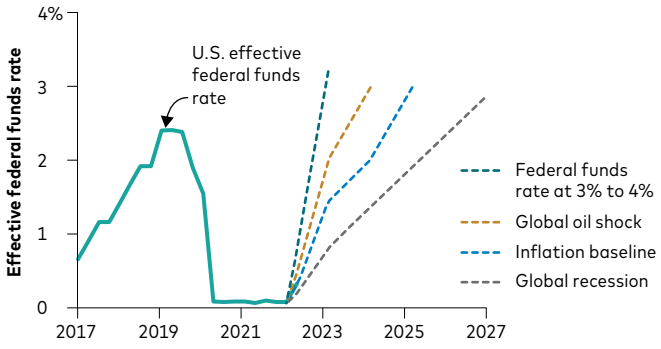
It is often hotly debated which of its two mandates—price stability and full employment—the Fed weighs more. While no model can completely capture this subjective nuance, historical data suggest that the Fed is more concerned about inflation getting out of hand.

11 The federal funds rate is the interest rate at which depository institutions trade federal funds (balances held at federal reserve banks) with each other overnight. When a depository institution has surplus balances in its reserve account, it lends to other banks in need of larger balances. The rate that the borrowing institution pays to the lending institution is determined between the two banks; the weighted average rate for all of these types of negotiations is called the effective federal funds rate. The effective federal funds rate is determined by the market but it is influenced by the Federal Reserve through open market operations to reach the federal funds rate target, which is generally referred to as the monetary policy rate.

Because history shows that wide fluctuations in oil prices usually spill over into economic sentiment and lower consumption globally, we next consider a scenario of global recession. In that case, the Fed would need to pause its hiking cycle or take a step back to get to 0.7% to 0.8% by the end of this year. Deteriorating global economic conditions could pull both growth and inflation lower in the U.S., reducing the need for aggressive rate hikes. In a global recession, activity would take some time to recover, which would push the prospect of reaching a terminal rate of 3% beyond 2025 (**Figure 6**).

FIGURE 6.

The effective federal funds rate in select scenarios



Notes: This figure describes the Fed's rate hike path under each scenario presented. The 12-month-ahead forecasts are obtained from the model estimates. A combination of model estimates and subjective analysis is used to estimate the forecasts' terminal rate and timing under each scenario.

Sources: Vanguard model estimates based on data from Refinitive, Moody's, and Bloomberg.

Until now, we have discussed likely scenarios for the U.S. and global economy against the backdrop of an ongoing Ukraine-Russia war and high inflation. For scenarios of global recession, the model estimates a slower hike path than our inflation baseline. But could certain conditions lead to an even more hawkish path than our consensus expectations? We would anticipate a persistent rise in inflation as the main driver for a hawkish Fed. Testing this theory in our model, we find that a positive shock to inflation that raises year-on-year core inflation to 7% by December 2022 could push the Fed to hike to 3% to 4% terminal rates this year. While it's not outside the realm of possibility given the inflation upside, we allot a low probability to this event for now. Absent a pandemic-like fiscal stimulus this year, elevated inflation would chip away at consumption and take pressure off prices, lowering the Fed's need to hike rates aggressively.

Conclusion

Replicating the Fed's decision-making is an important step toward understanding it. While the Taylor rule is a simple formulation of the Fed's dual mandate, our literature review tells us that other factors including global and financial conditions help predict its path.

Our model also suggests that the Fed prioritizes its price-targeting goal over its full-employment mandate to some extent, a conclusion with important implications. Estimating the relationship between each of these factors and the federal funds rate helps us imagine likely scenarios given current conditions.

The current geopolitical and economic uncertainty presents a challenge to the Fed as it engineers a soft landing. While where we eventually land is uncertain, our goal through this analysis is to provide a framework for assessing the Fed's responses to various possible scenarios. This can help investors understand the nuances that drive the Fed's decisions, allowing those with an active disposition to better position themselves and giving passive investors more confidence to stay the course.

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Appendix

FIGURE A-1.
Variables selected in the model

Factor categories	Factor data
Financial condition	10-Year Treasury Constant Maturity minus 2-Year Treasury Constant Maturity
	S&P 500 Composite Price Index
Labor market	U.S. unemployment rate
Inflation	U.S. CPI—all items less food and energy
	U.S. PPI
Proxy of global market	S&P GSCI Commodity Total Return Index

FIGURE A-2.
Five-year (60-month) out-of-sample results

Five-year out of sample	Root mean square error	R-squared
Traditional Taylor rule	0.03402	–4.97
Taylor rule with OLS	0.03116	–0.3686
Taylor rule with machine learning (ML)	0.02402	–0.4042
Six-factor ML model	0.0078	0.6068

Gradient-boosting regression model

We used the most important variables as identified in the last section as inputs in a gradient-boosting regression model to predict Wu-Xia shadow federal funds rates. We also used gradient-boosting regression on traditional Taylor rule factors to see whether the original rule's two factors matched with a nonlinear regression could improve on the original fixed coefficients' linear regression. In contrast to the random-forest model, the gradient-boosting algorithm builds additive regression models by sequentially fitting each individual decision tree (weak learners) based on pseudo-residuals from least squares in each iteration.

More specifically, the gradient-boosting model is built on a gradient descent that seeks to minimize the loss function at each stage. Assuming $f_m(x)$ to be the imperfect prediction model at stage m, we will have

$$f_m(x) = f_{m-1}(x) + \beta_m h_m(x),$$

where $h_m(x)$ is the new estimator introduced to improve $f_m(x)$ based on the residuals from the exiting weak learner $f_{m-1}(x)$.

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