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Accounting for Uncertainty and Risks in Monetary Policy

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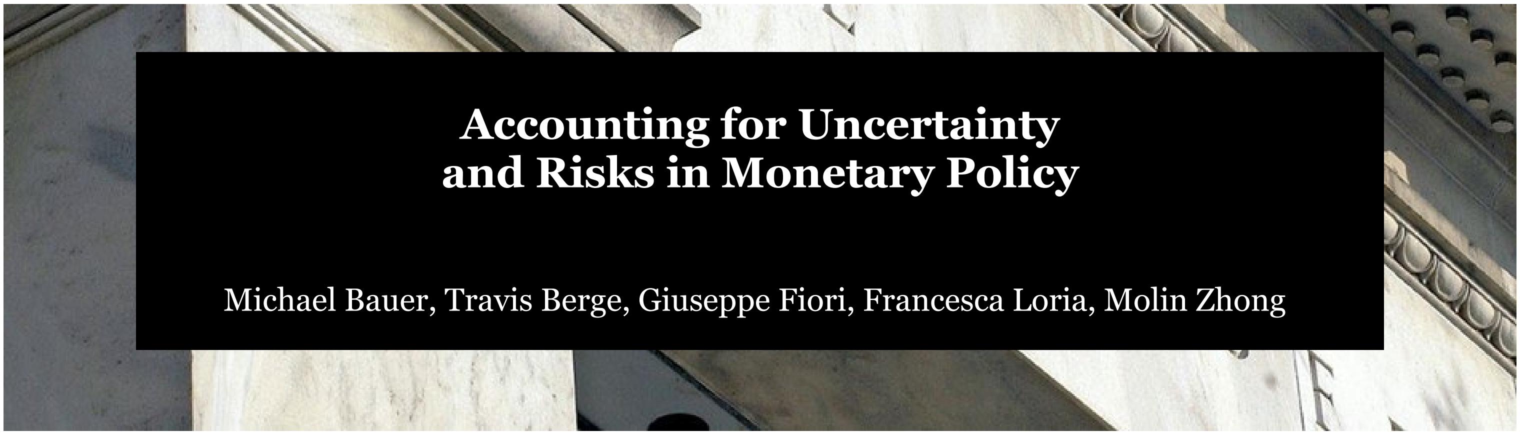

Accounting for Uncertainty and Risks in Monetary Policy

Michael Bauer, Travis Berge, Giuseppe Fiori, Francesca Loria, Molin Zhong

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The analysis in this paper was presented to the Federal Open Market Committee as background for its discussion of the Federal Reserve's 2025 review of its monetary policy strategy, tools, and communications.

Abstract: This paper discusses the measurement, assessment, and communication of risks and uncertainty that are relevant for monetary policy. It provides a taxonomy of policy-relevant uncertainty related to the state and the structure of the economy, and the formation of expectations. A wide range of tools is available to assess and quantify uncertainty and the balance of risks. Qualitative assessments of uncertainty—in policy statements, minutes, and speeches—are the main tools to communicate uncertainty and the balance of risks across major central banks. However, the use of quantitative tools for such communications—including scenario analysis—is evolving, and so far no clear consensus has emerged for best practices.

JEL Classification: E50, E58.

Keywords: Macroeconomic uncertainty, monetary policy, central bank communication.

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1. Introduction and overview

This paper reviews the forms of uncertainty and risks most relevant for monetary policy and the tools available to assess the uncertainty and the balance of risks surrounding an economic outlook. We then describe ways to communicate uncertainty and risks, drawing on U.S. and international experience. The normative implications of uncertainty and risks for monetary policy design are discussed in Garga and others (2025).

We distinguish three broad categories of uncertainty that relate to: (1) the state of the economy, including measurement issues and economic shocks; (2) the structure of the economy, including monetary transmission and structural change; and (3) the formation and measurement of the public's expectations about monetary policy and the economic outlook. A wide range of empirical measures and models are available to monitor uncertainty and risks. However, quantifying uncertainty and risks is inherently complex and often requires that models and judgment be used together to identify emerging forms of risks, especially during periods of high uncertainty.

Central banks use a variety of tools to assess uncertainty and the balance of risks around the outlook. Fan charts based on forecast errors are a simple way to measure and convey the degree of uncertainty associated with the forecast; scenario analysis can speak to a wide range of risks and their implications for the outlook; and statistical and econometric modeling can provide a systematic, data-driven assessment. However, the use of these tools is challenging, as it requires making choices about the forecasting models and the data, as well as identifying risks that are relevant for policy consideration. These choices are typically informed by historical experience and therefore may be of limited value as uncertainty and risks evolve.

The communication of risks and uncertainty conveys that policy is based on an economic outlook that is far from certain, and that policy may be adjusted as the outlook and balance of risks evolve. Qualitative central bank communication—through policy statements, reports, policy minutes, and official speeches—is the main tool employed by central banks to convey risk factors and uncertainty. Quantitative communication—including scenario analysis and outlook-at-risk models—is increasingly used to convey specific information about forecast uncertainty and alternative economic outcomes. So far, no clear consensus has emerged on the best practices for communicating risks and uncertainty to the public.

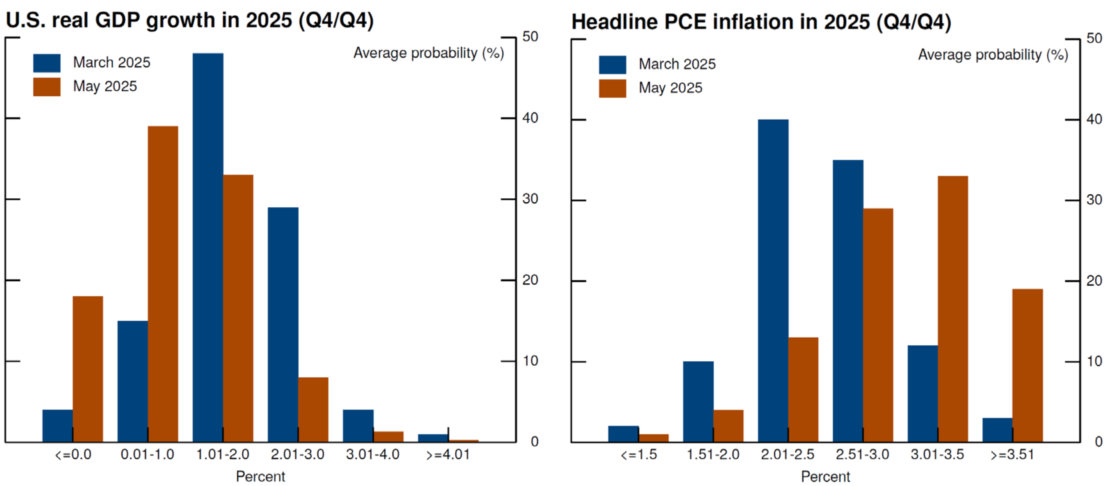
2. Forms of uncertainty and risks

Uncertainty and risks are relevant for monetary policy because they may affect the ability of central banks to achieve their statutory objectives. This section provides a taxonomy and a discussion of relevant empirical measures of uncertainty and risks.

There are many usages and definitions of the terms "uncertainty" and "risk" in policy discussions and in the economics literature. We choose to use "higher uncertainty" or "higher risk" to mean greater dispersion of possible future outcomes, either because confidence intervals around a central forecast are wider, or because tail risks are higher.[1] We use the term "balance of risks" to describe the direction in which outcomes are considered to be more likely, whether to the upside or to the downside.[2]

Figure 1 illustrates uncertainty and the balance of risks using the probability distributions for current-year real gross domestic product (GDP) growth and personal consumption expenditures (PCE) inflation given in the March and May 2025 Surveys of Market Expectations.[3] The distributions of GDP growth and inflation show a substantial amount of uncertainty in both surveys. The shift in probabilities from the March to the May survey towards lower GDP growth and higher inflation is an example of how the balance of risks may change significantly in a relatively short period.

Figure 1. Probabilistic Forecasts in the Survey of Market Expectations.



Note: Average probabilities of Q4/Q4 real GDP growth (left panel) and PCE inflation (right panel) falling into different intervals from the New York Fed Survey of Market Expectations.
Source: Survey of Market Expectations, Federal Reserve Bank of New York

[1] In other words, higher uncertainty and larger risks generally amount to increased *variance* of the distribution of future outcomes. There are other usages and definitions of the terms uncertainty and risk. For instance, "uncertainty" can refer to "Knightian uncertainty," according to which the future outcomes and their probabilities are not known, also referred to as "unknown unknowns." "Risks" can also refer to specific possible outcomes and their probabilities.

[2] The balance of risks is related to the concept of *skewness*, a measure of the asymmetry of a distribution. A negatively skewed distribution of outcomes indicates greater downside risks, whereas a positively skewed distribution points to upside risks.

[3] The Survey of Market Expectations is conducted by the New York Fed's Open Market Trading Desk in advance of each FOMC meeting to assess the expectations of primary dealer firms and other market participants.

2.1 Taxonomy of uncertainty and risks

Uncertainty results from a multitude of factors. In the following, we provide a taxonomy of uncertainty and risks, using the three broad categories proposed by Bernanke (2007): uncertainty about the state of the economy, the structure of the economy, and expectations.

Uncertainty about the state of the economy

Policymakers face a range of challenges in assessing the current state of the economy. *Real-time assessment* of economic conditions is difficult and gives rise to uncertainty because economic indicators are incomplete, prone to mismeasurement and revision, and usually released with a delay. For instance, GDP estimates are derived from an array of data, which vary in terms of availability, quality, and coverage, causing lags and revisions in national accounts data.[4] Assessing inflation in real-time is similarly challenging due to measurement lags and methodology, an example being inflation in housing services, which is slow moving and lags conditions in rental markets. In addition, traditional indicators may be slow or insufficient to capture rapidly evolving economic conditions, especially around “black swan” events. At the onset of the COVID-19 pandemic, for instance, economists and policymakers lacked accurate measures of social distancing, mobility, and supply chain pressures.

The assessment of the state of the economy also requires estimation of *unobserved policy-relevant variables*—for example, the output gap, the natural rate of unemployment, underlying inflation, or the equilibrium real interest rate.[5] Inference about these variables is demanding, especially in real time.

In addition to assessing the state of the economy, policymaking can be improved if the *nature of structural shocks* hitting the economy—for example, supply versus demand disturbances—is well understood. Because most economic shocks are unobserved, and their size and persistence are hard to pin down, such assessments are challenging and require considerable judgment. An example is the debate surrounding how much of the post-pandemic increase in inflation reflects a tightening in supply conditions, an increase in aggregate demand, or a mix of the two.[6]

[4] An example of the challenges in GDP measurement is the value of services, which is often difficult to estimate while contributing a large share of total output. Another example is the discrepancy between gross domestic income and GDP, which conceptually measure the same economic magnitude.

[5] A large literature has documented the difficulty in the real-time estimation of output gaps; see, for example, Orphanides and van Norden (2002), Edge and Rudd (2016) and Berge (2023). Rudd (2020) and Amisano, Berge and Smith (2025) discuss the uncertainty surrounding estimates of underlying inflation, and Kiley (2020) examines uncertainty in the context of estimating the equilibrium real interest rate.

[6] See Hajdini and others (2025) and Lipińska, Martinez-Garcia and Schwartzman (2025) on the dynamics and sources of the recent inflation episode.

Uncertainty about the structure of the economy

Models used for forecasting and policy analysis are simplifications of reality, and there is substantial uncertainty about which model best describes the economy. This *model uncertainty* is particularly consequential when confronting new or large shocks, which may necessitate considerable modifications to models, through, for instance, the addition of frictions in product, financial, and labor markets, or constraints emanating from the effective-lower-bound on the policy rate.

In addition, in economic models, there is additional uncertainty associated with key model parameters. An important example of *parameter uncertainty* is the responsiveness of inflation to resource slack, captured by the slope of the Phillips curve. Studies have found that the Phillips curve flattened between the 1970s and the end of the 2010s, although the degree to which this flattening reflects structural changes to the economy or effective monetary policy remains unclear. More recently, shocks and structural changes connected with the pandemic have led to substantial uncertainty about the slope of the Phillips curve, with some studies finding a nonlinear relationship between inflation and slack.[7]

Similar uncertainty applies to the *transmission of monetary policy* to economic activity. All else being equal, the effects of changes in interest rates on consumption depend on how agents consume out of their income, form expectations, and discount their future consumption. The effects of monetary policy on investment depend on financing and capital adjustment costs. Imperfect knowledge about these mechanisms and their underlying structural parameters ultimately translates into uncertainty about monetary policy transmission. Further, because monetary policy both shapes and responds to the economy, its effects are not directly observable and must be modeled. Although there is a great deal of evidence that monetary policy influences output and inflation, estimates of the timing and magnitude of these effects vary widely; further, monetary transmission may vary over time and depend on the state of the business cycle.

The structure of the economy is also continuously changing, and these *structural changes* can alter policy-relevant objects such as the maximum level of employment, the rate of potential output growth, and the equilibrium real interest rate. Structural changes ultimately come from a multitude of factors such as demographic changes, changes in the types of goods and services produced and consumed, and technology and its effect on the labor market. Economic and financial relationships may also change abruptly and in unpredictable ways—for instance, during periods of intense financial stress.

Uncertainty about expectations

Among many sources of uncertainty, the formation and the measurement of the public's expectations stand out as particularly important for monetary policy decisions. With regard to

[7] For a review of estimates of the Phillips curve, see Furlanetto and Lepetit (2024) and Hajdini and others (2025).

expectations formation, standard macroeconomic models typically assume rational expectations and inflation expectations that are anchored in the longer run. However, alternative assumptions about the way businesses and households form expectations—including learning and backward-looking expectations—may have implications for both the strength and the lags of monetary policy's transmission to the real economy. Accordingly, it is important to consider alternative possibilities for the way expectations are formed when setting policy.[8]

Surveys and financial markets provide *measures of public expectations* about the economic outlook and monetary policy that may offer important clues about how expectations are formed. However, interpreting survey-based measures of expectations may be challenging, as estimates can be noisy and typically differ across firms, households, forecasters, and market participants. A specific issue related to market-based measures of expectations is that in uncertain times, an informational feedback loop may develop wherein policymakers and financial markets both try to learn from each other's expectations. In such a "hall of mirrors," financial market prices may become less informative, adding further uncertainty about the public's true expectations.

The public's understanding about the *policy reaction function* influences the transmission of monetary policy to the real economy. Although policymakers can provide information about its reaction function, the public's perception of the reaction function can vary over time, in part reflecting learning from central bank communication. These dynamics create additional uncertainty about monetary policy transmission.[9]

2.2 Measurement of uncertainty

Here, we give a broad overview of commonly used empirical measures of uncertainty, dividing them into four categories: financial market-based, survey-based, text-based, and statistical measures.[10] Table 1 summarizes these four categories, alongside key advantages and potential limitations, while figure 2 illustrates some commonly used indicators of uncertainty for each of the four categories.

Measures of uncertainty based on *financial markets* are derived from prices of financial assets, including futures, options, and other derivatives. Many of the indicators listed in table 1 also capture shifts in the balance of risks towards adverse outcomes. The VIX, for instance,

[8] The Federal Reserve Board's FRB/US model can be run under a variety of assumptions of expectations formation, as different economic agents can be assumed to form expectations in different ways. This flexibility allows the model to explore the implications of alternative expectations-formation processes (see Brayton and others, 1997 and Brayton, Laubach and Reifschneider, 2014). For example, agents can be assumed to have model-consistent expectations—meaning that agents' expectations of the future are the modal forecasts generated by the model itself—a form of rational expectations that is helpful when evaluating policy changes. Alternatively, agents can have expectations that come from a vector autoregression model, which implicitly assumes a more limited understanding of the economy.

[9] See Bauer, Pflueger, and Sunderam (2024a, 2024b).

[10] For a survey of uncertainty measures, see Cascaldi-Garcia and others (2023).

reflects expected volatility, but in practice, it rises disproportionately during periods of financial market stress. The key appeal of these indicators is that they are available at a very high frequency, are forward looking over specific periods of time, and reflect risk as priced by markets. An important limitation, however, is that these measures typically include risk and liquidity premiums, complicating their interpretation.[11]

Measures based on *surveys* rely on the responses to questions about current or future economic outcomes from surveys of businesses, households, and professional forecasters. Many surveys attempt to directly measure uncertainty and the balance of risks by asking respondents to provide probability distributions for future outcomes.[12] Survey data can also be used to measure uncertainty by quantifying forecast disagreement, the dispersion of central forecasts across survey respondents. However, there is mixed evidence on the usefulness of disagreement as a proxy for uncertainty.[13] Intuitively, disagreement might be a poor proxy for uncertainty when forecasters share similar central predictions but all face high uncertainty or when differing forecasts reflect differences in beliefs about the most likely outcome rather than genuine uncertainty. A key advantage of surveys is that they directly measure beliefs about the economy from firms, households, forecasters, or market participants. Disadvantages of surveys include their relatively low frequency—typically monthly or quarterly—and the fact that survey respondents may not have strong incentives to carefully consider their responses, in contrast to financial market measures that involve financial gains and losses.

Measures using *textual analysis* quantify uncertainty based on the frequency of newspaper articles or other documents that discuss it. Text-based indexes reflect the public's perception of uncertainty and the balance of risks about specific policies and economic events. Key appeals of text-based indexes are their timeliness and specificity about sources of uncertainty that are hard to measure using traditional data. Drawbacks include the lack of probabilistic and quantitative interpretations, and the potential sensitivity to changes in the text sources, for instance in media coverage habits.

Lastly, measures based on *statistical models* quantify uncertainty as the time-varying volatility of the forecast errors across many economic and financial indicators. The advantages of this approach are that the resulting measure of uncertainty is grounded in econometric theory and leverages a large amount of data. However, these measures depend on modeling choices

[11] Risk and liquidity premiums are the additional returns that investors demand for holding risky and illiquid securities. In practice, these risk premiums are also a catchall for all other factors affecting asset prices unrelated to fundamentals.

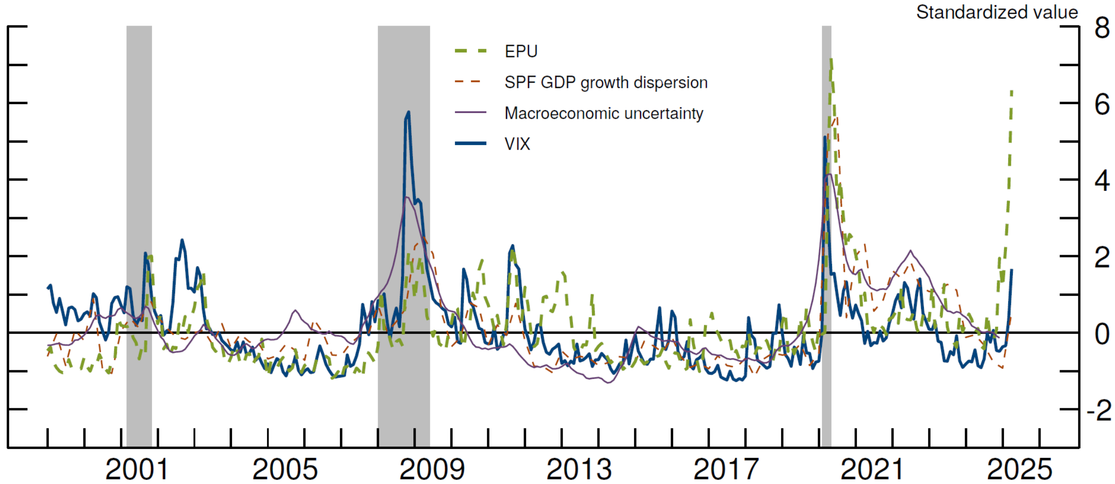
[12] The Philadelphia Fed's Survey of Professional Forecasters, the New York Fed's Survey of Consumer Expectations and its Survey of Market Expectations, and the Atlanta Fed's Survey of Business Uncertainty each elicits probability distributions.

[13] Some studies find uncertainty and disagreement to be positively correlated (Zarnowitz and Lambros, 1987; Giordani and Soderlind, 2003; Dovern and others, 2012). Others documented this relationship to be episodic (Lahiri and Sheng, 2010, D'Amico and Orphanides, 2014), weak (Abel and others, 2016) or lagged (Clements, 2014).

that may be imperfect and may not easily address new risks or abrupt shifts in uncertainty. As will be discussed in section 3.3, statistical models are also used to quantify changes in the balance of risks around the outlook.

Overall, many different empirical measures are available as direct or indirect proxies of policy-relevant uncertainties, but each measure has its own advantages and disadvantages. Monitoring a suite of different measures can help identify salient risks and uncertainty, despite the significant degree of comovement across many indicators.

Figure 2. Uncertainty Measures over Time.



Note: All measures are standardized to zero mean and unit standard deviation. Economic policy uncertainty (EPU) and the VIX are at the monthly frequency, running through April 2025. Macroeconomic uncertainty from Jurado, Ludvigson, and Ng (2015) is also monthly and is updated through December 2024. Survey of Professional Forecasters GDP growth dispersion is at the quarterly frequency through 2025:Q2. Shaded areas are recessions as defined by the National Bureau of Economic Research.

Sources: Economic Policy Uncertainty Index for United States via FRED; Survey of Professional Forecasters, Federal Reserve Bank of Philadelphia; Sydney Ludvigson's website; Chicago Board Options Exchange VIX data via Bloomberg.

Table 1. Overview of Uncertainty Measures.

Based on	*Commonly used measures*	*Frequency*	*Advantages*	*Disadvantages*
Financial markets	Realized volatility, stock market volatility index (VIX), variance risk premium, market-based monetary policy uncertainty, inflation uncertainty, Treasury yield skewness	Continuous or daily	High frequency, forward-looking, reflects risk as priced by financial markets	Risk and liquidity premiums complicating interpretation
Surveys	Survey of business uncertainty, consumers' perceived uncertainty, NY Fed desk survey, professional forecasters' uncertainty	Typically monthly or quarterly	Directly measure beliefs about economy and degree of forecast uncertainty from variety of economic actors	Lower frequency in comparison to other measures; respondents may not carefully consider their responses
Textual analysis	Economic policy uncertainty, trade policy uncertainty, world uncertainty	Daily or monthly	Timeliness and specificity about types of uncertainty that are hard to measure using traditional data	Lack of probabilistic and quantitative interpretations, and potential sensitivity to changes in text sources
Statistical models	Macroeconomic uncertainty, financial uncertainty, real economic uncertainty	Monthly or quarterly	Grounded in econometric theory using large dataset, provides summary and variable-specific measures of uncertainty	Model specificity; may not easily address new risks or abrupt shifts in uncertainty

Note: See references in appendix.

3. Assessing uncertainty and the balance of risks around the outlook

This section discusses methods for assessing the uncertainty and risks around a forecast. Accounting for the balance of risks associated with a forecast is particularly critical when policymakers need to consider policy tradeoffs in the face of adverse outcomes. When risks are not balanced, the mean outlook—that is, the outlook computed by weighting outcomes by their probabilities—will differ from the modal, or most likely, outlook. As discussed in Garga and others (2025), this mean–mode differential has an important bearing on policy considerations.

3.1 Fan charts

A simple way to assess uncertainty is to use fan charts—that is, plotting confidence bands based on historical forecast errors around the forecast. Confidence bands are typically assumed to be symmetric around the forecast, although fan charts can be constructed to incorporate asymmetry, either through a judgmental adjustment or because the historical data suggest an asymmetric risk.

Forecast errors have the advantage of encapsulating previously realized uncertainty and risks, no matter the source, but their use to proxy uncertainty has drawbacks. First, the size of a typical forecast error is sensitive to the time span included in the sample. For example, both the Tealbook and the Summary of Economic Projections (SEP) calculate fan charts based on errors over the past 20 years. Currently, the past 20 years include two extreme events—the Global Financial Crisis and COVID-19 pandemic—and, as a result, errors from forecasts made between 2004 and 2024 are twice as large as those from forecasts produced between 1983 and 2003, a period of low economic volatility known as the Great Moderation.[15] Second, fan charts based on forecast errors rely on the past being a good proxy for the future. But historical experience may be of limited value during periods of increased uncertainty, as there may be structural breaks in parameters and changes in propagation mechanisms that are difficult to identify in real time. In contrast, the use of some of the forward-looking indicators reviewed in section 2.2, together with judgment or econometric models, may allow policymakers to identify risks that are most relevant for the outlook.

3.2 Judgment and scenario analysis

Policymakers and forecasters may also use judgment to assess uncertainty and the balance of risks. The SEP, for example, provides the FOMC participants' qualitative assessment of uncertainty and the balance of risks associated with the outlook for output, the unemployment rate, and inflation. The assessment of uncertainty is reported by counting the number of participants judging the uncertainty around their projection as lower than, broadly similar to, or

[15] The standard deviation of the median Survey of Professional Forecasters forecast error for four-quarter-ahead real GDP growth, CPI (consumer price index) inflation, and the unemployment rate from 2004 to 2024 are 2.9 percentage point, 1.9 percentage point, and 1.6 percentage point, respectively. When calculated over the period from 1983 to 2003, the values are 1.6 percentage point, 1.1 percentage point, and 0.7 percentage point.

higher than that in the past 20 years. Likewise, participants can judge the balance of risks as weighted to the downside, broadly balanced, or weighted to the upside. The evolution of uncertainty and the balance of risks are reported by plotting the resulting diffusion indexes over time.

Another approach to assessing the balance of risks around the outlook is scenario analysis—that is, the comparison of forecasts produced under different assumptions.[16] Scenario analysis is very flexible, and the approach can address the various forms of risk and uncertainty discussed in the taxonomy. The first step of scenario analysis is the subjective identification of salient risks to the outlook. The implications of these risks can be qualitatively described, or a model can be used to quantify their effects. When risks stem from uncertainty around the structure of the economy, scenarios can explore alternative model calibrations—for instance, tracing the effects of aggregate demand or aggregate supply changes under alternative specifications of the Phillips curve. Scenario analysis can also be used to compare simulations under different monetary policy rules. Importantly, scenario analysis requires several consequential choices, including the choice of the relevant risks, the economic model, and the methodology.

In each Tealbook, the Federal Reserve Board staff produces several alternative scenarios that explore the economic implications of events that deviate from the baseline assumptions.[17] These scenarios may reflect assumptions that are plausible but not incorporated in the modal forecast. Alternatively, scenarios may explore risks that are unlikely to materialize but could have large economic effects and be significant for monetary policy.

Figure 3 explores the risks analyzed under the alternative scenarios presented in the Risks and Uncertainties (R&U) section of the Tealbook. The blue whisker bands represent the minimum and maximum deviation from the baseline projection of four-quarter-ahead real GDP growth and core PCE inflation associated with the various alternative scenarios. Whiskers above (below) zero are from scenarios that quantified upside (downside) growth or inflation risks. The red dots show the realized forecast error for the relevant variable from the baseline projection. Comparing the whiskers—a summary of the range of outcomes explored by the scenarios—to the red dots—the ex post realization of uncertainty—sheds light on how the chosen scenarios described uncertainty and the balance of risks over time.

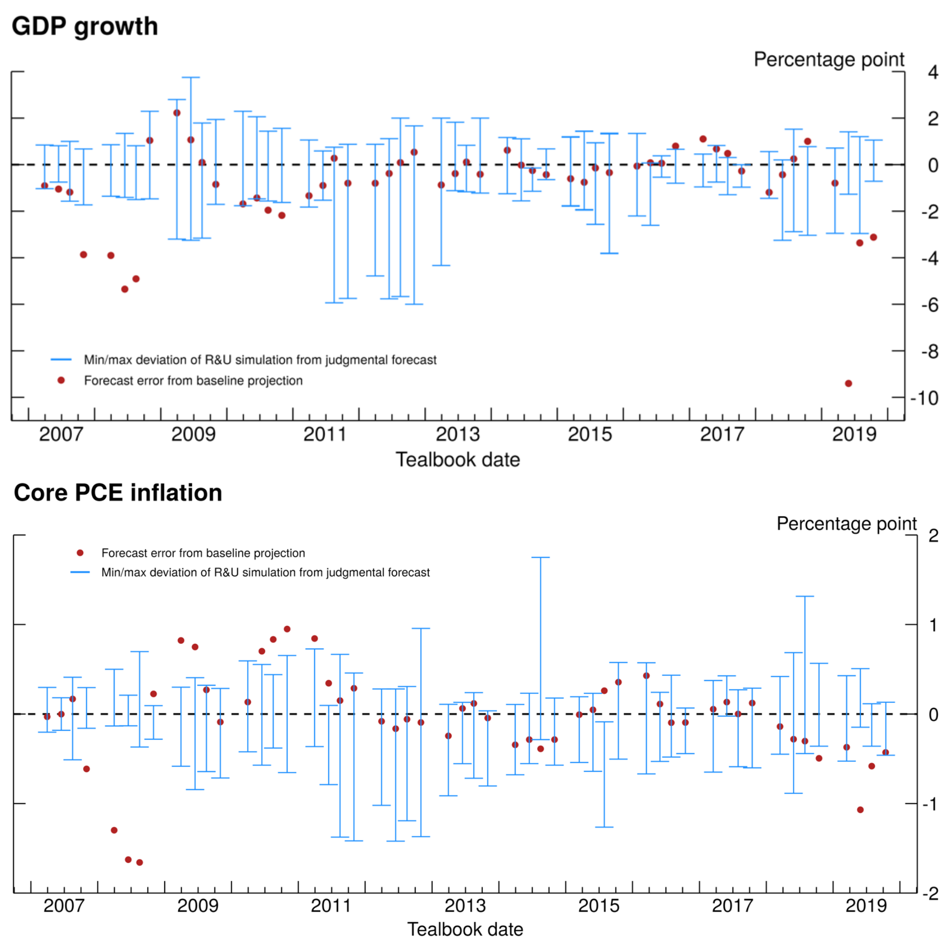
Scenarios encompassed the GDP growth and inflation forecast errors most of the time. The chart also illustrates the difficulty in producing scenarios to address novel risks. None of the scenarios shown in 2007–08, for example, sufficiently characterized downside risks that ultimately came about during the Global Financial Crisis. In 2009–11, the forecast errors indicate that the recovery in activity was somewhat slower and inflation higher than anticipated.

[16] A different use of scenario analysis is in financial stress testing, where the results from stress scenarios provide an assessment of financial stability concerns.

[17] Ciccarelli and others (2025) discuss the use of scenario analysis at the European Central Bank to perform sensitivity and risk analysis.

At times, chosen scenarios illustrated risks with severe consequences, even if those risks were not realized. For example, in late 2012, several scenarios featured financial market stress stemming from the European debt crisis. In 2014, alternative scenarios considered upside risks to inflation due to an unanchoring of inflation expectations. Naturally, the risks to output and inflation that arose from the COVID-19 pandemic were not foreseen in the Tealbooks produced in 2019.

Figure 3. How Large Are the Risks from the Alternative Scenarios Presented in the Tealbook?



Note: The blue whisker bars show the range of outcomes for four-quarter-ahead real GDP growth (top) and core PCE inflation (bottom), from the alternative simulations in the R&U section of the Tealbook, in deviations from the baseline projection. The red dots show the forecast error—defined as actual less forecast—from the baseline Tealbook forecast. The chart is produced using the second Tealbook from each quarter. Sample period is March 2007–December 2019.

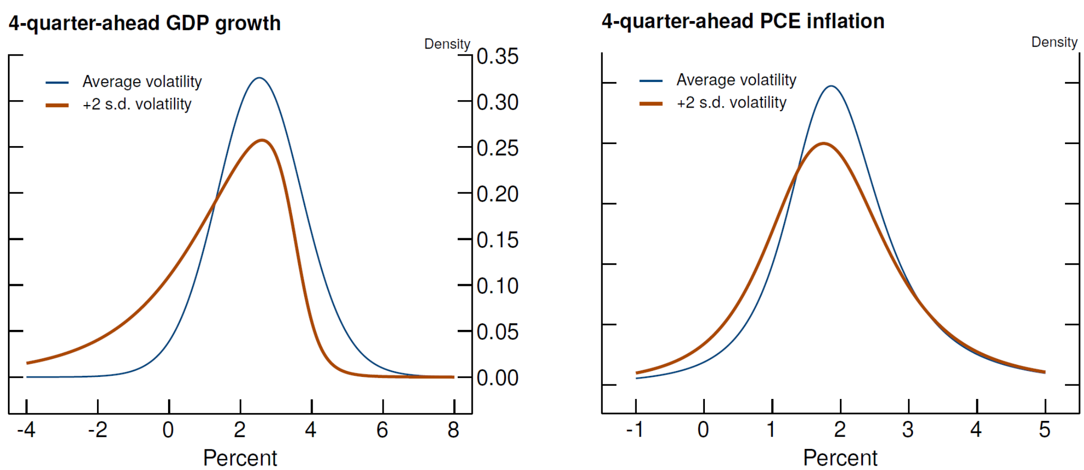
Source: Tealbook (formerly Greenbook) Data Set, Federal Reserve Bank of Philadelphia; staff calculations.

3.3 Econometric assessments

There is a growing literature that uses econometric models to measure uncertainty and assess the balance of risks. As discussed in section 2.2, one approach measures the degree of predictability of economic variables, using the volatility of forecast errors for hundreds of economic series to proxy uncertainty. A second approach, known as "outlook at risk," links economic or financial indicators to the entire *distribution* of future outcomes, and not just the mean or modal outcome.[18] This approach may identify periods when the outlook is especially uncertain—for example, when the distribution is especially wide—or when risks are not balanced—for example, when a tail of the predictive distribution exhibits a notable degree of skewness.

Figure 4 presents an example of an outlook-at-risk model by plotting the predicted distributions of GDP growth and PCE price inflation conditional on a measure of financial conditions and on uncertainty, as proxied by stock market volatility. The red line in the figure shows how the predicted distributions for real GDP growth and inflation shift when stock market volatility increases. Although the modal outcome for GDP growth is little changed, the distribution becomes more skewed toward lower GDP growth outcomes when stock market volatility is high. The distribution for expected inflation also becomes somewhat more dispersed with more weight in the lower tail.

Figure 4. Implications of Stock Market Volatility for Risks to the Dual Mandate Based on an Outlook-at-Risk model.



Note: Distribution of four-quarter-ahead GDP growth (left panel) and PCE price inflation (right panel) predicted using the Financial Conditions Impulse on Growth (FCI-G) and realized volatility from the S&P 500 index. The blue distribution is the predicted density given financial conditions and realized volatility at their mean values. The red distribution is the density assuming average financial conditions, but with realized volatility at two times its standard deviation. Sample period is 1990:Q1—2024:Q4.

Source: FCI-G index data, Federal Reserve Board (Ajello and others, 2023); S&P 500 index data via Bloomberg; staff calculations using the methodology of Adrian, Boyarchenko, and Giannone (2019).

[18] Adrian, Boyarchenko and Giannone (2019) introduce the growth-at-risk approach to predict GDP growth tail risks; Kiley (2022) applies it to predict unemployment rate risks, while Lenza, Moutachaker, and Paredes (2023) and Lopez-Salido and Loria (2024) do so for inflation risks. Other examples of models developed to predict tail risks include Ajello and others (2024), Caldara, Scotti and Zhong (2023), Caldara and others (forthcoming), and Bekaert, Engstrom and Ermolov (forthcoming).

A related literature explores how to bring judgmental information to statistical models to construct conditional forecasts and perform scenario analysis. The approach combines the benefits of judgmental scenario analysis with the statistical rigor of econometric models and can be used to tilt model projections to incorporate specific risks, or to identify periods in which risks are not sufficiently accounted for within a given set of scenarios.[19]

Another way to gauge the uncertainty associated with an economic outlook is by simulating macroeconomic models. When a model is subject to repeated shocks, it is possible to construct uncertainty bands that describe possible evolutions of the economy. For example, in the R&U section of the Tealbook, an estimate of the uncertainty surrounding the judgmental projection is produced by assuming a policy rule and simulating possible paths of future shocks using the FRB/US model.

Assessing uncertainty and the balance of risks with models is, of course, challenging. As with forecast error-based uncertainty measures, models typically assume the current risks mirror those seen in the past and may misrepresent uncertainty as new risks emerge. The tails of the predictive distributions will shift only after a shock appears in the data, and this characteristic may cause the measures to be slower moving than others. And as described in section 2.2, the variables that can be used in the context of these econometric methods differ with respect to the precise risks that they measure. The choice of the model, and the variables used as inputs into the model, are driven by past patterns. As such, they may be unable to identify novel risks.

4. Communicating uncertainty and the balance of risks

The communication of uncertainty and risks by central banks is important to help the public understand the economic outlook and clarify policy decisions. Risk considerations can directly influence monetary policy decisions, as has happened in the United States, for example, following the Russian debt default in the fall of 1998, at the onset of the Global Financial Crisis, and during the COVID-19 pandemic. Even when the balance of risks does not directly shape policy decisions, effective communication about how policymakers view uncertainty and risks provides guidance about how policy may respond to changes in economic and financial conditions. Since the adoption of the FOMC's Statement on Longer-Run Goals and Monetary Policy Strategy in 2012, the assessments of the balance of risks are explicitly recognized as considerations in monetary policy decisions.

In this section, we describe approaches to communicating uncertainty and risks used by advanced economy central banks. The communications toolkit is varied and has evolved over time; an overview is presented in table 2. Narrative risk assessments—such as those contained in policy statements, monetary policy reports, and official speeches—are common communication approaches, while quantitative assessments—such as model-based scenario analysis and the

[19] See, for instance, Cogley, Morozov, and Sargent (2005), Antolin-Diaz, Petrella, and Rubio-Ramirez (2021), and Adrian and others (2025).

output of statistical models—can offer a precise evaluation of the risks. A key challenge for communicating uncertainty and risks is to strike a balance between transparency about the implications of risks for future policy decisions while avoiding committing to a policy rate path. Using a diverse set of tools allows central banks to address different audiences, communicate a nuanced picture of economic risks, and signal contingency plans.[20]

4.1 Narrative approaches

Over the past 35 years, central bank communication strategy has fundamentally shifted toward greater transparency, with policymakers now using policy statements, minutes of policy meetings, and official speeches as the main approach to communicate policymakers' assessments of uncertainty and the balance of risks.

Each central bank surveyed in table 2 includes in their postmeeting policy statements language on the risks relevant to the outlook that broadly represents the committee members' views on the balance of risks and the role that it plays for current policy decisions. The language in these statements is often brief and carefully calibrated, but the way it evolves over time offers important signals about changes in policymakers' overall risk assessment. At times of heightened uncertainty, central banks often emphasize salient risks that are relevant to policy decisions.

In conjunction with the policy statements, most central banks release detailed economic projections, typically at a quarterly frequency, in documents usually called monetary policy reports. These reports provide a comprehensive assessment of the economy's current state and the outlook, and they can be used to discuss the implications of uncertainty and risks for policy.[21] This discussion can be qualitative in nature, although some central banks also communicate risks with quantitative tools, as we discuss in the next subsection.

There are several other outlets for qualitative communication of risks and uncertainty. Post-meeting press conferences, for example, allow for a more nuanced discussion of uncertainties and the balance of risks. At most central banks, the materials presented to the media during press conferences have explicit sections describing risks and uncertainties. After policy decisions have been taken, meeting minutes and transcripts also offer insights into the views among the policy committee's members regarding the spectrum of risk and uncertainty assessments.

[20] See, for example, the discussions in Bernanke (2004), Svensson (2007), Draghi (2014), and Mester (2016), among others.

[21] These forecasts typically do not include an explicit policy rate projection. Of the central banks reviewed in table 2, only the Riksbank, the Norges Bank, and the Reserve Bank of New Zealand publish forecasts of the policy rate. An alternative approach—taken for example, by the Bank of England and the European Central Bank—is to produce a forecast that is conditioned on a market-based projection for the policy rate.

Speeches by central bank officials offer additional opportunities to discuss risks and uncertainty. Typically, speeches to the public focus on a narrative of the risks to the outlook. However, a number of recent speeches by policymakers have combined descriptive assessments with quantitative analyses to communicate uncertainty and risks.[22]

4.2 Communicating uncertainty and risks quantitatively

Central banks complement qualitative descriptions of uncertainty and risks with quantitative tools to communicate their confidence in the outlook. These tools include fan charts, scenario analyses, and outlook-at-risk models.

The Bank of England pioneered the use of fan charts as a tool to communicate uncertainty. Its first *Inflation Report* in 1993, for example, included error-based fan charts to visually represent forecast uncertainty around inflation projections. By the late 1990s and early 2000s, fan charts had become a popular tool for communicating uncertainty—likely reflecting their intuitive format.

Over time, however, fan charts appear to have fallen somewhat out of favor. One possible reason is that the probabilistic nature of fan charts can be quite nuanced so that the public tends to focus on the central tendency of the outlook. Another reason is that fan charts are based on historical experience and may therefore be of limited use when facing new risks. While some central banks produce fan charts that convey both a measure of uncertainty and the current balance of risks—at the Bank of England, for example, policymakers alter the skewness of the bands to match their judgmental risk assessment—these adjustments complicate the interpretation of the charts.[23] Because of these practical shortcomings, several central banks have discontinued the use of fan charts in their monetary policy reports.[24]

Recently, several central banks have used scenario analysis to communicate uncertainty and risks in their monetary policy reports.[25] The most common use of scenario analysis is to

[22] Recent speeches by policymakers have included qualitative or quantitative analysis of tariff policy, low productivity, and inflation dynamics; see Schnabel (2024), Lagarde (2025), Macklem (2025), Musalem (2025), Taylor (2025), and Waller (2025).

[23] In the SEP, fan charts are symmetric and based on forecast errors. However, the fan charts are presented alongside several different measures of uncertainty, including the distribution of SEP participant forecasts and summaries of individual participants' assessments of the balance of risks and uncertainty.

[24] The Bank of Canada suspended the publication of fan charts in the aftermath of the 2014–15 oil price shock. The Norges Bank stopped publishing fan charts at the onset of the COVID-19 pandemic. The Riksbank also stopped publishing fan charts around its economic forecasts during the pandemic and removed fan charts from its policy rate projection in 2023.

[25] The Bank of Canada, the Reserve Bank of Australia and the Reserve Bank of New Zealand each published scenarios to assess trade policy uncertainty; see the January and April 2025 *Monetary Policy Reports* by the Bank of Canada, the May 2025 *Statement on Monetary Policy* by the Reserve Bank of Australia, and the May 2025 *Monetary Policy Statement* from the Reserve Bank of New Zealand. The European Central Bank presented

highlight the implications of specific risks during periods of substantially heightened uncertainty. For example, at the peak of the COVID-19 pandemic, many central banks published forecasts based on alternative assumptions regarding the pandemic's evolution. After the Russian invasion of Ukraine, the European Central Bank (ECB) released scenarios to assess the economic effects of the war and rising energy prices. Most recently, reflecting elevated uncertainty regarding U.S. trade policy, several central banks included alternative scenarios regarding trade policy uncertainty in their respective monetary policy reports. Notably, the Bank of Canada communicated its outlook only using alternative scenarios, without publishing a baseline forecast.

Only a few central banks incorporate scenario analysis in their regular monetary policy reports. In the period following the COVID-19 pandemic, the Riksbank started using scenario analysis to address a number of risks to the inflation outlook, and since 2023 it has published scenarios in every quarterly monetary policy report.[26] The Bank of England included scenarios in its monetary policy report in May 2025, following the recommendations of Bernanke (2024). Using scenarios to communicate uncertainty to the public is innovative but it is probably too early to evaluate the advantages and disadvantages of this tool.

A crucial distinction among scenario analyses used for central bank communication is whether the scenarios include an expected policy path. The Riksbank is the only central bank that reports an interest rate path that demonstrates the expected monetary policy response in alternative scenarios, while others typically maintain the same assumed policy path as in the baseline. Garga and others (2025) discuss the challenges involved in communicating alternative scenarios, and the implications for monetary policy contained in those scenarios, to the public.

A few central banks communicate uncertainty and the balance of risks by presenting estimates of the entire distribution of future outcomes using various outlook-at-risk models. The Norges Bank, for example, includes in its quarterly monetary policy report estimates of tail risk to projections for output, inflation, and housing prices. The ECB also presents estimates for the predictive distribution of inflation from these kinds of models. However, as these methods are new, their efficacy as communication devices is uncertain.

5. Conclusion

Monitoring the uncertainty and risks associated with the economic outlook is vital for the appropriate conduct of monetary policy. There are a variety of measures of uncertainty and risks that can inform policymakers' assessments. Quantifying the signals from these measures is,

alternative scenarios surrounding the future path of commodity prices, see the sensitivity analysis in the March 2025 *ECB Staff Macroeconomic Projections for the Euro Area*. The May 2025 *Monetary Policy Report* from the Bank of England presented scenario analysis addressing the implications for the outlook of heightened uncertainty and inflation's persistence.

[26] See Sveriges Riksbank (2024) for details on the experience of using scenarios at the Riksbank.

however, complex and policymakers rely upon both judgment and a comprehensive suite of macroeconomic and statistical approaches to monitor uncertainty and risks.

Central banks communicate uncertainty and risks in a number of ways. The most used and likely most effective tools are policy statements, press conferences, minutes and public speeches. Quantitative communication—including fan charts, scenario analysis, and outlook-at-risk models—is also used by central banks to convey specific information about forecast uncertainty and alternative economic outcomes. However, these quantitative tools are complex and can be difficult to use and communicate. So far, no clear set of best practices for communicating uncertainty and risks to the public has emerged.

Table 2. Tools Used by Central Banks to Communicate Risks and Uncertainties.

Central Bank	Public Forecast Variables	Quantitative Tools			Qualitative Communication
		Fan Charts	**Alternative Scenarios**	**Other Tools**	
Bank of Canada	GDP growth, inflation, output gap; no policy rate forecast; quarterly, 2- to 3-year horizon	No; dropped in 2015	Used selectively for major risks; more common post-2015 (oil prices; COVID-19; tariff policy)	Risk assessment tables	Extensive discussion of risks in *Monetary Policy Report*; speeches
Bank of England	GDP growth, inflation, unemployment, wage growth; no policy rate forecast; quarterly, 2- to 3-year horizon	Yes; judgmentally asymmetric to reflect balance of risks	Notably used for Brexit (2016–20) and COVID-19; May 2025 *Monetary Policy Report* includes alternative scenarios	Sensitivity analysis on conditioning assumptions	*Monetary Policy Report*; minutes; speeches
Bank of Japan	GDP growth, inflation; no policy rate forecast; quarterly, 3-year horizon	No; dropped in 2015	Limited use	Risk balance charts; upside/downside risk quantification	*Statement on Monetary Policy; Outlook for Economic Activity and Prices*; minutes; speeches
European Central Bank	GDP growth, inflation, unemployment; no policy rate forecast; quarterly, 2- to 3-year horizon	Limited use in projections (symmetric forecast error-based)	Used to address specific risks such as during COVID-19 and at onset of Ukraine war	Scenario analysis for sensitivity analysis; risk assessment matrices	*Economic Bulletin*, press conferences, accounts of meetings
Federal Reserve	GDP growth, inflation, unemployment, federal funds rate projection by SEP participants; quarterly, 2- to 3-year horizon	Symmetric forecast-error-based fan charts	Alternative scenarios available only with a 5-year lag	Qualitative assessment of uncertainty and risks in SEP; dispersion of SEP forecasts	FOMC statement, press conferences, minutes, Summary of Economic Projections, speeches
Norges Bank	GDP growth, inflation, unemployment, policy rate forecast; quarterly, 3- to 4-year horizon	No; dropped in 2020	Generally, no; produced alternative baseline forecasts during COVID-19 pandemic	Model-based uncertainty metrics in *Monetary Policy Report*	*Monetary Policy Report*; press conferences
Reserve Bank of Australia	GDP growth, inflation, unemployment; no policy rate forecast; quarterly, 2- to 3-year horizon	Symmetric forecast-error based charts	"Key Risks" portion of *Statement on Monetary Policy* includes both qualitative and quantitative discussion of risks to outlook	Detailed qualitative description of key risks	*Statement on Monetary Policy*; press conferences; speeches
Reserve Bank of New Zealand	GDP, inflation, unemployment, policy rate forecast; quarterly, 2- to 3-year horizon	No	Extensive use during COVID-19; trade policy uncertainty; "Special topics" section of *MPS* can discuss risks		Policy minutes and policy statements; speeches
Sveriges Riksbank	GDP growth, inflation, unemployment, policy rate forecast; quarterly, 2- to 3-year horizon	No; dropped in post-COVID period	Regularly publishes alternative scenarios, which include expected policy paths	Includes range for long-term neutral rate	*Monetary Policy Report*, *Monetary Policy Update*; minutes; speeches

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Appendix

References in table 1

Financial markets

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- Variance risk premium: Bollerslev, Tauchen, and Zhou (2009).
- Market-based monetary policy uncertainty: Swanson (2007) and Bauer, Lakdawala, and Mueller (2022).
- Treasury yield skewness: Bauer and Chernov (2024).

Surveys

- Survey of business uncertainty: Altig, and others (2022) in partnership with the Federal Reserve Bank of Atlanta.
- Consumers' perceived uncertainty: Leduc and Liu (2016) using the University of Michigan Surveys of Consumers. The New York Fed Survey of Consumer Expectations also provides an inflation uncertainty series.
- Professional forecasters' uncertainty: Rossi and Sekhposyan (2015) and Grishchenko, Mouabbi and Renne (2019), among others, using the Survey of Professional Forecasters.

Textual analysis

- Economic policy uncertainty: Baker, Bloom, and Davis (2016).
- Trade policy uncertainty: Caldara, and others (2020).
- World uncertainty index: Ahir, Bloom, and Furceri (2022) using Economist Intelligence Unit reports.

Statistical models

- Macroeconomic uncertainty: Jurado, Ludvigson, and Ng (2015).
- Financial uncertainty: Ludvigson, Ma, and Ng (2021).
- Real economic uncertainty: Londono, Ma and Wilson (2024).