

Designing Monetary Policy Rules in an Uncertain Economic Environment*

BY MICHAEL DOTSEY AND CHARLES I. PLOSSER

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well-designed monetary policy can help the economy respond efficiently to economic disturbances by limiting the deviation of economic activity from its potential while keeping inflation close to its desired rate. But successful implementation of such strategies must confront significant challenges arising from various forms of economic uncertainty. In this article, Michael Dotsey and Charles Plosser discuss the design of monetary policy rules in an environment in which policymakers face two distinct forms of uncertainty: the uncertainty surrounding the precise values of key policy variables that often appear as determinants in such rules, and learning uncertainty, which arises when people have only an incomplete knowledge of the economy itself.

A well-designed monetary policy can help the economy respond efficiently to economic disturbances by limiting the deviation of economic activity from its potential while keeping inflation close to its desired rate. But successful implementation of such strategies must confront significant challenges arising from various forms of economic uncertainty. This article

discusses the design of monetary policy rules in an environment in which policymakers face two distinct forms of uncertainty. The first involves the uncertainty surrounding the precise values of key policy variables that often appear as determinants in such rules. These variables are typically measures of resource utilization relative to some concept of potential. This data uncertainty can arise because the relevant conceptual definition of potential may be uncertain and even if it is clearly defined, it may not be observable and thus measurement error becomes an important consideration. The sec-

*The views expressed here are those of the authors and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

ond form of uncertainty we refer to is learning uncertainty, which arises when people have only an incomplete knowledge of the economy itself.

Regarding the first source of uncertainty, it is well documented that the key policy variables mentioned above are measured with considerable error. Thus, the true value of these variables is uncertain at the time policy is made. With respect to the second source of uncertainty, we believe that most people do not possess complete knowledge of the economy and that their behavior is characterized by a continual learning process in which their views about the economy evolve over time. Policymakers must recognize these uncertainties when designing policy. Throughout our discussion, we take as given the desirability of rule-like behavior for policy.¹ It is widely accepted in the economics profession that rule-like behavior is preferable to discretion because more desirable economic outcomes can be obtained with commitment.² We will

¹ For example, see the following: Michael Dotsey and Charles Plosser (2007), Michael Dotsey (2008), and Charles Plosser (2007).

² In the monetary setting, this has been made abundantly clear by, among others, Richard Clarida, Jordi Gali, and Mark Gertler, and Michael Woodford.



Michael Dotsey is a vice president and senior economic policy advisor in the Research Department of the Philadelphia Fed. This article is available free of charge at www.philadelphiafed.org/research-and-data/publications.

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Charles Plosser is the president and chief executive officer of the Philadelphia Fed.

also concentrate on the conduct of monetary policy in normal times and will, therefore, not address the special problems brought about by the zero lower bound on nominal interest rates.³

The basic conclusion from the literature is that when policymakers are trying to achieve the best outcomes in terms of economic welfare, these types of uncertainty make it desirable for the central bank to respond relatively aggressively to deviations of inflation from target and to rely less on measured deviations of either output or unemployment from their natural or potential values. Rather, the central bank should also respond to economic growth irrespective of where economic activity is with regard to potential or trend.⁴

efficient economic performance. Simple interest-rate rules tend to perform well in many different economic models, a fact that suggests they can be useful in practice. Thus, it is no accident that the behavior of most central banks in developed economies can be reasonably approximated by a simple interest-rate rule.⁵

However, the formulation of monetary policy rules must take into account the uncertainty that policymakers face, since rules designed under the assumption of no uncertainty are often disastrous when one explicitly considers uncertainty. In particular, a rule may, in theory, perform quite well when data are measured accurately but be quite bad when data are subject to

sion.⁶ Thus, relying on these types of measures can potentially lead policy astray. By a statistical measure we mean an estimate of potential output or unemployment that is based solely on data and, therefore, is independent of any particular theoretical model. For example, a common measure of potential output involves extracting a trend rate of output growth or some other relatively smooth measure of output growth that removes much of the short-run variation in output.⁷

There is also a concern that statistical measures are not likely to correspond to the conceptual metrics most relevant for monetary policy. Indeed, it is difficult to assign any theoretical justification for the use of these purely statistical constructs.⁸ Thus, when deciding on which measure of economic activity is important for formulating monetary policy, central banks operate under a large degree of uncertainty. Much recent research has shown that ignoring this uncertainty can create problems.

We will first discuss the problems that data uncertainty poses for designing monetary policy. A strong conclusion from the literature on data

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USEFULNESS OF INTEREST-RATE RULES

In analyzing the design of beneficial ways in which to conduct monetary policy under uncertainty, we will concentrate on the use of an interest-rate rule. The types of rules we will discuss are fairly simple ones and ones that have been shown to be useful for policymaking. These rules are generally designed to stabilize some measure of economic activity and inflation, because doing so leads to more ef-

severe measurement errors. Also, rules that work well under the assumption that individuals fully understand their economic environment may not do so well when individuals are constantly learning about economic circumstances.

AN OVERVIEW OF UNCERTAINTY

Many of the variables that a central bank reacts to in the course of setting its interest-rate instrument are in fact poorly measured. In particular, statistical measures of potential output or natural rates of unemployment are measured with great imprec-

³ For a discussion of the problems the zero lower bound presents for monetary policy, see Dotsey's 2010 article.

⁴ Potential output is the output that could be produced with the labor, capital, and technology available in the absence of economic distortions arising from stickiness in prices and wages. A more complete description of potential can be found in the *Business Review* article by Roc Armenter. Trend is the long-term growth path of an economic variable.

⁵ For a review of simple interest-rate rules, see the article by John Taylor and John Williams. See also the article by Marc Giannoni and Michael Woodford and the one by Stephanie Schmitt-Grohe and Martin Uribe for a discussion of their optimality.

⁶ The natural rate of unemployment is the rate of unemployment that would arise if there were no stickiness in the setting of wages and prices. That is, it is the rate of unemployment that would occur if prices and wages were completely flexible. It is also the rate of unemployment that the economy would converge to in the long run after all price and wage rates had time to fully adjust to economic disturbances. The concept is thus tightly related to potential output (see footnote 4).

⁷ Common statistical methods involve the use of band-pass filters, Hodrick-Prescott filters, or fitting polynomials of time to the data.

⁸ See the 2010 speech by Charles Plosser and Roc Armenter's and Keith Sill's *Business Review* articles. All three point out that there is no agreed-upon way of measuring potential and that various measures may differ. In addition, Sill emphasizes that in setting prices, firms are most concerned with the evolution of their marginal cost and that marginal cost is not highly correlated with unemployment rates.

uncertainty is that “gap-type measures,” especially statistical measures of gaps, are not reliable enough to base policy on, a conclusion that is shared by the literature on learning.

Most of our attention will be focused on the topic of data uncertainty for two reasons. First, the effects of data uncertainty on policy design have been more fully studied, and second, the work done by the Philadelphia Fed’s Real-Time Data Research Center underscores the importance of measurement issues.

We then turn to some issues associated with the likely possibility that people may not possess a fully articulated understanding of the economy.

CONCEPT UNCERTAINTY

In most modern macroeconomic models used to study monetary policy, minimizing the theoretical gap between actual output and potential output improves economic welfare. Thus, the notion of potential output plays a key role in setting monetary policy. However, theory-based concepts of potential often differ from the statistical concepts that many people believe belong in policy rules. We refer to the lack of coherence between statistical and theoretical measures of gaps as “concept uncertainty.”

The theoretical gaps are also specific to the particular theory or model being used to study the economy. Because each model is different, the gaps in each model are different. For example, the way that one models firms’ pricing decisions can theoretically affect the value of an output gap.⁹ This

⁹ In fact, as things stand theoretically, the situation is even a bit more muddled. It turns out that it may not be the level of the gap that is most relevant for policy; it may be the change in the gap that should influence monetary policy. For example, Woodford’s model shows that changes in the theoretical gap, not the gap’s level, are the relevant variable for welfare and hence the relevant variable that the interest rate should respond to.

lack of an agreed-upon macroeconomic model indicates that designing monetary policy rules that help achieve reasonably good economic performance is a challenging undertaking. How one goes about doing this represents an ongoing part of economists’ research

Levels of statistical gaps may not be good indicators of inflationary pressures in the economy.

agenda and is beyond the scope of this paper. What we will try to do here is to emphasize certain lessons that appear to be consistent across many economic models and for which there is a growing consensus regarding their implications for policy.

One lesson from the literature is that the statistical gaps often prescribe policies opposite to those obtained from the theory-based gap.¹⁰ For example, an unanticipated improvement in productivity often leads potential output to increase by more than actual output and hence generates a negative theoretical output gap. This outcome occurs because various inflexibilities built into operational models of the U.S. economy imply that economic variables move more slowly than they would if they could adjust without cost and with complete flexibility and potential output is the output that would arise if there were, in fact, no inflexibilities.

In contrast, potential output based on some statistical trend does not increase as much as actual output in response to a positive productivity shock, leading to a positive output gap (see the article by Roc Armenter).¹¹

¹⁰ We wish to point out that there is also no agreed-upon model of the macro economy and that theoretical gaps differ across models. Our discussion, however, pertains to results that are consistent across a wide range of economic models.

This occurs because when output increases in response to an increase in productivity, only part of that increase is initially attributed to a change in trend, and thus, statistically constructed potential output is always smoother than actual output. Therefore, the two

different measures would lead to opposite monetary policy responses, and the response based on the statistical measure would be in the wrong direction.

Furthermore, levels of statistical gaps may not be good indicators of inflationary pressures in the economy. Empirically, they do not help to forecast inflation and that has been especially true over the last 25 years.¹² Keith Sill analyzes some of the reasons for this failure, namely, that measures of various gaps are not very correlated with the costs of producing goods, and it is the underlying behavior of costs that governs firms’ pricing decisions in most modern macroeconomic models.

These conceptual problems call into question the usefulness of statistically based gaps in designing monetary policy. Furthermore, it is far from evident that monetary policy has always been conducted with regard to statistically based measures, and when it has, the results have at times been disastrous. We will return to this point after discussing the measurement issues more fully, but the 2002 study by Athanasios Orphanides has made a compelling argument that part of the

¹¹ A positive output gap occurs when actual output is greater than potential output. A negative output gap occurs when actual output is less than potential output.

¹² For a detailed description of this failure, see the studies by James Stock and Mark Watson.

Great Inflation of the 1970s was due to misperceptions about the unemployment gap.

UNCERTAINTY SURROUNDING STATISTICAL MEASURES

Even though statistical output gaps have not universally guided U.S. monetary policy, it does appear that they have periodically played a role in influencing U.S. monetary policy. Thus, it is worth looking into the measurement issues and the implications that these measurement issues have for using statistical gaps.

Essentially, constructing an output or unemployment gap requires breaking down output or unemployment into a trend component and a cyclical component. From a policy perspective, we are interested in how much current output or unemployment is deviating from the current measure of trend.

There are two primary reasons why both statistical output gaps and unemployment gaps may be poorly measured from the perspective of implementing monetary policy. The first is that the data from which they are constructed are significantly revised, and the second is that future data also significantly affect our estimates of the current and past measures of trend and hence potential. That is, it helps to know the entire path of output or unemployment, both past and future, when figuring out what part of their current values reflect a general trend.

For example, consider a simple exercise that estimates trend unemployment and the deviation of unemployment from trend. The figure shows the difference between estimates of trend unemployment using all of the available data, which we denote as the final estimate, and its estimate when only data available at each point in time are used to construct the trend. We will refer to this as a real-time estimate.¹³ (See *Constructing the Figure*.)

Although we have used a very

simple statistical technique to calculate trend unemployment, the basic thrust of our results would carry over if more sophisticated statistical techniques were used.¹⁴ In addition, we have performed the analysis using the latest estimates of unemployment and

¹³ A true real-time estimate would use only the data as they were reported at the time. Therefore, we ignore measurement error issues associated with initial data that are subsequently revised, but it turns out that estimation errors associated with data revisions are a relatively small problem.

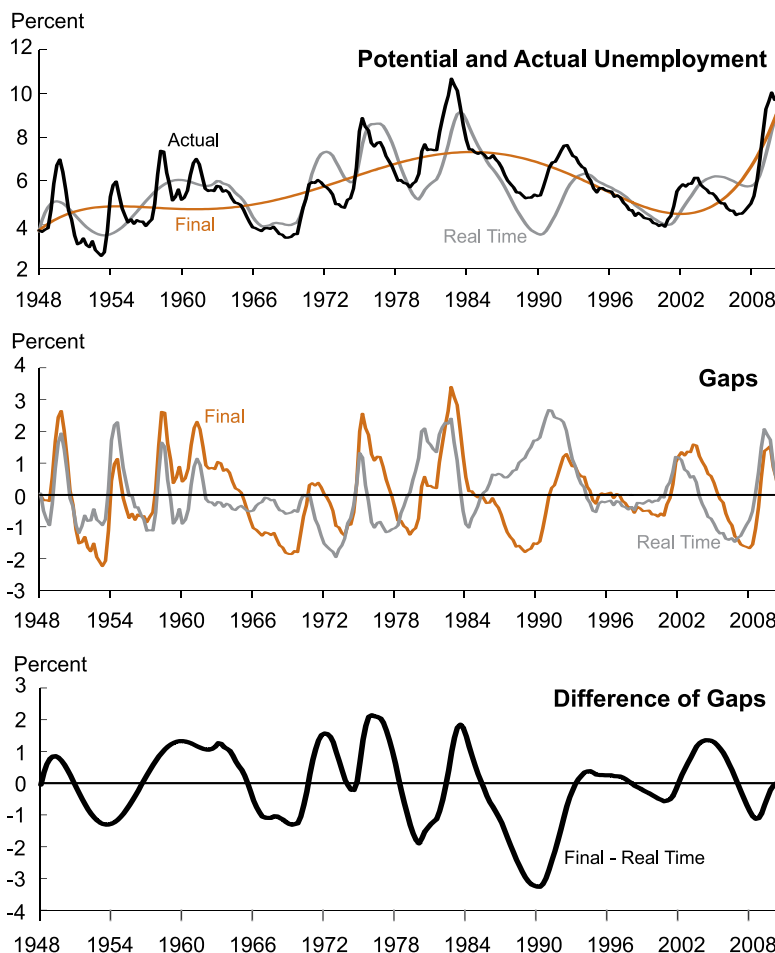
¹⁴ For a detailed comparison of different statistical measures of trend unemployment, see the 2002 study by Athanasios Orphanides and John Williams.

so have ignored the effects of data revisions. In general, although revisions do contribute to measurement error in estimating the unemployment gap in real time, this channel is less important than the inability to see future unemployment rates when estimating trend unemployment.

The evidence regarding the statistical uncertainty in measuring unemployment gaps is also present when one examines output gaps. A detailed examination of the measurement problems in calculating output gaps is provided in a paper by Athanasios Orphanides and Simon van Norden. Their basic findings are similar to what

FIGURE

Potential and Actual Unemployment



Source: Estimates constructed by authors using data from the Bureau of Labor Statistics.

we have just shown for the unemployment gap. Using various statistical estimates that are more sophisticated than the one used in our example (there are many ways to estimate a trend), Orphanides and van Norden arrive at very different estimates of the gap, especially the real-time gap. The different estimates in real time can vary by more than 6 percentage points and by more than 3 percentage points when final data are used. Furthermore, for various measures the revisions between real-time and final

estimates are frequently larger than 4 percentage points in absolute value. Thus, the revisions are often nearly the same size as the output gap measures themselves. Also, the revisions are persistent, implying that measurement errors are long-lived.¹⁵ Finally, the estimated gaps in real time are often of

¹⁵Autocorrelation coefficients range from 0.80 to 0.96. Autocorrelations show the correlation between two values of the same variable at different times, rather than the correlation between two different variables.

the opposite sign when compared with the final estimates.

In general, data revisions also contribute a small share to the difference in the real-time and final estimates of the output gap. Most of the revision is due to the fact that the final estimates use all of the data over the full sample and that data are useful in establishing the estimated trend.

We should mention that there are also data revisions of many inflation series and that inflation, therefore, suffers from measurement issues. However, because the data uncertainty surrounding inflation is affected only by data revisions to inflation itself and not by imprecise estimates of an inflation gap, the data uncertainty surrounding inflation is generally minor when compared to the uncertainty surrounding the unemployment or output gap. Therefore, we ignore the uncertainty associated with inflation and treat inflation as an accurately measured variable in real time.¹⁶

After reviewing the measurement problems, we conclude they are severe. The question then is what role these measurement problems should play in the way we design monetary policy.

IMPLICATIONS OF DATA UNCERTAINTY FOR MONETARY POLICY DESIGN

The general message from the literature is that basing policy on gap-type concepts is problematic and that it pays to respond fairly aggressively to movements in inflation from target. It also appears that responding to economic activity itself, as opposed to “gaps,” is quite helpful when design-

¹⁶ However, there have been episodes in which core personal consumption expenditures (PCE) have been substantially revised. One particularly large episode occurred in 2001 when inflation, as measured by the core PCE, was revised up by approximately 1 percent and what was initially observed as declining inflation actually became a period of rising inflation. For more details, see the study by Dean Croushore.

Constructing the Figure

In this example, the trend is constructed using a common statistical technique of fitting the unemployment rate to an equation based on time.* For the final estimate, the equation is estimated on data from the first quarter of 1948 to the fourth quarter of 2010, and the orange line in the top panel represents the fitted curve. The real-time estimates are constructed by estimating the same equation using data only up to the period in question and calculating the trend value at that time. We start in 1963 so that our initial real-time estimate is made using 15 years of data. In particular, for the estimate of the trend in the first quarter of 1963, we use data from the first quarter of 1948 to the first quarter of 1963 and calculate the trend for the first quarter of 1963. We then update our estimation of the trend by using an additional quarter of data and make the analogous calculation of the trend for the second quarter of 1963. We continue this procedure until the fourth quarter of 2010. As we approach the end of the sample period, the two trend measures begin to converge. They do so because the data used in constructing each measure become similar as the end of the sample is approached, and they are exactly the same for the last data point. This happens not because the real-time estimates are getting better but because the final-time estimates no longer have the advantage of information contained in unemployment rates that have yet to occur.

The actual unemployment rate is shown by the black line in the top panel of the figure, and estimates of the real-time trend are displayed by the grey line. The final-time estimates are depicted by the orange line. It is obvious that the real-time and final-time estimates are very different. In the middle panel, we plot the unemployment gaps, which are the difference between the unemployment rate and the estimated trends. The average absolute values of the gaps are 0.83 for the real-time gap and 0.93 for the final-time gap. The differences between the two gaps are large, with an absolute average value of 0.95. Thus, the differences in the gap measures are bigger than the estimates of the gaps themselves. Furthermore, the gaps are often of opposite sign and the differences in their values are persistent.

* In particular, we postulate that the unemployment rate is a particular function of time. In particular we estimate $u = a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4 + a_5t^5 + e$ using data from 1948Q1 to 2010Q4, where t is the number of periods from the beginning of our data sample. We use the estimate of this function to calculate the trend.

ing policy under data uncertainty. Basically, one should not base policy on poorly estimated measures, and economic activity is much better measured than gaps.

A useful paper that articulates this message is the 2002 study by Orphanides and Williams that investigates the effects of mismeasurement of the natural rate of unemployment, which is also easy to translate into a similar message regarding the use of statistically based output gaps.

Orphanides and Williams calibrate misperceptions of these natural rates using U.S. data from the first quarter of 1970 to the second quarter of 2002. As in our analysis above, they measure misperceptions by the difference between potential measured in real time and potential when measured using the data over the entire sample. For these authors as well, the additional data provided by the full sample turn out to be very important for breaking down unemployment into its true trend and cyclical movements. Hence, the limitation of not observing the future potentially creates a lot of uncertainty about the trend in unemployment. As in the study by Orphanides and van Norden, the authors show that the misperceptions about the natural rate of unemployment are large and highly persistent.

Given this uncertainty, Orphanides and Williams analyze what types of monetary policy rules work in their fairly simple environment. Although it is natural to question whether results in such a simple setting can be generalized to more realistic and complex models of the economy, we believe that qualitatively, at least, the lessons learned from their exercise are informative for designing policy.

The basic result is that under data uncertainty, the monetary authority wants to minimize the degree to which that uncertainty affects policy. That conclusion seems quite intuitive. Fur-

thermore, the more uncertain the central bank is at any given point in time, the more it should reduce the potential effect that misperceptions may have on policy. This is certainly a message that should resonate with policymakers in the current economic environment.

The central bank minimizes uncertainty's effect on monetary policy by moderating its response to the gap compared to what it would do if it knew the gap with certainty. The central bank also increases its response to inflation and is somewhat inertial, changing interest rates gradually. This inertial behavior reduces the effects of uncertainty. The results go further and indicate that central bank policy is improved when it responds to changes in unemployment (or output growth) rather than only responding to gaps.¹⁷

Furthermore, the optimal policy derived under uncertainty does not perform badly in a world that hypothetically has no uncertainty, while policies formulated as if there were no uncertainty can be quite disastrous when, in fact, there are measurement issues. In part, that feature, as Janet Yellen has pointed out, is due to the fact that rules based on natural rate concepts tolerate significant departures of inflation from target when natural rates are badly measured. For example, if the monetary authority incorrectly thought that current output was well below potential, it would ease monetary policy and tolerate additional inflation. The rules that instead respond to changes in economic activity are not as forgiving because economic activity is much more precisely measured, and inflation is, therefore, less likely to drift from target.

¹⁷ The substitution of responding to changes in economic activity rather than responding to the level of some gap is also reminiscent of the study by Bennett McCallum and Edward Nelson, who reach this conclusion using a model that is different from that of Orphanides and Williams.

The 2003 study by Orphanides provides additional intuition as to why gap-type rules perform badly when both inflation and gaps are mismeasured in real time. With mismeasurement, these types of rules essentially introduce a policy error into monetary policy. The interest rate set by the central bank responds to measurement error because the interest rate is not only responding to the true gap but also to the error in measuring that gap. The induced policy error, in turn, affects the economy, increasing the variance of both output and inflation.

The exercises in the 2002 study by Orphanides and Williams and the 2003 study by Orphanides are, to our minds, not just mere theoretical curiosities but are indicative of actual problems that have occurred when policy has been based on gaps and when these gaps have been badly measured. A particularly powerful example is given in the 2002 study by Orphanides, in which he discusses the Great Inflation of the 1970s. While we don't believe that mismeasurement is the sole reason for the stagflation of that era, we do believe it was a contributing factor.¹⁸

The economic experience of the 1970s was indeed a disaster, and monetary policy played a role in the decade's dismal economic performance. Part of the problem appears to have its foundation in basing monetary policy on unemployment gaps. Persistent errors in measurement lead to persistent errors in policy.

Over much of the 1970s real-time estimates of the natural rate of unemployment indicated that the economy was operating below its full-employment potential when in fact the opposite was true. This mispercep-

¹⁸ Another potentially important aspect was that individuals began to believe that the Fed had raised its inflation target. We will return to this feature when we discuss the role of learning.

tion lent an inflationary bias to policy over that period. Thus, had the Fed been responding to inflation and the unemployment gap by following a classic Taylor rule over this period, the misperceptions about both potential unemployment and forecasts of current inflation would have led to funds rate settings that were very close to what actually occurred.¹⁹ Thus, the FOMC might have believed it was operating according to a well-designed policy rule, when in fact the errors induced by misperceptions about key variables implied a policy that acted as if the inflation target was increasing.

On the other hand, the 2002 study by Orphanides and Williams also indicates that during the strong growth of the late 1990s, the Fed was not responding to gaps but was following policy rules that incorporated economic growth. By adhering to this alternative type of rule, which responds aggressively to deviations of inflation from target and to economic growth, the Fed averted a large deflation that would have occurred if it had, in fact, been paying attention to unemployment gaps. According to the book by Robert Hetzel, former Fed Chairman Alan Greenspan's dismissal of the relevance of gaps as a basis for setting monetary policy had its precursor under the regime of William McChesney Martin. During most of Martin's tenure as Chairman, the Fed raised interest rates early on in recoveries, responding to economic growth rather than gaps.²⁰

To summarize, the lessons from

this literature for policymakers when responding to statistical measures of a gap are (1) statistical gaps should not be a major contributing factor in implementing policy, (2) policy should aggressively respond to inflation when it moves away from target, (3) it is appropriate to take measures of economic growth into account when deciding on the level of short-term interest rates, and (4) there is a role for gradualism or inertia in policy.

UNCERTAINTY DUE TO LEARNING

Another type of uncertainty arises because individuals may not be fully aware of the underlying theoretical model that explains the economy, even when such a model exists. In this case, individuals may look at actual data and try to infer from the data what will happen in the future. That is, their economic forecasts will depend on statistical inference based on histori-

best policy designed under the assumption that individuals know the true model of the economy performs very poorly when, in reality, individuals don't know the model and forecast the future based solely on historical data.

To set the stage more precisely, we examine their analysis in a bit more depth. Their model, like most models used for policy analysis, is one in which there is a trade-off between stabilizing inflation and stabilizing unemployment. One cannot fully stabilize both inflation and unemployment. The central bank can stabilize inflation to a greater extent, but doing so leads to more economic volatility. The reverse is also true, so the central bank tries to stabilize both variables as best it can.

Doing so requires the central bank to react to deviations of inflation from target and unemployment from its natural rate, raising the interest rate when inflation is too high and lowering the interest rate if unemployment is above

To understand how policy design is affected by learning when individuals have an imperfect understanding of the economy, we need to first understand how the presence of learning affects economic outcomes.

cal data and not on a deep theoretical understanding of the economy. In this case, the central bank's own actions affect what individuals believe about the actions the central bank will take in the future and cause individuals to update their beliefs about the future.

It turns out that in such a situation, the best monetary policy will be substantially different from the best policy that would arise if everyone knew how the economy operated. The effects of this type of uncertainty are dealt with in the 2006 and 2007 papers by Orphanides and Williams. A striking feature of their results is that the

its natural rate. Thus, their economic model embeds important real-world characteristics.

To understand how policy design is affected by learning when individuals have an imperfect understanding of the economy, we need to first understand how the presence of learning affects economic outcomes. Basically, learning gives rise to more volatility and persistence in the economy. Relative to knowing exactly how the economy works, individuals are less informed and, therefore, make mistakes. Thus, economic activity is influenced not only by fundamental shocks to

¹⁹ Stanford economist John Taylor developed a formula to suggest how a central bank should set short-term interest rates as economic conditions change to achieve both its short-run goal for stabilizing the economy and its long-run goal for inflation.

²⁰ William McChesney Martin served as Chairman of the Federal Reserve from April 1951 to January 1970.

the economy but also by misperceptions due to learning. The effect of economic disturbances becomes more prolonged because it takes time for individuals to learn.

For example, if inflation goes up in response to some economic disturbance, inflation will be higher than individuals originally thought. This higher inflation will lead them to make a forecasting error: They will forecast higher inflation in the future, and importantly, they may reassess the value of the central bank's inflation target. Their misperceptions will, to some extent, be realized. Firms, whose expectations of future inflation rise, raise their prices and inflation does, in fact, rise. As the effect of the economic disturbance wears off, individuals' forecasts of inflation will become more closely aligned with what they would have forecast if they had perfect knowledge of the economy. However, the deviation of the forecast under imperfect knowledge from that under perfect knowledge persists for a while, and that deviation leads to more persistence in unemployment and inflation.

The effects of learning on the actual behavior of inflation can be even more dramatic and more harmful if changes in inflation lead individuals to reassess the central bank's inflation target. In those circumstances, individual expectations of inflation and the goals of the central bank can become unhinged. The result can be economic instability.

Understanding that individuals are learning, the monetary authority can improve economic performance by taking these features into account when designing policy. For example, the central bank should be more aggressive when reacting to deviations of inflation from target. By doing so, it reduces the persistence of inflation and reduces the consequences that arise when individuals gradually learn about the economy. It also reduces the prob-

ability that individuals will reassess the underlying goal for inflation. For example, if the monetary authority reacted so vigorously to changes in inflation that inflation never changed, then individuals would have no problem forecasting inflation. It would always be at the target. Individuals would make no forecasting mistakes with respect to inflation, and there would be no deleterious effects from learning on economic activity – at least with regard to inflation.

Perfectly targeting inflation, however, is not desirable because it would create too much volatility in unemployment. Recall the trade-off. However, there is now an added cost of inflation volatility in an environment where individuals learn. Volatility in inflation makes it harder to learn and hence to forecast future inflation. It is now beneficial for the central bank to react more strongly to changes in inflation. Also, as in the previous discussion, it is worthwhile to react to changes in unemployment and to not rely solely on output gaps when conducting policy.

Not reacting aggressively to inflation and responding vigorously to output gaps may have played a significant role in the rising inflation and stagflation of the 1970s. This thesis is persuasively argued in a 2005 paper by Orphanides and Williams and serves to validate the thesis set forth in Orphanides' 2002 paper. In their study, Orphanides and Williams postulate that during the large oil-price shocks in the 1970s, it is reasonable to assume that individuals were constantly learning and updating their beliefs about the economy. In addition, the authors re-document the extreme real-time mismeasurement of the natural rate of unemployment in official estimates. In particular, real-time measures of the natural rate greatly underestimated the true natural rate. Further, the FOMC at the time was aggressively

responding to unemployment gaps in an effort to stabilize the economy. The misperception of the unemployment gap led to persistent, overly expansionary monetary policy to the extent that public perceptions of the Fed's desired inflation rate began to rise and inflation expectations became unhinged. In other words, the Fed lost credibility for maintaining price stability. The result was stagflation: rising inflation and a severe economic contraction.

Orphanides and Williams then analyze two interesting hypothetical situations in a model economy similar to the one alluded to above. The first hypothetical question is: What if the FOMC had responded to the economy more like the subsequent policy instituted by Paul Volcker, where less weight was placed on stabilizing unemployment or, more generally, economic activity? The answer is that both unemployment and inflation would have been considerably lower. The second hypothetical question is: What if the FOMC had paid no attention at all to the unemployment gap? In that case, both inflation and unemployment would have been even lower still. Thus, an overemphasis on economic stabilization can in practice have serious economic consequences, which, in theory, can be avoided by responding aggressively to deviations of inflation from target and placing less emphasis on economic stabilization in the policy rule.


SUMMARY

In this article, we have examined how two types of uncertainty — uncertainty from badly measured variables and uncertainty that arises because individuals do not fully understand how the economy operates — affect the design of monetary policy. The message from both examples is qualitatively the same. The central bank should acknowledge the existence of the uncertainty and formulate

its response to the economy accordingly. Ignoring the uncertainty generally leads to policies that do rather poorly and can be significantly improved.

Taking account of the types of uncertainty that we describe in this article and which we think are signifi-

cant sources of uncertainty in reality leads to monetary policies that aggressively respond to inflation and that also respond to economic growth. Of interest is that policy should downplay the role of output and unemployment gaps and that policy should be very in-

ertial, reacting gradually to economic disturbances. In the current economic environment, we believe the overriding message for future policy is that an overreliance on the magnitude of any particular gap is likely to yield results that could be greatly improved. 

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Risk and Uncertainty*

BY PABLO A. GUERRON-QUINTANA

Many news reports and economic experts talk about uncertainty. But what does the word mean in an economic context? Specifically, what do economists have in mind when they talk about it? In this article, Pablo Guerron-Quintana discusses the concepts of risk and uncertainty, what the difference is between the two terms, and why their presence in the economy may have widespread effects. He also talks about measuring risk at the aggregate level — that is, risk that affects all participants in the economy — and he reviews the various types of risk measures that economists have proposed.

Many news reports and economic experts talk about uncertainty. Take, for example, the recent discussion about the U.S. budget situation. Although several proposals have been offered that aim to achieve a fiscally sustainable budget, we do not know with certainty which measures will ultimately be adopted or their timeline. According to some economists, this uncertainty seems to have contributed to a slowdown in investment, hiring, and economic activity and has the potential to affect our standard of liv-

ing. But what does uncertainty mean? More important, what do economists have in mind when they talk about it?

This article will discuss the concepts of risk and uncertainty and why their presence in the economy may have widespread effects. We will also talk about measuring risk at the aggregate level, that is, risk that affects all participants in the economy. Different measures of this aggregate risk have been proposed: (1) disagreement among forecasters, (2) stock market volatility, (3) interest rate volatility, and (4) tax rate volatility. Each of these measures has its pros and cons.

Over the years, the concepts of *risk* and *uncertainty* have often been used interchangeably in the popular press, but economists have long distin-

guished between the two. Indeed, the concept of uncertainty was probably first introduced to economics by Frank Knight in his 1921 treatise *Risk, Uncertainty, and Profit*.¹ Knight drew the distinction between *risk* – unknown outcomes whose odds of happening can be measured or at least learned about – and *uncertainty* – uncertain events that we do not even know how to describe. Economists often label these ideas *Knightian risk* and *Knightian uncertainty*, although sometimes they are called *objective uncertainty* and *subjective uncertainty*. (See *Uncertainty Is Different from Risk*.)

Risk can affect us at an individual level. In our daily lives, we get hit by unanticipated events such as accidents or diseases or being hired for a dream job or even winning the lottery. While the last two examples are pleasant surprises, the first two events involve physical and mental strain and potential monetary losses. Since most of us dislike facing stressful situations, we modify our behavior when bad luck knocks on our door. For instance, we buy insurance to protect us from the monetary loss we could sustain from car accidents or the cancellation of a vacation trip. Furthermore, the knowledge that we may lose our job can be strong enough to deter us from taking that well-deserved vacation. All of these examples provide powerful reasons why we may want to learn more about risk.



Pablo Guerron-Quintana is an economic advisor and economist in the Research Department of the Philadelphia Fed. This article is available free

of charge at www.philadelphiafed.org/research-and-data/publications.

*The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

¹ The interest in uncertainty in economics seems to coincide with a broader wave of interest in the topic in science, as reflected by Heisenberg's 1927 work on uncertainty in physics.

Uncertainty Is Different from Risk

T

o understand the difference between risk and uncertainty, let's consider the experiment of flipping a fair coin (Case A). In this experiment, the unknown is whether the coin will land heads or tails.

Since we are dealing with a fair coin, we know that the odds of heads after each flip are 50-50. That is, if we were to flip the coin let's say 100 times, the coin would land, on average, 50 times heads and 50 times tails. The crucial insight from this experiment is the observation that we *know* exactly the odds of each of the possible events: 50 percent heads and 50 percent tails. Furthermore, we have this knowledge before starting the experiment. This is precisely the essence of risk: We can describe the odds of the unknowns.

Now let's consider an alternative experiment (Case B). As before, we are interested in learning the result of flipping a coin. The key difference is that we know the coin is no longer fair, but we do not know the odds of obtaining heads. Furthermore, the coin is replaced by a new (and unfair) coin after each flip.^a Under this scenario, the only thing we know is that the coin will land either heads or tails. If we were thinking about flipping the coin 100 times, we could not (before we start the experiment) tell how many times the coin will land on heads. This is an example of Knight's *uncertainty*.

Another way to see the difference between risk and uncertainty is as follows. Suppose 100 people are asked to place odds on the coin landing on heads in experiments A and B. In Case A, people would agree that the odds are 50-50, but in Case B, their assessment would range from 0 to 100 percent. Furthermore, those people would prefer to bet on getting heads in experiment A than on getting heads in experiment B.^b

The concept of uncertainty goes beyond those situations in which we cannot establish the likelihood of events. It also includes cases when we do not even know

the outcomes. An extreme example is as follows. Imagine that a person from the Midwest decides to vacation in Volcanoland, a fictitious country buffeted by constant volcanic and seismic activity. If a sudden volcanic eruption surprises our friendly Midwesterner, his lack of knowledge and experience with volcanoes makes his immediate future quite uncertain. How long is the eruption going to last? Does he have enough food and water? Is his shelter safe? Our friend is asking himself these questions because he is uncertain about the possible outcomes from an eruption. In this example, we are aware that something has happened (an eruption), but we do not know its potential consequences.

Assessing the impact of uncertainty is trickier. The reason, as explained in the introduction, is that one cannot assign probabilities to the possible outcomes or one does not know all the possible outcomes. This lack of knowledge means that the consequences of uncertainty can range from nothing to vast monetary losses.^c To see this point, let's reconsider the case of tossing an unfair coin 100 times. Suppose that we get \$1 each time the coin lands on heads and pay \$1 otherwise. What we know before flipping the coin is that we may make as much as \$100 (all trials land on heads) or we may lose \$100 (all trials land on tails). Furthermore, any payment in between is possible. The unfair nature of the coin makes it impossible for us to determine the expected payoff from entering into this contest.

Now consider the case of the Midwesterner facing a volcanic eruption in Volcanoland. What are the potential consequences for this person? On the one hand, the only annoyance our friend may face is ashes falling from the sky. The uniqueness of this event also implies that if the eruption turns out to be violent, our friend may be risking a lot more than a spoiled vacation. As with the case of the coin tossing exercise, we cannot determine beforehand the potential losses from being exposed to a geologic contingency.

^a This assumption is needed to ensure that we cannot learn the odds of getting heads by repeatedly flipping the coin. If this were the case, after the learning stage, we would be in a case essentially the same as that of flipping a fair coin, whose odds of landing on heads are a known constant, although different from 50-50.

^b This preference to act on known rather than unknown probabilities is called the Ellsberg paradox (Ellsberg, 1961).

^c Larry Epstein and Tan Wang provide a comprehensive analysis of uncertainty.

The idea that risk can affect not only our daily lives but also the overall economy is not new. Indeed, in the 1930s, the English economist John Maynard Keynes indicated that investors' mood could lead to economic

downturns. He reasoned that investment was in part driven by investors' view of the economy. If they are uncertain about the economy's prospects, they reduce investment, triggering a downturn.

ASSESSING THE IMPACT OF RISK

Risk can affect the economy in at least two ways: through investment and/or through savings. The current "risky" scenario about where house

prices are heading (up, down, or stable) and whether interest rates are going up makes the investment decision nontrivial. The optimal response to risky situations may be to wait and see. In other words, households choose to delay investment (buying a house) until things calm down. The reason is that individuals may face an adverse scenario with high interest rates and a contraction in house prices. This possibility makes investment quite risky, inducing households to wait for better times. Put differently, when facing uncertain scenarios, investors must decide on the timing of their investment decisions.²

But risk can affect savings as well. Imagine that you owe credit card debt and that your monthly payment is \$200. Suddenly, your credit card company announces that interest rates may go up next month. Moreover, the company announces that if interest rates go up, interest payments will most likely double for some customers. Under these circumstances, you may find it desirable to consume less today and use that extra cash to repay part of your debt. The additional cash should be used to repay part or all of your debt. If you choose otherwise, you may face credit card payments as high as \$400 next month. Even more worrisome, because of those large payments, you may have to cut your consumption by a large amount tomorrow.

The previous example can be extended to the case of countries. Imagine that a country issues debt to cover part of its investment and other expenses. If the country's creditors disclose that interest rates may change next month, the country may want to repay part of its debt to reduce the future burden of interest rate payments. In order to pay more today, the country needs to produce more. But in-

creasing production takes time (hiring more workers, building factories, and so on). This means that the only way the country can repay its obligations is by cutting its expenses, that is, reducing consumption and investment. In other words, the country needs to sell more goods abroad (increase exports) and buy fewer goods from abroad (decrease imports). Since not all goods can be exported (for example, haircuts, legal and medical services, and houses), some industries will be forced to produce less. This decline in production will result in higher unemployment for a segment of the population.

Obviously, how our decisions change when we face risky situations depends on our attitudes toward risk. For instance, a gambler (a person who loves taking additional risk) may well opt to purchase a home with the hope that prices will eventually recover. The gambler understands there is a big chance that prices may not recover for a while. Yet the mere fact of taking a chance gives him satisfaction and hence drives him to bet on the housing market. In contrast, a cautious person may choose not to gamble on the housing market and may refrain from buying a house these days. For the cautious person, the potential losses far outweigh the benefits from buying a house in a depressed market and hoping it will recover.³

³ In the context of an economic model, whereas a gambler would correspond to a person whose preferences are described by a linear utility function, a risk-averse person — a cautious person — has a concave utility function. If the two persons were to invest in a risky project, such as buying stocks, the gambler would care only about the project's payoff, since he considers only his total consumption. He would take on whatever project offers large rewards, even though it may also entail large losses. In contrast, the cautious person would also factor in the odds that the project could fail. Even if the promised payoff is large, a risk-averse person may opt out of the project because the odds that it will fail are too big. In other words, he would rather have fewer swings in his income even if that means a lower average income.

Since the presence of risk can entail monetary losses, people try to protect themselves by buying insurance. In simple terms, an insurance contract transfers the risk of loss from the policy holder to the insurer, usually a large company. The contract typically sets a small and regular payment to be made by the insured person. In

How our decisions change when we face risky situations depends on our attitudes toward risk.

exchange, the insurer promises to pay the policy holder a given monetary amount if certain events happen, as defined in the contract. Some examples include having a car accident, having a vacation trip cancelled, or being laid off from a job. In this last case, the insured person is a worker and the insurer is the federal government and/or the state.

But accidents happen; people get sick; workers get laid off. More important, these unpleasant events happen more frequently than we would like. So why do insurance companies exist? One reason is that the insurer and the policy holder may have different views about the odds that an event will occur. To illustrate my point, imagine a person who is afraid of flying. His pessimistic view about air transportation leads him to look for insurance. In contrast, an insurance company knows that flying is the safest medium of transportation. The odds of an incident are very small, so the insurer is more than willing to extend a policy to the concerned flyer.⁴

Even if the insurer and the policy holder have the same assessment of

⁴ Indeed, the odds of dying in a plane crash for the average American is about 1 in 11 million.

² Committing to early investment brings in extra returns, while waiting is beneficial because of access to additional information. See the article by Ben Bernanke.

the odds that an event will occur, the insurer may still be willing to extend a policy to the insured person. For example, this is the case with car insurance. For instance, a car owner who lives in a crowded city has a greater probability of being involved in an accident, a situation that requires payments from the insurer to the policy holder.⁵ To reduce their exposure to this type of event, insurance companies offer policies to a large number of drivers. Since car accidents tend to be isolated events, the likelihood of an insurance company facing accident claims from all its insured customers at the same time is very low. Hence, although the insurer may need to make frequent payments, the insurer is also receiving payments (premiums) from those policy holders who have not been involved in an accident or the deductibles from those who have been. In this way, the insurance company has enough funds to pay its insured customers who have car accidents.

MEASURING RISK: SOME BASICS

From the discussion in the previous sections, it should be clear that risk can influence our lives. Obviously, the influence of risk depends on the circumstances under which it affects us. For example, consider the risk associated with the weather. Under normal circumstances, a day with bad weather means that we may be late getting to work; that is, the expected loss — the risk — is low. But in some cases, the risk can be high. Imagine if you missed an interview for your dream job because of bad weather. The stakes are even higher when we think of the risk associated with buying a house or a government that is considering issuing bonds. In the first case, risk arises from

fluctuations in the price of houses, and in the second case, the variability of interest rates (and hence the cost of issuing bonds) matters. The bottom line in these examples is that understanding the consequences of risk requires measuring it. Once we have a measurement, we can then take actions such as postponing the purchase of a house or buying insurance.

Economists have proposed different measures of risk: (1) disagreement among forecasters, (2) stock market volatility, (3) fluctuations in interest rates, and (4) fluctuations in tax rates.⁶

Disagreement Among Forecasters. Imagine that today is a bright and sunny day. If you were asked to forecast the weather for the afternoon, assuming that you don't have access to a weather forecast service, you would most likely answer "a sunny afternoon." In fact, everyone would agree with you. Now imagine that today is sunny, but a few clouds lurk on the horizon. The presence of those clouds makes forecasting the weather for this afternoon more difficult. Some people may forecast a sunny afternoon; others may guess a cloudy but dry afternoon, while a third group may forecast a rainy afternoon.

The idea behind the last example is that periods of elevated risk are associated with very imprecise forecasts about future events. In other words, the more risky the event, the harder it is to forecast and, therefore, the larger the disagreement among forecasters. In our example, the risky situation arises from those clouds on the horizon. Rather than the weather, economists are frequently interested in the total number of goods that an economy produces, that is, a country's gross domestic product (GDP). Hence, our first measure

of risk comes from the forecasters' disagreement about what the growth rate of GDP is going to be a year from now. This measure is published quarterly by the Federal Reserve Bank of Philadelphia in the *Survey of Professional Forecasters*. It is the percent difference between the 75th and 25th percentiles of the one-year-ahead projections for U.S. real gross domestic product.

Figure 1 shows that the degree of riskiness (measured by forecast dispersion) was large in the 1970s, in particular, during the oil embargo of 1974 and at the beginning of the Fed's disinflationary era around 1979. The figure also suggests that disagreement has diminished during the 1990s and the first half of the 2000s. This decline coincides with what economists call the Great Moderation, that is, the period between 1984 and 2007 characterized by two relatively mild recessions and, in general, moderate fluctuations in the economy. During this period, the increasing agreement among forecasters resulted from the more stable, and thus more predictable, economy. This reasoning has led some observers to argue that the prolonged boom prior to the recent crisis arose from a stable economy.⁷ This stability stimulated consumption and investment. To meet higher demand, firms increased their production by expanding their facilities (additional investment) and increasing employment.

Another look at Figure 1 reveals a rise in risk since the start of the 2007 financial crisis. The highest level of risk happens by the end of 2008, which coincides with the collapse of Lehman Brothers. What makes the 2007-2010 episode different from other periods over the last 20 years is that risk remained heightened for more than a year. With so much risk around, it is not surprising that firms and house-

⁵ Eric Smith and Randall Wright analyze the interesting issue of why car insurance is so expensive in certain metropolitan areas.

⁶ Economists have proposed other ways to measure risk. The interested reader is invited to consult the article by Nicholas Bloom, Max Floetotto, and Nir Jaimovich.

⁷ See the study by James Stock and Mark Watson.

holds postponed their purchasing and investing decisions. Interestingly, the improvement in the economy of recent months seems to coincide with a decline in risk. Note how the measure at the end of 2010 is getting close to its pre-crisis levels.⁸

A simple way to make sense of the numbers in Figure 1 is as follows. You and I own an apple tree, and we are interested in forecasting our tree's annual production. Furthermore, let's suppose that our disagreement over the years is represented by Figure 1. In the first quarter of 1980, our forecast disagreement reached an all-time high of almost three. This means that at that moment, if I had forecasted that our tree would produce 100 apples in 1981, your forecast would have been 103.⁹ Now, let us move forward to March 2007 when our disagreement was the lowest (0.4). At that point, if my forecast was 100 apples, you would have forecasted 100.4 apples. We were essentially making the same forecast. After the turbulent financial events of 2008, our disagreement rose to 1.5 apples and remained at that level for most of 2009.

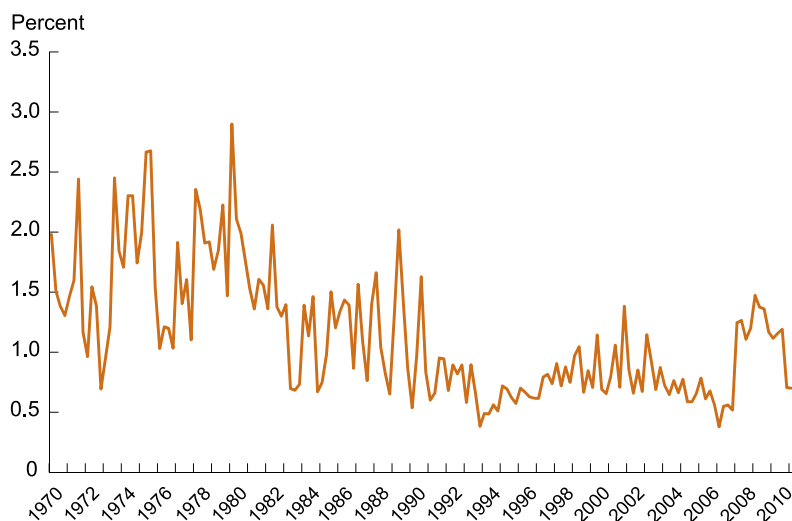
Stock Market Fluctuations. During times of high risk, new information about the state of a company (for instance, its profits and prospects for future projects) tends to arrive frequently. In response to the arrival of information, investors buy and sell stocks in the company quite frequently. As a result, the stock price of the company fluctuates substantially in the short run. The more uncertain inves-

⁸ Of course, the causality could go the other way around: Periods of high growth promote tranquil times and hence low risk. In a recent paper, Scott Baker and Nicholas Bloom use stock market information from several countries to argue that the causality runs from risk to economic growth.

⁹ For simplicity, I assume in this example that I am the person making the conservative forecast.

FIGURE 1

U.S. Real GDP Growth Forecast Dispersion



Source: *Survey of Professional Forecasters* from the Federal Reserve Bank of Philadelphia, quarterly data 1970:Q1 - 2010:Q3

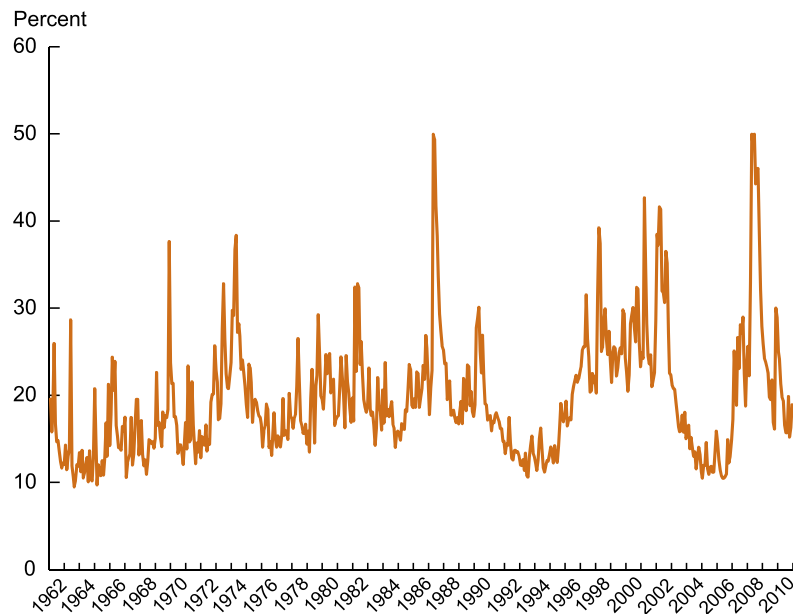
tors are about a company, the more they bet up or down on that company's stock. Hence, our second measure of risk comes from the variability (volatility) in the stock prices of companies publicly traded on the New York stock exchange. This indicator (displayed in Figure 2) is closely tracked by financial practitioners, since it is considered a measure of investor sentiment: The higher stock market volatility is, the more pessimistic investors are, that is, the greater the expectation that the market will fall. But recall that worried investors tend to wait and see. Hence, a sudden and persistent increase in stock market volatility may be signaling weak demand down the road and a potential contraction in the overall economy. It is this linkage between stock market volatility and economic activity that has made our second measure of risk popular both in academia and in policy circles. (See the studies by Nicholas Bloom.)

Based on Figure 2, it is clear that periods of economic and financial

turmoil are associated with strong fluctuations in the stock market.¹⁰ For example, the market was more volatile during the oil embargo of 1974 or the Asian financial crisis and the collapse of dot-com companies in the late 1990s. Similarly, the stock market crash of October 1987 resulted in a large spike, albeit temporary, of our measure of risk.¹¹ Figure 2 also shows that the U.S. economy enjoyed a period of tranquility and low risk starting around 1988 and extending into 1997. More recently, the onset of the mortgage crisis (2007) and the demise of Bear Stearns (March 2008) and

¹⁰ The U.S. stock market volatility is taken from the article by Nicholas Bloom. The measure corresponds to the Chicago Board of Options Exchange VIX index of implied volatility from 1986 onward. Prior to 1986, actual volatility in monthly returns is calculated as the monthly standard deviation of the daily S&P 500 index.

¹¹ Some economic observers attributed this quick reversal in risk to the Federal Reserve System's (and its then-Chairman Alan Greenspan's) swift actions to support financial markets. See the paper by Mark Carlson.

FIGURE 2**Stock Market Volatility: 1963 - 2011**

Source: Nicholas Bloom. Monthly data 1963:M1 - 2011:M1

Lehman Brothers (September 2008) shook financial markets. Figure 2 reveals that our measure of risk rose in response to those events. In fact, risk reached its all-time high in October 2008 and remained elevated for most of 2009.

An advantage of the stock market volatility measure is that it goes back to the 1960s and therefore allows us to illustrate how risk responds to political events. For example, the spike in risk at the beginning of 1964 coincides with President Kennedy's assassination. Moving forward, the Cambodian campaign and the Kent State shooting in 1970 pushed risk up.¹² Finally, the attacks on the World

¹² The shooting at Kent State University (Kent, Ohio) resulted in four people being killed and nine others wounded. Students were protesting the Vietnam War. The shooting happened just days after President Nixon announced the launch of the Cambodian incursion. This military action was intended to defeat North Vietnam's troops using the eastern part of Cambodia to stage attacks on South Vietnam.

Trade Center and the Pentagon in September 2001 are also associated with more risk in the market.

To make sense of the numbers in Figure 2, let's consider the following example. You own stock in a large group of leading companies in diverse industries in the U.S.¹³ You are interested in learning the odds that the return on your portfolio will move up or down by 10 percent next month. If you were wondering this in October 2008 and asking about your return in November 2008, the results in Figure 2 imply that the odds are roughly 50 percent that the return on your portfolio will move up or down by 10 percent. In contrast, if you were asking the same question in December 2006, you would conclude that the chances that your returns would go up or down by 10 percent is practically 100 percent. This

¹³ More precisely, you own stock in each of the 500 companies that are part of the S&P 500 index.

means that you are almost certain that the returns to your portfolio would not exceed ± 10 percent in January 2007.¹⁴ This is because stock market volatility was so low in December 2006 that sudden changes in stock prices and hence abrupt movements in stock returns were very unlikely.

I must stress that when stock market volatility is high, it does not necessarily mean that the market expects a sharp decline in stock prices. It only means that the market expects that sudden price movements in either direction (up or down) are more likely. Since most people tend to be concerned about losses, investors seem to dislike high stock market volatility (high risk) because it signals that a sharp collapse in stock prices is more likely.

Interest Rate Volatility. An alternative description of risk results from direct measures of fluctuations in interest rates. Such measures have been used recently in papers that try to assess the impact of risk on the economy. (See my paper with Jesus Fernandez-Villaverde, Juan Rubio-Ramirez, and Martin Uribe.)

The idea behind the measure of interest-rate volatility is that people tend to trade (sell or buy) bonds very frequently during periods of high risk. This frequent exchange of bonds makes their price fluctuate substantially, which results in large swings in interest rates.¹⁵ Hence, periods of large

¹⁴ These numbers were computed following the interpretation outlined in the study by Robert Whaley. Succinctly, the probability is computed by asking ourselves what is the probability that a random normal variable falls within σ standard deviations from 0. Here, $\sigma = \frac{E_r}{\sqrt{VIX}} \sqrt{12}$, E_r is the anticipated movement in the asset return, and VIX is the stock market volatility in Figure 2. In our first example, the values are $E_r = 10$ percent and $VIX = 50$ percent, which implies $\sigma = 0.69$ or a probability of 50 percent. If the VIX drops to 10 percent, then $\sigma = 3.46$, which, based on a normal distribution, implies a probability of 1.

¹⁵ The price and interest rate of a bond are inversely related, so any movement in prices translates directly to fluctuations in interest rates.

fluctuations (volatility) in interest rates are interpreted as episodes in which risk is high. As an example, Figure 3 illustrates the evolution of our interest-rate risk measure for Argentina. A quick look at this figure reveals that risk in Argentina was high in early 1998 and again during the period 2001 to 2004.¹⁶

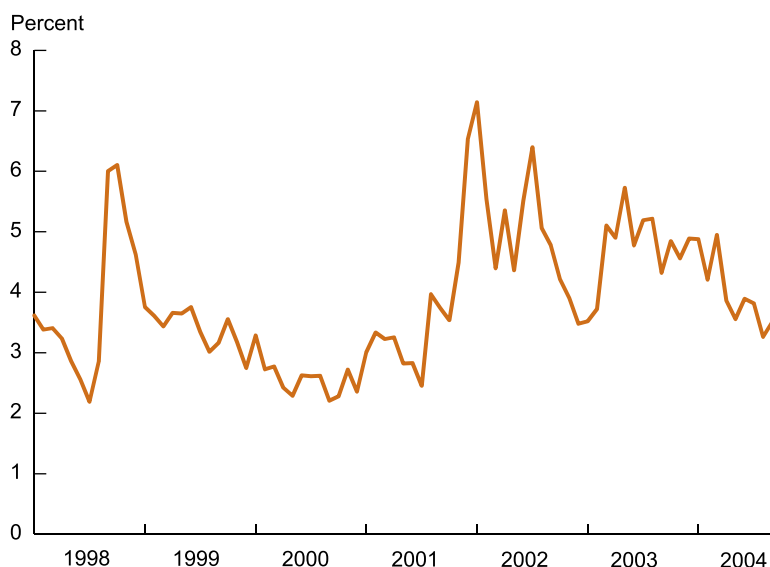
To understand these changes in risk, some background information about Argentina is necessary. The 1990s were mostly a boom period for Argentines (presumably due to economic reforms introduced early in that decade). The country experienced sustained economic growth and stable prices. In the eyes of investors, Argentina was an example for other countries to follow. However, this stability started to collapse around 1998 when several East Asian countries experienced financial difficulties, forcing them to stop payments on their debt obligations to international lenders. Although Argentina was in better economic health than the defaulting countries, nervous lenders worldwide feared that Argentina (and other countries in South America) would follow suit. Investors could not assess how much the Argentinean economy would be affected by the collapse of Asian economies. Ultimately, Argentinean debt was heavily traded during this period, which resulted in sudden fluctuations in interest rates and hence a spike in risk.¹⁷ As time went by, it was clear that Argentina would be able to

¹⁶ The Argentinean interest rate is the sum of the real rate on the three-month U.S. Treasury bill plus Argentina's Emerging Markets Bond Index+ (EMBI+). The T-bill rate is taken from the St. Louis Fed's FRED database. The EMBI+ index is published monthly by J.P. Morgan. The risk measure in Figure 3 is constructed using the econometric approach described in my paper with Jesus Fernandez-Villaverde, Juan Rubio-Ramirez, and Martin Uribe.

¹⁷ Interestingly, risk in the U.S. was also elevated in the late 1990s, as shown in Figure 2.

FIGURE 3

Interest Rate Volatility in Argentina



Source: Jesus Fernandez-Villaverde et al. (2011). Monthly data 1997:M12 - 2004:M9

meet its obligations, so the country became less risky. This is reflected by the drop in our measure of risk between 1999 and 2000.

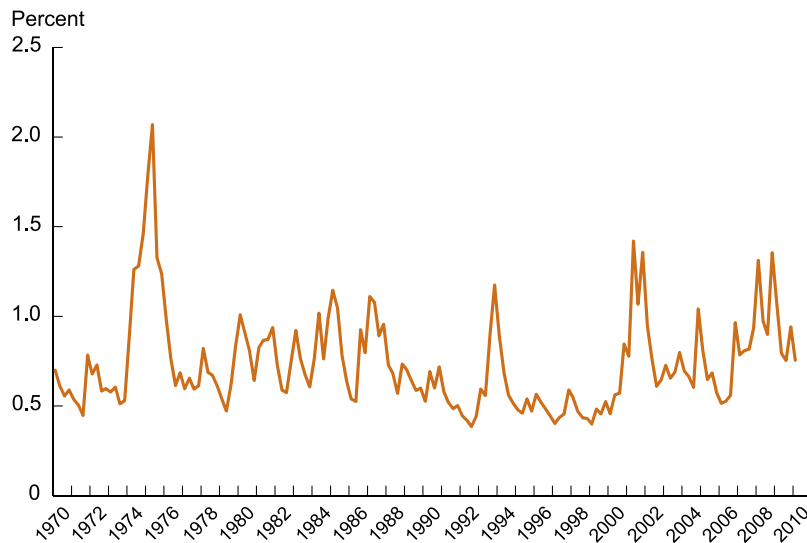
After almost a decade of boom, the Argentinean economy slowed down in 2000 and contracted in 2001. At the same time, the Argentinean currency (the peso) was greatly overvalued, which made Argentina's products more expensive than those imported from abroad and hence reduced its exports. This decline in production and lack of exports meant that fewer resources were available to repay debt. In response, investors demanded higher interest rates for loans extended to Argentina. These tough economic conditions led the country to default (stop paying principal and interest on its debt), which triggered the spike in our measure of risk by the end of 2001. Risk remained heightened for the next two years as the country continued to miss payments on its obligations.

Figure 3 shows that risk started to decline around 2003. This improve-

ment seems to coincide with the beginning of Nestor Kirchner's presidency. To some observers, the economic policies implemented by Kirchner and his predecessor (Eduardo Duhalde) paved the way to an orderly recovery. By the end of our sample period (August 2004), risk had reached its lowest level in three years, since international investors anticipated that Argentina would eventually try to meet or renegotiate its debt obligations. Indeed, in 2005, the country restructured its obligations with roughly 75 percent of its debt holders.¹⁸

A simple way to make sense of the numbers in Figure 3 is as follows. Imagine that you are living in Argentina in August 2000. You just bought a new car with an adjustable interest rate loan. The prevailing annual interest rate at that point was about 8 percent.

¹⁸ Old bonds were replaced by new debt with longer maturity and nominal value of between 25 and 35 percent of the original debt.

FIGURE 4**Capital Tax Rate Volatility**

Source: Jesus Fernandez-Villaverde et al. (2012). Quarterly data 1970:Q1 - 2010:Q1

By construction, Figure 3 tells us that there was a 68 percent chance that the interest rate would go up or down by 2 percentage points. This means that in August 2000 you believed that your interest rate could be as high as 10 percent or as low as 6 percent in September 2000. Let's move forward to December 2001. Our risk measure indicates that with a probability of 68 percent, your interest rate could jump up or down by 7 percentage points! This means that, all other things equal, you could have faced interest rates as high as 15 percent on your car loan. For a principal of \$10,000, these numbers imply that whereas your monthly payment in September 2001 could have been as high as \$800, your payment in December 2001 could have been \$1,170.¹⁹ Clearly, there is a non-

¹⁹ An annual interest rate of 10 percent is roughly equivalent to 0.8 percent on a monthly basis. Similarly, a 15 percent annual interest rate translates into a monthly rate of 11.7 percent.

trivial increase in your payments when the economy gets riskier.

The Argentinean example teaches us two important lessons about risk. First, risk can be contagious. Even though Argentina was a well-positioned economy in the late 1990s, it suffered from substantial fluctuations in its risk index. In this case, risk was imported from financial turmoil abroad. The second lesson is that risk can arise from domestic factors. The economic instability of Argentina and its subsequent inability to meet its obligations at the end of 2001 resulted in the massive spike in Argentina's risk. Here, there were no foreign elements triggering the sudden change in interest rate fluctuations.

Tax Rate Volatility. A final description of risk comes from fluctuations in tax rates. This notion was recently proposed in my paper with Jesus Fernandez-Villaverde, Keith Kuester, and Juan Rubio-Ramirez. The idea is that governments tend to overhaul tax systems during periods of fiscal strain

(such as the current one), which results in substantial fluctuations in tax rates. The worse the fiscal situation, the more volatile the taxes are.

Figure 4 presents our new risk measure based on the volatility of the capital tax rate in the United States.²⁰ The measure shows that risk associated with fiscal policy was high during President Clinton's first term. Indeed, the Omnibus Budget Reconciliation Act, which was signed into law in 1993, raised tax rates, affecting both individuals and businesses. Similarly, our risk measure rises during President George W. Bush's tax cuts in the early 2000s.

It is also apparent from Figure 4 that the recent financial crisis has heightened the fiscal-related risk. Risk was high between 2007 and 2009; only in early 2010 does risk linked to fiscal policy go back to pre-crisis levels.

In our paper we show that risk associated with fiscal policy can slow down the economy. The reason is that volatility makes it difficult to forecast future tax rates on capital. As a consequence, investors considering investing in new projects may opt to wait or completely skip those projects. This is because investors fear that large volatility may ultimately translate into large future taxes, thus reducing the profitability of their investments. If the capital tax rate volatility is sufficiently high, the decline in investment can induce a general contraction in economic activity (lower production and higher unemployment).

Imagine that you are back in the fourth quarter of 1995. You just invested in a new project whose payoffs are taxed at 35 percent. By construc-

²⁰ The tax rate on capital corresponds to aggregate effective rates on capital income. The risk measure in Figure 4 is constructed using the econometric approach described in my paper with Fernandez-Villaverde, Kuester, and Rubio-Ramirez.


tion, Figure 4 tells us that there was a 68 percent chance that the capital tax rate would go up or down by 0.5 percentage point. This means that in December 1995, you believed that the tax rate on capital income could be as high as 35.5 percent or as low as 34.5 percent in March 1996. Let's move forward to December 2001. Our risk measure indicates that with a probability of 68 percent, your tax rate could jump up or down by 1.4 percentage points! This means that, all other things equal, you could have faced a tax rate on capital as high as 36.4 percent.

This sudden change in the tax rate is sufficient to deter investment, at least temporarily, and induce a contraction in economic activity.

SUMMARY

This article introduced the economic concepts of risk and uncertainty. It provides clear and simple definitions and examples of risk and uncertainty. Furthermore, this article shows that risk can have important consequences for economic activity. For example, an increase in the volatility of interest rates at which countries

borrow can induce a contraction in consumption and investment.

Economists have proposed alternative measures of risk: (1) disagreement among forecasters, (2) stock market volatility, (3) interest rate volatility, and (4) tax rate volatility. All of these measures indicate that risk increases during periods of political and economic turmoil, such as President Kennedy's assassination, the 1987 stock market crash, and the recent financial crisis. Furthermore, these measures show that risk in the U.S. was low during the late 1980s and the first half of the 1990s. 

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Everything You Always Wanted to Know About Reverse Mortgages but Were Afraid to Ask*

BY MAKOTO NAKAJIMA

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ost people have probably heard of reverse mortgage loans. But even though these loans have been getting more attention lately, it's possible that many people still aren't sure about what reverse mortgages really are. This is not surprising, since reverse mortgages are a relatively new type of mortgage loan. Although reverse mortgages are currently used by only a small fraction of people, their popularity has been growing in recent years. In this article, Makoto Nakajima discusses reverse mortgage loans, particularly the most popular type, which is administered by the government. He discusses who uses reverse mortgage loans and how they are used and compares the pros and cons of these mortgages.

You've probably heard of reverse mortgage loans. But even though these loans have been getting more attention in the media and in academia, it's possible that you're still not sure about what reverse mortgages really are.¹

¹ For media reports, see, for example, "Pros and Cons of Reverse Mortgages" (*Time*, July 20, 2009); "Pimping Up Your Reverse Mortgage" (*Businessweek*, February 5, 2007). Various transgressions associated with reverse mortgages made the list of "Six Problems the Consumer



Makoto Nakajima is a senior economist in the Research Department of the Philadelphia Fed. This article is available free of charge at www.philadelphiafed.org/research-and-data/publications.

This is not surprising, since reverse mortgages are a relatively new type of mortgage loan — and very different from the conventional type of mortgage — and they are used only by older homeowners.

Financial Protection Bureau Should Tackle First" (*Time*, July 6, 2010). In particular, *Time* and the *Wall Street Journal* ("Debate on Reverse-Mortgage Risks Heats Up," December 14, 2010) report that some banks and brokers push older households into taking out reverse mortgages in ways that are not necessarily beneficial for the borrowers but ways in which banks and brokers can earn large fees or other profits. However, both also report that improved federal guidelines regarding fees associated with reverse mortgages have helped to lower the incidence of such transgressions.

*The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

Although reverse mortgages are currently used by only a small fraction of people, their popularity has been growing in recent years. Surprisingly, their popularity continued to grow into 2009, but the growth of reverse mortgage loans may have started to decline in 2010.²

This article discusses reverse mortgage loans, particularly the most popular type, which is administered by the government. One feature that makes government-administered reverse mortgage loans attractive to borrowers in an economic downturn accompanied by a house price decline is that this type of mortgage loan has a built-in insurance against declines in house prices. I will explain this feature and other features of reverse mortgage loans below.

ABCs OF REVERSE MORTGAGE LOANS

Nowadays, the most popular type of reverse mortgage loan is administered by the government, while the private market for reverse mortgages has been relatively shrinking. The government-administered reverse mortgage is called a home equity conversion mortgage (HECM). These mortgage loans are administered by the Federal Housing Administration (FHA), which is part of the U.S. Department of Housing and Urban Development (HUD). HECM loans represent over

² In 2011, the two biggest lenders of reverse mortgage loans, Bank of America and Wells Fargo, decided to leave the reverse mortgage market. Reasons given include the decline in house prices and the inability to assess borrowers' financial health, such as income (*New York Times*, "2 Big Banks Exit Reverse Mortgage Business," June 17, 2011).

90 percent of all reverse mortgages originated in the U.S. market (see Hui Shan's article).³

When buying a house, especially a first house, most people in the U.S. use a conventional mortgage loan. With a conventional mortgage, people make a down payment, which is typically around 20 percent of the house value, and borrow the remaining value of the house (around 80 percent).⁴ The borrower repays the principal and makes interest payments on the outstanding loan balance. As the borrower repays the principal, he accumulates home equity. The typical repayment period is 30 years. When the borrower finishes repaying the loan, he owns 100 percent of the equity in his house, free and clear.

How are reverse mortgages different from the conventional mortgages described above? Below are the six distinctive features of the government-administered HECM loans. First, as the name suggests, a reverse mortgage loan works in the *reverse* way from a conventional mortgage loan. With a reverse mortgage, instead of paying interest and principal and accumulating home equity, reverse mortgages allow homeowners to borrow against the home equity they have accumulated.

Second, reverse mortgage loans have different requirements than conventional mortgage loans. These mortgages are available only to borrowers age 62 or older. Also, borrowers must be homeowners and must live in the house. Properties eligible for HECM loans are (1) single-family homes, (2) one unit of a one- to four-unit home, and (3) a condominium approved by

HUD. Finally, borrowers must have repaid all or almost all of their other mortgage loan at the time they take out a reverse mortgage. Home equity lines of credit (HELOCs) are similar to reverse mortgage loans in that they allow households to borrow flexibly against accumulated home equity. However, while the repayment of HELOCs is based partially on the borrower's income, repayment of reverse mortgages is based solely on the value of the house. This difference makes reverse mortgages more readily avail-

to live in the same house, there is no need to repay any of the loan amount. There is no gradual repayment with a fixed schedule, as with a conventional mortgage loan or a HELOC; repayment is made in a lump sum from the proceeds from the sale of the house. Naturally, borrowers who manage to live in the same house for a long time benefit most from reverse mortgages.

Fifth, borrowers are insured against substantial drops in house prices. Borrowers (or their heirs) can repay the loan either by letting the

When buying a house, especially a first house, most people in the U.S. use a conventional mortgage loan.

able for use than HELOCs, especially for those with limited income after retirement. According to Andrew Caplin, many older homeowners fail to qualify for conventional mortgage loans because of income requirements. In short, reverse mortgages are more suitable for older homeowners who own the house they live in and whose income is relatively low.

Third, reverse mortgage borrowers are required to seek counseling from a HUD-approved counselor in order to be eligible for a HECM loan. The goal is to be certain that older borrowers understand what kind of loan they are getting and what the potential alternatives are before taking out a reverse mortgage loan.

Fourth, repayment of the cash received is due only when the house is sold and all the borrowers move out or when all the borrowers die.⁵ As long as at least one of the borrowers continues

reverse mortgage lender sell the house or by paying in cash. Most use the first option. In the first case, a mortgage lender sells the house attached to the reverse mortgage loan and uses the proceeds of the sale to repay the loan and to pay for various costs. If the sale value of the house turns out to be larger than the sum of the total loan amount and the various costs of the loan, the borrowers receive the remaining value. In the opposite case, where the house value cannot cover the total costs of the loan, the borrowers do not need to pay anything extra. The insurance covers the difference. In fact, the mortgage lender does not have to absorb the loss, either, because the loss is covered by insurance, which is a part of HECM loans. The FHA imposes an insurance premium for this benefit; the insurance premium is included in the total costs of a HECM loan. In a housing market downturn, reverse mortgage loans can play a particularly important role by protecting older households with reverse mortgages from being hit by large declines in house prices.⁶

Finally, there are various ways to receive cash (payment options) out of

³ Many other reverse mortgage products, such as Home Keeper mortgages, which were offered by Fannie Mae, or the Cash Account Plan offered by Financial Freedom, were recently discontinued, in parallel with the expansion of the HECM market. See the article by Bruce Foote.

⁴ Mortgages with lower (or zero) down payments were also used, especially during the period leading to the recent downturn.

⁵ Other incidents may make reverse mortgage loans come due, such as the failure to pay property taxes or to maintain the property. On the other hand, borrowers can pre-pay regardless of when the loan is due, typically without any additional cost.

home equity. Borrowers can choose according to their needs when they borrow against the value of their house. Here are the five payment options listed on the home page of HUD's website. Borrowers can change the payment options during the life of a reverse mortgage, at a small cost.

- **Tenure:** Borrowers continue to receive a fixed amount of cash as long as one of the borrowers continues to live in the same house.
- **Term:** Borrowers receive a fixed amount of cash for a fixed length of time.
- **Line of credit:** Borrowers can flexibly draw cash, up to a limit, during a pre-determined drawing period.
- **Modified tenure:** Combination of the tenure option and the line of credit option.
- **Modified term:** Combination of the term option and the line of credit option.

The tenure option is similar to Social Security in the sense that the borrowers can keep receiving cash as long as they are alive (and stay in the same house). The term option is similar to the tenure option, but borrowers receive cash only during a fixed period. If borrowers live and stay in the house beyond the fixed period, borrowers can no longer receive cash out of the reverse mortgage.⁷ Under the tenure

⁶ Of course, the government and, ultimately, taxpayers pay for the insurance benefit in cases in which reverse mortgage borrowers are hit by a large decline in house prices. Therefore, in assessing the value of reverse mortgage loans for society, we must compare the benefits enjoyed by reverse mortgage borrowers on those occasions against the costs borne by taxpayers. I will discuss this issue in the conclusion.

⁷ The borrowers might die or move out before receiving all of the scheduled payments. In that case, the debt under the term option is determined according to the amount the borrowers have received up to that point.

option, the time span for receiving cash is basically the remaining lifetime of the borrowers. So the time span under the term option tends to be shorter than under the tenure option. When the total loan amount is the same, the borrowers can receive higher cash payments per period if they receive them over a shorter time span under the term option. The line-of-credit option is similar to a HELOC in that it is flexible in terms of the timing and the amount withdrawn.

How much can one borrow using a reverse mortgage? Let's start with the case in which borrowers receive a one-time cash payment under a reverse mortgage. The starting point is the appraised value of the house, but there is a federal limit for a government-administered HECM loan. Currently, the limit is \$625,500 for most states. The limit was raised in 2009 from \$417,000 as part of the Housing and Economic Recovery Act of 2008. If the appraised home value exceeds this limit, the home value is assumed to be the HECM limit when the loan amount is calculated. Private mortgage lenders offer *jumbo reverse mortgage loans*, which allow borrowers to cash out more than the federal limit. However, borrowers have used jumbo reverse mortgages less and less often as the federal limit has been raised.

Reverse mortgage borrowers cannot receive the full amount of the house value (or the HECM limit if the house value exceeds it) because there are various costs that have to be paid from the house value as well. There are two types of costs: noninterest costs and interest costs. Moreover, if borrowers have outstanding mortgages, part of the new mortgage loan will be used to pay off the outstanding balance of other mortgages. Noninterest costs include an origination fee, closing costs, an insurance premium, and a loan servicing fee. The insurance premium depends on the value of the house and

how long the borrowers live and stay in the same house. More specifically, the insurance premium is 2 percent of the appraised value of the house (or the limit if the value is above the limit) initially and 1.25 percent of the loan balance annually.⁸ Interest costs depend on the interest rate, the loan amount, and how long the borrowers live and stay in the house. The interest rate can be either fixed or adjustable. In the case of an adjustable interest rate, there is typically a ceiling on how much the interest rate can go up per year or during the life of the loan.

In sum, the amount that homeowners can borrow, which is called the *initial principal limit*, is larger if (1) the house value is larger, (2) there is a lower (or zero) outstanding balance on other mortgage loans, (3) the borrower is older,⁹ and (4) the interest rate is lower. Figure 1 shows the distribution of the initial principal limit among government-administered HECM loans between 2003 and 2007, expressed as a percentage of the house value against which mortgage loans are borrowed. You can see that many homeowners can borrow around 60 to 70 percent of the appraised house value using reverse mortgages. If the term option is chosen, the total loan amount is divided depending on the number of times the borrowers receive cash.¹⁰ With the tenure option, the

⁸ In October 2010, the annual insurance premium was increased from 0.5 percent to 1.25 percent of the appraised value of the house, in response to the decline in house prices.

⁹ As long as all of the borrowers live in the same house, there can be multiple borrowers for a reverse mortgage loan. In this case, "age of the borrower" refers to the age of the youngest borrower.

¹⁰ To be more precise, the total amount of cash received will be adjusted because the total amount of interest and noninterest costs changes as the withdrawal schedule changes. Typically, borrowers receive the same cash amount each period.

amount of cash payment per period is determined by the number of times the borrowers are expected to receive cash.

REVERSE MORTGAGE LOANS BY THE NUMBERS

Since reverse mortgage loans first appeared in 1987, the number of households with reverse mortgages has grown. Figure 2 shows the proportion of home-owning households age 65 or older that had reverse mortgages between 1997 and 2009. Both government-sponsored and private mortgage loans are included. As you can see in the figure, the use of reverse mortgages was limited until around 2000. In 2001, the proportion of older (65 years old or above) homeowners who have reverse mortgages was about 0.2 percent. The proportion of households using reverse mortgages has increased rapidly since then, reaching 1.4 percent in 2009. Although the level (1.4 percent) is still low, the growth is all the more impressive if one considers that the popularity of reverse mortgages continued to rise even though the housing market and mortgage markets in general have been stagnating.¹¹

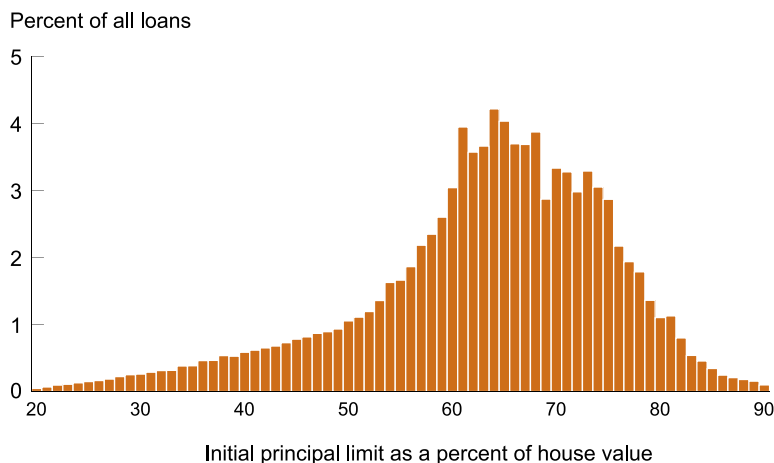
For comparison, Figure 3 shows how the popularity of HELOCs has changed over time. The popularity of HELOCs, as measured by the proportion of households with HELOCs, has moved with house prices (Figure 4 shows the average U.S. house price), rising from 1999 to 2005 but falling since 2007. The difference in the dynamics suggests that the popularity of reverse mortgages is driven not only by the growth in house prices but also by other elements. I will discuss some of these elements below.

Why did the use of reverse mortgages continue to rise even during the recession with the disappointing

¹¹ Later in this article I will discuss why the popularity of reverse mortgage loans remains so low.

FIGURE 1

Distribution of Initial Principal Limit of HECM Loans, 2003 - 2007

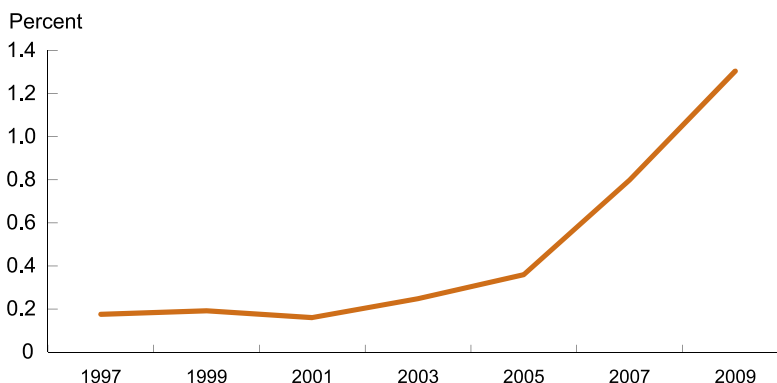


Source: Article by Hui Shan

Note: Only the government-administered HECM loans during 2003-2007 are included.

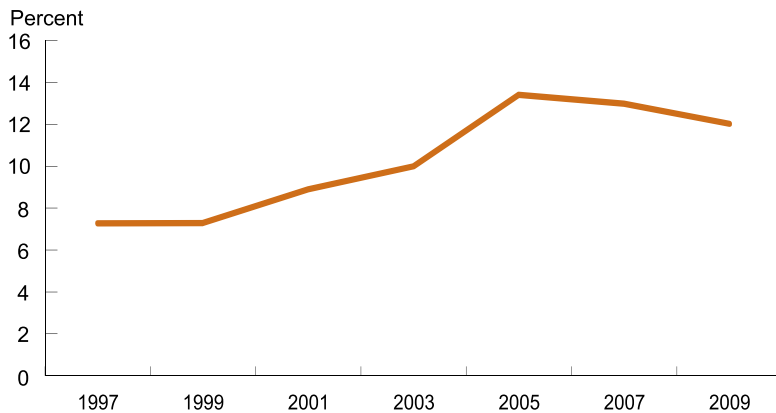
FIGURE 2

Percentage of Older Households with RMLs



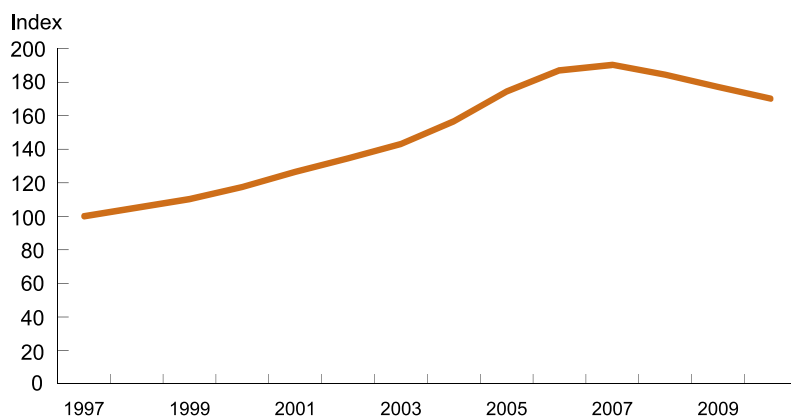
Data Source: American Housing Survey, various years

Note: Both public and private reverse mortgage loans are included.

FIGURE 3**Percentage of Households with HELOCs**

Data Source: American Housing Survey, various years

performance of the housing market? There are five possible explanations. First, the recession lowered the value of retirees' financial assets, especially their stock market investments, and these retirees had to tap home equity in the form of reverse mortgages. Second, the maximum amount that older households can take out using a government-administered reverse mortgage loan was increased in 2009. This change might have attracted more potential borrowers. Third, the continued increase in medical expenditures and other health-care costs after retirement has been pushing up the demand for financial instruments, such as reverse mortgages, that allow homeowners to cash out home equity. Fourth, more and more baby boomers have been retiring with relatively insufficient savings. Finally, more and more people have learned about reverse mortgages or got to know people who use reverse mortgage loans, both of which have made people more familiar with these financial products.

FIGURE 4**House Price Index for the U.S. (1997 = 100)**

Data Source: Federal Housing Finance Agency

Whether the strong growth in the reverse mortgage market will continue depends on what lies behind its strong growth so far. If the last three reasons are the main ones, we should expect reverse mortgages to continue to grow in the near future. In addition, the fact that people live longer and that the proportion of older people in the total population continues to get larger with the aging of the baby boomers also implies that it is likely that the reverse mortgage market will continue to grow, although the potential market size of reverse mortgage loans is still being debated. (See *Estimating the Market Potential of Reverse Mortgage Loans*.)

So now we have seen that the use of reverse mortgages has been increasing. But who is actually taking out reverse mortgages? Hui Shan looked at the characteristics of areas with more reverse mortgage borrowers and then investigated how those characteristics

Estimating the Market Potential of Reverse Mortgage Loans

S

ince the inception of reverse mortgage loans as a financial product, there has been a discussion of how large the potential market for reverse mortgages is. The question has been of interest to many people especially because the use

of reverse mortgage loans has been more limited than expected.* An intuitive way to estimate the potential market size of reverse mortgage loans is to count the number of households in the data that might be better off if they had access to reverse mortgages. One of the first such calculations was conducted by David Rasmussen, Issac Megbolugbe, and Barbara Morgan. Using 1990 U.S. census data, they argue that more than 6.7 million households age 69 or above (almost 80 percent of home-owning households age 69 and above) or 11.1 million of households age 62 or above could benefit from access to reverse mortgages. They compute this by counting households age 69 (or 62) or above with

home equity exceeding \$30,000 and without mortgage loans. Sally Merrill, Meryl Finkel, and Nandinee Kutty implemented a similar exercise with a more conservative set of assumptions. They counted the number of households age 69 or above with housing equity between \$100,000 and \$200,000, relatively low incomes of less than \$30,000 per year, and a strong commitment to stay in their current house (specifically, those who have not moved for the last 10 years), and that own their house free and clear. Merrill, Finkel, and Kutty concluded that the potential market size of reverse mortgage loans is rather limited, at about 0.8 million households, or about 9 percent of all homeowners over age 69.

The two estimates are very different. But even the lower estimate suggests that there might be a large potential for growth of the reverse mortgage market, considering that only 1.4 percent of home-owning households age 65 or above were using reverse mortgage loans in 2009.

* For example, until 1994, HUD had issued only 7,994 HECM loans, even though it was authorized to make 25,000 HECM loans, according to a HUD report published in 1995.

changed over time.¹² She found that areas with more reverse mortgage borrowers tend to have lower household income, higher house value, and relatively higher homeowner costs. These characteristics are consistent with the types of households that benefit most from taking out reverse mortgage loans. She also found that areas with more reverse mortgage borrowers tend to have lower credit scores. There are two possible explanations for this finding. First, as mentioned earlier, reverse mortgage loans do not require good credit scores. Relatively younger households that want to borrow against home equity but cannot qualify for HELOCs because of low credit scores

might end up using reverse mortgage loans. Second, borrowers with lower credit scores tend to have lower overall wealth and thus need to borrow against home equity. In terms of the demographic characteristics of reverse mortgage borrowers, Shan found that more singles (both male and female) are using reverse mortgages, compared with couples, and reverse mortgage borrowers tend to own houses of higher value. The median house value among reverse mortgage borrowers was \$222,000 in 2007, which was about 25 percent higher than the median house value of all older homeowners (\$175,000).

Shan also found that there have been some notable changes in terms of the characteristics of reverse mortgage borrowers over the past 20 years. In particular, reverse mortgage borrowers have always been older than those

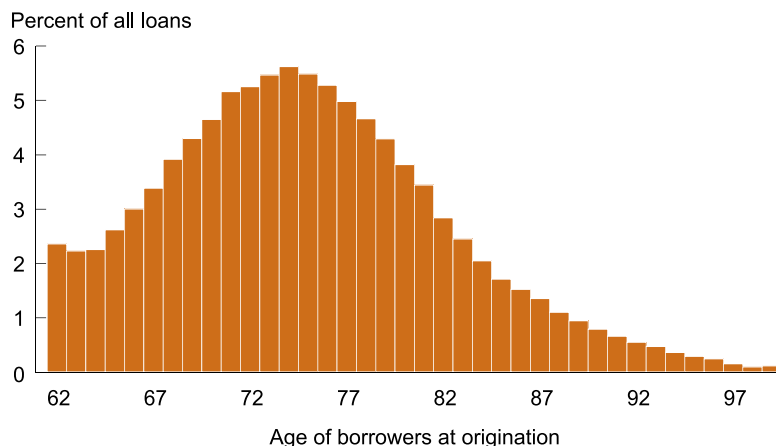
who did not take out reverse mortgage loans, but the gap has been closing as average reverse mortgage borrowers have been getting younger. For example, the average age of older homeowners in 1989 was 70, while the average age among reverse mortgage borrowers was 75. In 2007 the average age of reverse mortgage borrowers was 72, which was just one year above the average age of older homeowners (71). Figure 5 shows the age distribution of reverse mortgage borrowers who took out reverse mortgage loans in earlier periods (1989-2002) and in more recent periods (2003-2007). You can see that the distribution is shifting to the left, meaning more and more relatively younger households are taking out reverse mortgage loans. An interesting observation is that there is a spike at age 62 (the earliest age at which the federally administered reverse

¹² Marvin M. Smith provides a nontechnical summary of Shan's work in the Federal Reserve Bank of Philadelphia's *Cascade* (Spring/Summer 2010).

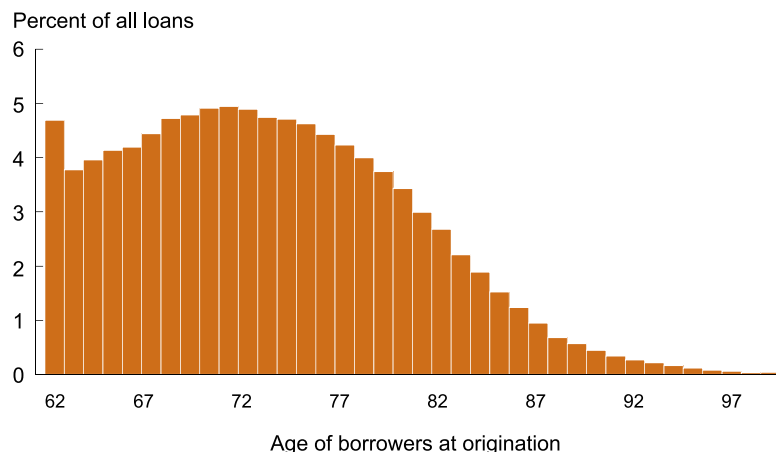
FIGURE 5

Age Distribution of Reverse Mortgage Borrowers

Early Loans (1989 - 2002)



Recent Loans (2003 - 2007)



Source: Article by Hui Shan

Note: Only the government-administered HECM loans are included.

mortgage becomes available) in both figures, and the spike has become more dramatic in recent years. This suggests that more and more households are “waiting” to reach age 62 so that they can take out reverse mortgage loans.

Remember the earlier discussion of the various ways to receive cash under a reverse mortgage. Which payment options are most popular? The line of credit option has been the most

popular by far. HUD reports that the line of credit plan is chosen either alone (68 percent) or in combination with the tenure or term plan (20 percent). In total, close to 90 percent of borrowers use the line of credit plan.¹³

¹³ Using data from 2007, Shan also reports that 82 percent of borrowers choose the line of credit plan. In Shan’s sample, only 10 percent choose the tenure or modified tenure plan.

It seems that older homeowners use reverse mortgages mainly to flexibly withdraw cash out of accumulated home equity.

THREE POTENTIAL BENEFITS OF REVERSE MORTGAGE LOANS

Now let’s analyze the benefits and costs of reverse mortgage loans using economic intuition, starting with benefits. First, when other, more conventional mortgage loans are not easy to obtain, reverse mortgages provide a way for older homeowners to cash out home equity without leaving their home. Alternatively, older homeowners can cash out their home equity by either selling their home and downsizing (moving to a smaller and cheaper house) or becoming renters. However, research shows that is not what most older homeowners want. The study by Steven Venti and David Wise shows that most older households do not move unless some catastrophic event occurs (such as the death of a spouse or a sharp deterioration in health) and they are forced to move out. Another study by the AARP (formerly, the American Association of Retired Persons) found that 89 percent of surveyed Americans over 55 years of age reported that they want to remain in their current residence as long as possible. Figure A in the box on page 26 shows the homeownership rate among older households, taken from my working paper with Irina Telyukova (2011a). (For more details, see *Financial Situations of Older Households*.) You can see that the homeownership rate declines as households age, but slowly. Considering this evidence, cashing out home equity using reverse mortgages while staying in the same house offers substantial benefits over the alternatives of moving to a smaller house or becoming a renter.

Second, reverse mortgages provide insurance against a decline in house

Financial Situations of Older Households

I

n a working paper (2011a), Irina Telyukova and I organized the facts about the financial situations of older U.S. households, using a rich data set called the Health and Retirement Study (HRS). To keep track of the same households over

time, we looked at six groups of households — those age 65, 70, 75, 80, 85, and 92 in 1996 — and kept track of the financial situations of these six groups between 1996 and 2006. Below is a summary of our findings.

About 90 percent of households at age 65 are homeowners (Figure A). The proportion declines as households age, but it remains at around 50 percent for households at age 90. A large fraction of the decline is caused by two-adult households becoming one-adult households, possibly because of the death of a spouse. About 80 percent of two-adult households remain homeowners even at age 90.

Older households also consistently reduce borrowing as they age. Figure B shows the proportion of households with secured debt, mainly home mortgages and other types of borrowing against home equity. The proportion declines with age; for example, among households that are age 90, only about 3 percent hold a positive balance of unsecured debt. If they cannot borrow even though they want to, reverse mortgage loans can potentially be beneficial for those households.

Figure C shows the proportion of households with unsecured debt, mainly credit card debt. The proportion also decreases consistently with age. About 5 percent of homeowners hold a positive balance of credit card loans.

Figure D exhibits how financial asset holdings among older households change as the households age. The figure shows that median older house-

holds, especially in the later part of life, reduce their holdings of financial assets. The figure also shows that younger households seem to have experienced some increase in their financial assets. This could be due to booms in stock and housing prices during the period 1996-2006. While households in retirement tend to reduce their holdings of financial assets, the gains from strong markets overwhelmed the gradual reduction of these households' financial assets.

Figure E looks at the median housing asset holdings. Median housing assets increased for most groups, but a large part of the increase was due to rising house values during the period we are looking at.

FIGURE A

Homeownership Rate

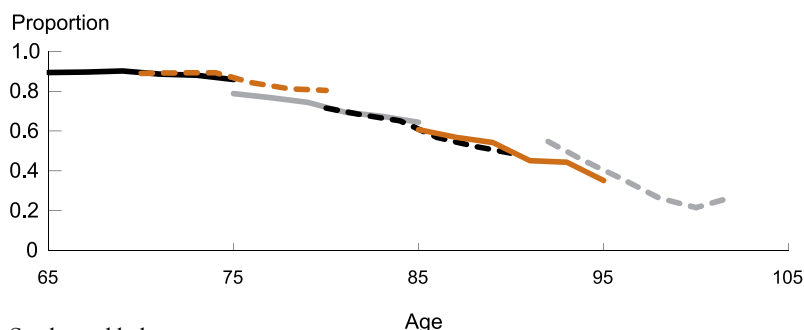
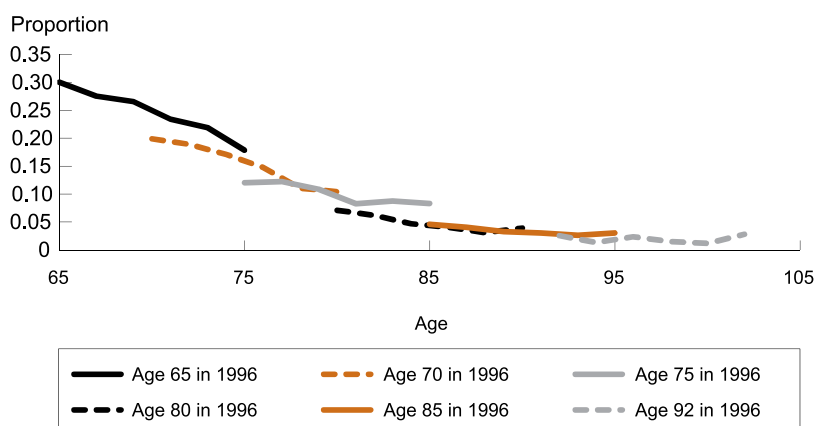
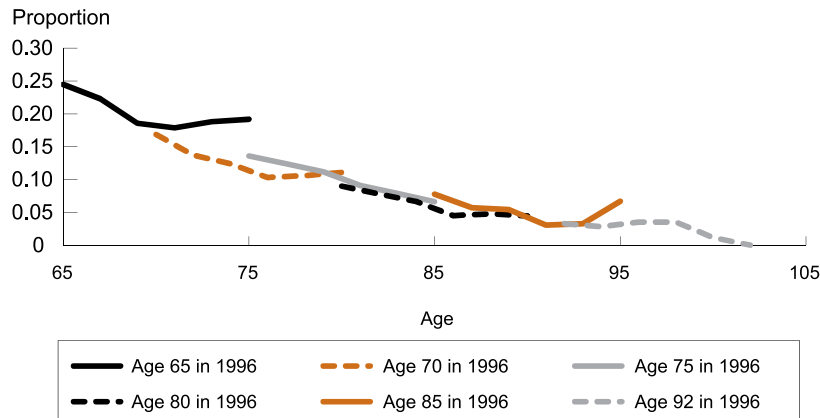
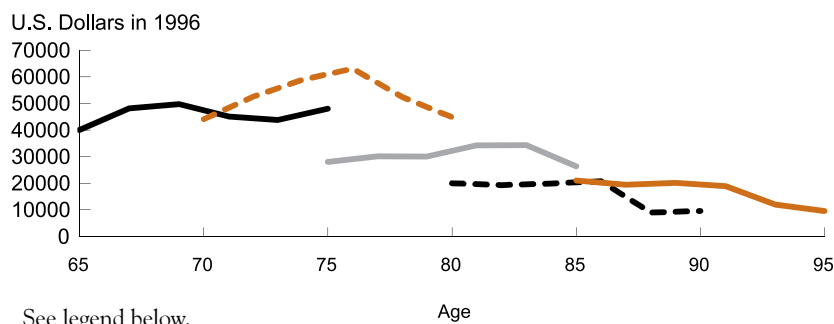


FIGURE B

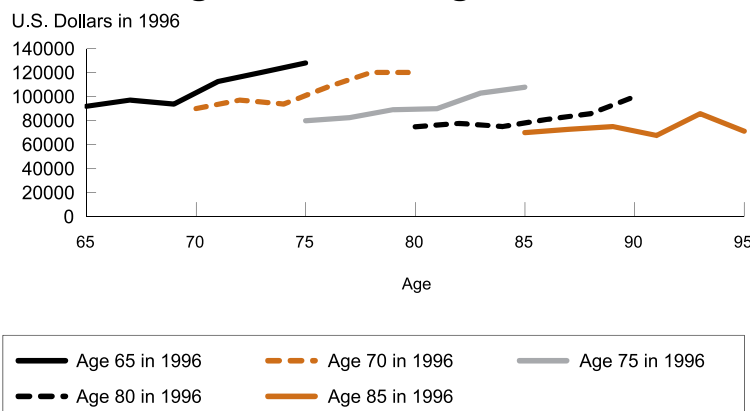
Proportion of Households with Secured Credit



Data Source: Health and Retirement Study, various years

FIGURE C**Proportion of Households with Unsecured Credit****FIGURE D****Median Financial Asset Holdings**

See legend below.

FIGURE E**Median Housing Asset Holdings**

Data Source: Health and Retirement Study, various years

value, at the cost of an insurance premium. The insurance does not cover a small decline in house value in the sense that reverse mortgage borrowers do not benefit from the insurance as long as the selling price of the house when the loan is due still covers the loan amount and all the costs; in that case, the borrowers just receive less cash when the loan is due. However, in a case where the selling price turns out to be so low that it is insufficient to cover the loan amount and the costs, the reverse mortgage borrower is not obliged to pay the gap. The gap is paid by the insurance that is a part of HECM loans. Currently in the U.S., because of the recent sharp drop in house prices, many homeowners are caught in a situation where the value of their house is lower than the total amount of mortgage debt or the HELOC borrowed against the house (this situation is called negative home equity). They cannot sell their house without paying the difference between the amount of debt and the house value with cash or by foreclosing. Under these circumstances, reverse mortgage borrowers benefit from the insurance feature because reverse mortgage borrowers are protected from negative home equity.

Third, reverse mortgage loans provide insurance against longevity risk when the tenure option is used. Under the tenure option, reverse mortgage borrowers do not need to worry about outliving the loan because borrowers can keep receiving payments no matter how long they live. In this sense, the tenure option is similar to the Social Security system with defined benefits, providing an annuity and relieving borrowers from the concerns of outliving their savings. Since not many reverse mortgage borrowers actually use

this option, this benefit might not be that important. Is the limited use of the tenure option due to low demand by reverse mortgage borrowers or due to the high costs associated with it? This is an open question.

THREE POTENTIAL DISADVANTAGES OF REVERSE MORTGAGE LOANS

Of course, reverse mortgages are not without problems. First, reverse mortgages might discourage saving and thus hurt older homeowners who discover that they did not save enough. If households can always save exactly the amount they need in the future, there is no such problem. But can all households do so? Research by David Laibson says no. Laibson argues that people tend to have self-control problems and cannot save as much as they need. An illustrative example of such a problem is quitting smoking. People might think they can smoke today but they will quit tomorrow. But when tomorrow comes, they tend to think in the same way: They can smoke today and quit tomorrow. In the current context, households think they can spend today but start saving tomorrow. But when tomorrow comes, they might think in the same way: Spend today and postpone saving one more day, and so on. In such a situation, Laibson argues, illiquid assets (in the sense that they are costly to sell or withdraw) such as housing or retirement plans (individual retirement accounts [IRAs], 401(K), etc.) give people a way to commit to saving. They are like a piggy bank: Once you put cash into it, it is not easy to get the cash out. Basically, people can force their future selves not to withdraw money and thus save.

However, under these circumstances, flexible mortgage instruments such as reverse mortgage loans work to undo the piggy bank role of housing and thus could hurt people. People could commit to saving by purchasing

a house because it is not easy to sell the house. However, this commitment to saving is not effective if it is easy to cash out one's home equity using reverse mortgages. It is still costly to sell the house to get cash, but by using a reverse mortgage loan, one can cash out flexibly without selling the house. So reverse mortgages are like

mortgage loans come with another kind of risk for borrowers: moving out of the house too soon. Since reverse mortgage loans require relatively large upfront costs, borrowers suffer if they have to move out of their house shortly after taking out a reverse mortgage and before fully enjoying its benefits. In a sense, when taking out a reverse

Reverse mortgages help borrowers reduce various kinds of risks, such as the risk of a decline in house prices, but at the same time, reverse mortgage loans come with another kind of risk for borrowers: moving out of the house too soon.

a big hole in the piggy bank. In this sense, reverse mortgage loans could hurt (relatively young) older homeowners by making it easy for them to cash out home equity. (Relatively old) older homeowners might end up having insufficient savings because it was easy for them to cash out home equity using reverse mortgages when they were (relatively) younger.¹⁴ The age limit for government-administered reverse mortgage loans (62) and the requirement that to be eligible for reverse mortgage loans households must own their house with little or no outstanding mortgage balance can prevent such dissaving through reverse mortgage loans to some extent, but as people live longer and longer, the problem becomes more and more serious.

Second, reverse mortgages help borrowers reduce various kinds of risks, such as the risk of a decline in house prices, but at the same time, reverse

mortgage, borrowers are betting that they will live in the same house long enough to benefit from the reverse mortgage, and naturally, some borrowers end up losing the bet. In her recent working paper, Valentina Michelangeli argues that this is the main reason, regardless of all of the benefits of reverse mortgage loans listed earlier, only a small number of eligible households are actually using reverse mortgages; the risk of moving out too soon is too large even with all the benefits reverse mortgages offer to borrowers.

Third, reverse mortgage loans could exacerbate moral hazard problems, as analyzed by Thomas Davidoff and Gerd Welke. Moral hazard, in general, refers to a situation in which a person insulated from risk does not take responsibility for the consequences of his actions and, therefore, has a tendency to act less carefully than he otherwise would. A typical example is an insured driver who drives carelessly because he is insured in case of an accident. With reverse mortgages, since borrowers are insured against the risk of a decline in house prices, the sale price of the house does not affect reverse mortgage borrowers if it

¹⁴ At the same time, people might be discouraged from saving as much as they would like because it is costly to sell a house or cash out home equity. In this case, reverse mortgages play a positive role in reducing such costs and encouraging saving.

is not enough to cover the total loan amount and all the costs of the reverse mortgage loan. In this case, how well reverse mortgage borrowers maintain a house will not affect how much they gain, which is zero anyway. At the end of the day, borrowers might not maintain the house (and therefore the house's value). However, the poor maintenance is not a direct problem from the perspective of reverse mortgage borrowers (because they don't suffer from it), but this problem might hurt reverse mortgage borrowers indirectly, since poor maintenance yields a lower selling price, and the government, in response, has to raise the cost of reverse mortgage loans to cover the lower price. In addition, the poor maintenance of the house might be a cost to society as well.

WHY ARE SO FEW PEOPLE USING REVERSE MORTGAGES?

One important question surrounding reverse mortgages is: why are only 1.4 percent of households using them, when even a conservative estimate of the proportion of older households that could benefit from access to reverse mortgage loans is 9 percent? (See *Estimating the Market Potential of Reverse Mortgage Loans*.) One possible answer is that the problems with reverse mortgages, especially the fear of moving out of one's house too soon after taking out a reverse mortgage and the high costs, outweigh their benefits, and thus not many households actually want reverse mortgage loans.¹⁵ Another possible answer is that many households that could benefit from reverse mortgages don't know about them. Let me introduce three more explanations for the limited use of reverse mortgages.

¹⁵ A self-control problem might actually work to increase the popularity of reverse mortgage loans because households cannot resist the urge to use reverse mortgages according to the hypothesis.

First, older households may want to leave wealth — of which housing is a large part — as a bequest. Older households may not use reverse mortgages possibly because having a reverse mortgage may make it harder to include a house as part of a bequest. However, there are studies, including the one by Michael Hurd, that have found that people's desire to leave a bequest is not strong, except for very wealthy households.¹⁶

Second, households may be worried about large medical expenditures and may want to keep their housing to pay for such expenditures in the future. Mariacristina De Nardi, Eric French, and John Jones found that older households want to keep wealth (and thus do not want to use reverse mortgages) because they expect to incur large medical expenditures, es-

News stories such as those that involve an older household being tricked into taking out a reverse mortgage to pay hefty costs for home repairs also play a role in strengthening older households' aversion to reverse mortgage loans.

pecially toward the end of life.¹⁷ This implies that when households actually need to cash out their home equity, they will not use reverse mortgages because they need immediate cash and probably do not expect to stay in their current house very long. On the other hand, reverse mortgages could help households that need to pay large medical bills by allowing them to pay the bills and still remain in their home.

¹⁶ In my working paper with Irina Telyukova (2011b), we investigate the importance of this and other hypotheses of why the take-up rate of reverse mortgage loans is so low.

¹⁷ Naturally, they focus on out-of-pocket medical expenditures, which are the uninsured portion of medical expenditures.

Therefore, medical expenditures could increase or reduce the popularity of reverse mortgages.

Third, Andrew Caplin emphasizes psychological elements. According to him, many older households might simply be reluctant to take on debt. Or some households may fear that a medical problem will keep them away from home for a lengthy period of time, in which case the reverse mortgage may become due and they have to vacate their house. The genuine risk of losing their house under these circumstances scares older households away from reverse mortgages, no matter how large the benefits are.¹⁸ Moreover, news stories such as those that involve an older household being tricked into taking out a reverse mortgage to pay hefty costs for home repairs also play a role in strengthening older households'

aversion to reverse mortgage loans.

In my working paper with Irina Telyukova (2011a), we show that between the 1990s and the 2000s, during which time the reverse mortgage market was expanding, older households did not reduce their wealth much as they aged. (See *Financial Situations of Older Households* for more details.) At first sight, this evidence suggests that they do not need to extract home equity using reverse mortgage loans. How-

¹⁸ Remember that borrowers have to live in the house, pay property taxes in a timely fashion, and maintain the house properly in order to keep using a reverse mortgage. If borrowers are out of the house for an extended period, this could make the reverse mortgage become due and force the borrowers to vacate the house.

ever, we argue that it might be partly because the housing and stock markets were both in good shape during that period, which reduced the need to tap in home equity. If that is the case, the demand for reverse mortgage loans will keep growing if the housing market stagnates further and the stock market cannot compensate for the lackluster performance of the housing market.¹⁹

CONCLUSION


In this article, I described reverse mortgage loans and shed some light on their economic benefits and costs. An important question surrounding reverse mortgages is how large the market for them will become. Since the take-up rate of reverse mortgage loans increased between 2000 and 2009, coinciding with the housing boom, and since there are signs that the growth in reverse mortgage loans may be slowing down, it is hard to answer questions about the long-term potential

¹⁹ On the other hand, if house prices are not consistently increasing, reverse mortgage loans become riskier for mortgage lenders. In that case, mortgage lenders either need to increase the costs of reverse mortgages to cover the risk or eventually get out of the business.

of reverse mortgages. In this article, I have argued that reverse mortgage loans have the potential to be beneficial for older households in the long run. As reverse mortgage loans become a standard tool for older households to extract home equity, it becomes even more important to understand the pros and cons of this financial instrument, not only for making sound decisions in terms of personal finances but also for understanding why public resources are used for the market. As I discussed, the government-administered reverse mortgage loans (HECM loans) have more than 90 percent of the market share, according to a recent study. The government regulates the terms of HECMs and subsidizes the loans. Moreover, the government insures against the risk of substantial drops in house prices for reverse mortgage borrowers by imposing an insurance premium.

Do we really need such extensive government involvement in the reverse mortgage market? This question is important, since the government's support for reverse mortgage loans is ultimately financed by taxpayers. There are two ways to look at the role

of reverse mortgages from a policy perspective. One way is to understand the government's involvement in the reverse mortgage market as part of the public support for homeownership.²⁰ Although the government has been supporting homeownership through various measures, this support is being re-examined in the wake of the financial crisis, which was partially triggered by the decline in house prices and the subsequent slow economic recovery. The government's role in the reverse mortgage market will naturally be re-examined in the same context.

Another way to understand government's support of reverse mortgage loans is to consider it as part of the support for life after retirement, similar to Social Security payments; taxpayers are supporting older households indirectly through reverse mortgage loans. Ultimately, whether and how the government should remain a key player in the reverse mortgage market is an open question. 

²⁰ The *Business Review* article by Wenli Li and Fang Yang discusses a variety of government programs to promote homeownership.

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Recent Developments in Consumer Credit and Payments*

BY MITCHELL BERLIN

On September 22-23, 2011, the Research Department and the Payment Cards Center of the Federal Reserve Bank of Philadelphia held their sixth joint conference to present and discuss the latest research on consumer credit and payments. Eighty-four participants attended the conference, which included seven research papers on the role of home equity in the decision to move to a new job; credit supply and house prices; legally mandated removal of credit remarks; policies to prevent mortgage default; adoption and use of payment instruments by U.S. consumers; liquidity constraints and consumer bankruptcy; and credit supply to bankrupt consumers. In this article, Mitchell Berlin summarizes the papers presented at the conference.

In her welcoming remarks, Loretta Mester, executive vice president and director of research at the Philadelphia Fed, noted that the recent financial crisis has uncovered a range of new issues related to household finance and payments and, further, that the Federal

Reserve System has taken on a menu of new responsibilities. She stressed that the long-term research typified by the papers presented at the conference is an essential input into good regulatory policy.

Mester highlighted the variety of research approaches represented in the conference program and stressed the possibilities for integrating the various approaches. In particular, she said

*The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. Links to most of the papers presented can be found on the Philadelphia Fed's website at: <http://www.philadelphiafed.org/research-and-data/events/2011/consumer-credit-and-payments/agenda.cfm>.

that the program included macroeconomic structural models that bring new perspectives that complement the findings of microeconomic studies of consumer credit. Mester argued that, in exchange, the microeconomic studies enrich the macro structural models, which rely on the parameter estimates for their calibration exercises.

Furthermore, she found the extensive use of large micro data sets in a number of the papers striking. The Philadelphia Fed has taken a leading role in managing these large data sets. In particular, the Philadelphia Fed administers RADAR,¹ a data warehouse that serves the Federal Reserve System.

HOUSE PRICES AND JOB SEARCH

In the first paper of the day, Yuliya Demyanyk, of the Federal Reserve Bank of Cleveland, reported on a study (with Dmytro Hryshko, Maria Jose Luengo-Prado, and Bent Sorensen) of the relationship between the decline in house prices and individuals' willingness or ability to move to seek employment. She emphasized that the results were very preliminary and that the audience should view them as provisional. During the recent recession, the record decline in housing prices was cited as one of the reasons for stubbornly high unemployment rates, a view that has generated conflicting reactions in the economic literature. Some economists have argued that households with negative equity have been unable to search for work in more distant labor markets because they are

¹ Risk Assessment, Data Analysis, and Research.



Mitchell Berlin is a vice president and economist in the Research Department of the Philadelphia Fed and head of the Banking and Financial

Markets section. This article is available free of charge at www.philadelphiafed.org/research-and-data/publications/.

unable to sell their houses without defaulting. Demyanyk and coauthors did not find much evidence for this view.

The authors presented results using two methodologies. The first used regression techniques and anonymized data sets from credit bureaus. The second used a calibrated macroeconomic model.

Demyanyk and coauthors' empirical approach was to use regression methods to estimate how the probability of moving was affected by local unemployment rates and households' home equity. Specifically, Demyanyk argued that if the likelihood of moving from a poorly performing local labor market was lower for households with lower home equity, this would be evidence of a *lock-in* effect. The researchers estimated the probability of two different types of moves separately: moves to a different county within the same state and moves to a different state. Although either type of move might be associated with changing jobs — the actual employment outcome cannot be directly observed — Demyanyk argued that moves to a different state were more likely to involve movement to a different labor market.

The researchers performed regressions using two different data sets, each with its own advantages and disadvantages.² The first data set merged information from one of the credit reporting agencies (TransUnion) with a separate source of mortgage-loan-level data. The disadvantage of this merged data set is that it is not fully representative; the sample is dominated by subprime homeowners, and as result, prime borrowers are underrepresented and renters aren't included at all. The advantage, however, is that this data set permits the authors to estimate households' home equity with some

precision. Demyanyk presented results from a 10 percent subsample of the whole data set at this conference.

The second data set that Demyanyk and coauthors used is from the New York Fed's Consumer Credit Panel, a 5 percent sample of all consumers in the Equifax credit files from 1999-2011. The authors selected a random subset of those consumers and

ously, the researchers found that in somewhat stronger local labor markets (positive employment growth), moves both to another county or to another state were less likely for households with negative equity than for households with positive equity.

For the Equifax data set, the authors found no significant effect for rising or falling house prices on the

The long-term research typified by the papers presented at the conference is an essential input into good regulatory policy.

included in their data members of the same household as those consumers.³ This data set included both prime and subprime homeowners and renters and was thus more nearly representative of households in the nation. But the authors could not directly estimate a household's home equity using this data set. Instead, they used whether local housing prices were rising or falling as a proxy for high or low home equity.

The authors' preliminary conclusion was that there is not much evidence for lock-in effects on the basis of their regression results. For the TransUnion data set, the authors found that in weak local labor markets (negative employment growth), moves to another county were less likely for households with negative equity than for households with positive equity, but moves out of state were more likely for households with negative equity. If the authors' argument that out-of-state moves are more likely to require moving to change jobs is correct, this result is inconsistent with the view that households are locked-in by negative equity. Somewhat more ambigu-

probability of moving either outside the county or outside the state. While Demyanyk said that this offers no evidence for lock-in, she recognized that rising or falling housing prices in a locality are a very noisy indicator of a household's home equity.

Demyanyk also offered some very preliminary findings from the study of a calibrated macroeconomic model, which she viewed as a way of providing more insight into the precise mechanisms through which housing shocks might affect moving to find a job. The model explicitly included the possibility of unpredictable declines in regional wage income and declines in house prices and also included the possibility of moving to seek a new job in response to both local and distant job offers. The authors conducted an experiment in which some regions experience a housing price decline, some a housing price increase, and some experience no change.

The model generated results broadly consistent with Demyanyk and coauthors' regression findings. They found that unemployed households moved whether or not housing prices had appreciated or fallen and that households with negative equity were more likely than other borrowers to take a distant job.

² Note that all the data used by the authors were anonymized. The data sets contain no personally identifiable information.

³ In this data set, household members are defined as consumers ages 25-66 with the same address as an individual included in the 5 percent sample.

EASY CREDIT AND HOUSE PRICES

Manuel Adelino, of Dartmouth College, reported the results of a study (with Antoinette Schoar and Felipe Severino) that provided evidence that easy credit led to higher home prices during the housing boom. Adelino explained that it is difficult to establish the direction of causality when we observe easier credit terms and rising housing prices. While the rise in house prices might have been caused by easier credit, rising prices may create expectations that house prices will continue to rise, thus making larger mortgage loans appear less risky to lenders.

From the researcher's standpoint, the difficulty is to find some factor that affects credit terms without directly affecting house prices. Then if changes in this factor are associated with changes in house prices, the channel arguably flows through its effect on the availability of credit. The authors' approach was to examine the effects of changes in conforming loan limits during the period of rapidly rising home prices.⁴ The authors argue that while the conforming limit was relaxed to reflect rising average home prices in the nation, there is substantial variation in both the level and rate of growth in house prices across local markets. Thus, changes in the conforming loan limit were unlikely to be driven by conditions in any one local market. In formal terms, Adelino and coauthors argue that the loan limits are plausibly exogenous with respect to local housing markets.

Adelino explained that the underlying assumption of their research design is that borrowing is significantly

less costly for loan-to-value ratios below 80 percent. That is, a house whose price is just above 125 percent of the conforming loan limit is significantly more costly to finance than an essentially identical house that is just below 125 percent of the conforming loan limit.

The authors used data from home sales for 10 MSAs over an 11-year period (1998-2008), which includes the housing boom years. In addition to the date of sale, the address of the property, and the sale price, the data set included a number of characteristics that affect the quality — and, potentially, the price — of the house, e.g., the number of rooms, the number of bathrooms, and the age of the house, among other characteristics.

Adelino described the logic of the authors' research design as follows. Imagine a home that was sold for slightly *less than* 125 percent of the conforming loan limit in 1999. Now, imagine that a very similar home in

the only material difference between those two homes is that the second one could be purchased with lower-cost financing due to the increase in the conforming loan limit.

Using a difference-in-difference approach, the authors compared the difference between the sale prices of the first two homes described above to the difference in the sale prices of the second two homes. They hypothesized that since more potential borrowers would qualify to buy the more expensive home in 2000 than in 1999, demand for such homes would increase. Thus, the sale price of those homes would tend to rise; in particular, it should rise more than the sale price of homes that were initially (and that remained) less expensive than the conforming limit.

Indeed, this is what they found in their main regression: If two houses were sold in subsequent years in the same zip code, the value per square foot was \$1.10 lower for the house with

From the researcher's standpoint, the difficulty is to find some factor that affects credit terms without directly affecting house prices.

the same neighborhood sold in 2000 and that the conforming loan limit had risen during the year. Although other factors may explain the difference between the prices of these two very similar homes, the change in the conforming limit would not, since it was not binding for either home in either year.

Now, imagine another pair of very similar homes in the same neighborhood. The first was sold for slightly *more than* 125 percent of the conforming loan limit in 1999. The second was sold in 2000, again for more than 125 percent of the 1999 conforming loan limit, but for less than the actual conforming loan limit in 2000. Thus,

a price above the cutoff in the earlier year. Furthermore, the effect was stronger in the earlier part of the period (1998-2001). According to the authors, this finding was consistent with their hypothesis, because the conforming loan limit became less important as households' access to second liens and to jumbo loans in the latter part of the sample period lowered financing costs.

In addition to their main regressions, in which the researchers controlled only for house size and neighborhood, they also ran regressions taking into account other factors that might affect the house's price. In particular they estimated hedonic regressions, in which the house price (or,

⁴ Only loan sizes above the conforming loan limit can receive guarantees from the GSEs. In addition to the value of the guarantee against default, the market for mortgage-backed securities composed of conforming loans is much deeper than for nonconforming loans.

alternatively, house value per square foot) was broken down into two parts: one part that can be explained by a host of observable characteristics, e.g., the number of rooms and bathrooms, among other factors, and another part that can't be explained by these characteristics, the *residual*. Using this residual as an alternative measure of home value, they found that value per square foot was \$0.65 lower if the house price was above the cutoff. In light of this finding, Adelino argued that unmeasured quality differences among houses were not likely to be the explanation for their main results.

The authors also found that the effect of being above the cutoff was stronger in those zip codes in which household income growth was negative. They argue that in such localities, households are more likely to be credit constrained, strengthening the argument that it is changes in the cost of credit that drive their results.

SHOULD CREDIT REMARKS BE FORGOTTEN?

Marieke Bos, of the Swedish Institute for Social Research, discussed the results of her study (with Leonard Nakamura) of the effect of legal mandates to drop credit remarks from individuals' credit files after a specified period of time. The study's main conclusion was that creditworthiness and access to credit increased when credit remarks were removed and that, for most consumers, the effects were long-lasting. Bos emphasized that her results were preliminary. She explained that while 90 percent of the 113 countries with credit bureaus do expunge credit remarks after some period of time, the amount of time varies significantly. In Sweden, credit remarks are removed after three years.⁵

⁵ In the U.S., reported delinquencies are expunged after seven years and bankruptcy filings after 10 years.

To help motivate her empirical work, Bos cited Ronel Elul and Piero Gottardi's (2011) model of the optimal policy for "forgetting" a default. In that model, expunging credit remarks increases the likelihood that an individual will make risky decisions prior to

and that both applications for credit and access to credit increased. The improvements in credit scores were most striking for those individuals with credit scores in the middle range before the derogatory credit remark was removed. Loan applications increased

The study's main conclusion was that creditworthiness and access to credit increased when credit remarks were removed and that, for most consumers, the effects were long-lasting.

defaulting, but once an individual has actually defaulted, forgetting improves his or her subsequent incentive to make prudent decisions. The optimal time to forgetting balances these two forces.

Prior empirical research by David Musto on the effects of removing a bankruptcy flag from credit files in the U.S. yields pessimistic results. In Musto's sample, individuals' access to credit improves when the bankruptcy flag is removed but most of those consumers subsequently experience declines in creditworthiness. In contrast to Musto's focus on removing bankruptcy flags, Bos and Nakamura focus on removing credit remarks, which, Bos argued, could easily arise from an oversight, a legal dispute, or more generally, from temporary factors outside the individual's control.

Bos and Nakamura's data set includes the credit files for individuals in Sweden for a six-year period, from February 2000 to October 2005. First, the authors examine the outcomes for individuals who had a remark removed (the *removal group*) compared with all individuals without a credit remark during the sample period.

Focusing first on the short-term effects of removing the credit remark, the authors found that individuals' credit scores improved significantly

just prior to removal of the remark for many borrowers — which, Bos suggested, might reflect individuals' uncertainty about the precise timing of removal — and remained high.

The authors then turned to longer-run outcomes. Bos noted that in contrast to Musto's findings, the initial improvement in credit scores for most consumers was not reversed in the longer term. She and Nakamura also found that removal led to a long-term increase in both applications for credit and access to credit. Furthermore, while the likelihood of delinquency was substantially higher for this group than for other individuals, the delinquency rate was not very high.

The results described so far are based on a comparison of outcome variables for consumers before and after a derogatory credit remark is removed. Bos noted that such a comparison is not a natural experiment that might isolate the effects of removing the derogatory credit remark from other time-varying factors that might affect individuals' outcomes. Nor can a true natural experiment be constructed. Instead, the authors compared the outcomes of the removal group with the outcomes for a control group of individuals, similar to the removal group. Specifically, the authors used the propensity score matching technique to

identify individuals who were similar to the removal group at the time the remark was removed.

Bos and Nakamura compared the change in various measures of creditworthiness and credit availability at different time horizons for the removal group and the control group. Relative to the pattern for the control group, they found that among members of the removal group, credit scores improved immediately after the removal of the derogatory remark and that the boost in creditworthiness lasted up to two years. Loan applications increased immediately prior to removal, and there was a differential effect of up to three and a half years. They also found that various measures of access to credit increased with removal. Following an initial decline, which the authors argue reflects a lag between applications for credit and the receipt of funds, the number of loans increased, as did credit limits and outstanding balances, for up to 30 months. The average increase in outstanding credits was SEK 21,000 (about \$3,100), a large increase.

The authors then considered default behavior over time. They found that the removal group had a significantly higher probability of delinquency than other individuals; up to 24 percent of the removal group was delinquent after 36 months, compared with 9 percent among the individuals with no remark and 11 percent among the matched sample. Nonetheless, the likelihood of subsequent delinquency was significantly lower than that found in Musto's sample.

HOUSING PRICES AND DEFAULT

Leonardo Martinez, of the International Monetary Fund, explained the results of a macroeconomic modeling exercise (with Juan Carlos Hatchondo and Juan Sanchez) that focused on the implications of housing price risk for household behavior.

Among other things, they used the model to examine the effects of minimum down payment restrictions and laws that permit lenders to garnish the income of defaulting homeowners.

Martinez explained that in their model, households have limited opportunities to hedge against declines in their labor income or to sudden

sions about how big a house to buy, how much money to put down, etc. That is, households can *self-insure*.

The authors used calibration techniques to fix the model's parameters. They chose a number of the model's parameters, for example, households' aversion to risk and the correlation between house prices and personal

The main innovations of this paper were to include a realistic long-term mortgage contract and to allow the major contract terms, e.g., interest rates and down payments, to arise endogenously through supply and demand in a competitive market.

declines in housing prices. Although other researchers have examined similar models with and without explicit housing decisions, the main innovations of this paper were to include a realistic long-term mortgage contract and to allow the major contract terms, e.g., interest rates and down payments, to arise endogenously through supply and demand in a competitive market.

In their model, households can decide to either buy or rent — by assumption, renting is intrinsically less attractive than buying for all households — and households take out long-term fixed-rate mortgages to finance their home purchases. Mortgages can be refinanced and households may default. In the model, households make all decisions knowing that their future wage income or house prices might rise or fall in any period. Households know how income and house prices move together on average, but they can't predict precisely what will happen in any particular period. Even though the authors assume that households can't purchase explicit insurance against declines in labor income or house prices, they can protect themselves through prudent savings decisions, their deci-

income, from the existing literature. Then authors chose values for the remaining model parameters with the goal of matching three targeted factors that can be measured from published data: the average house-price to income ratio, the median net-worth to income ratio, and the homeownership rate from the 2004 Survey of Consumer Finances.

The authors then simulated the fully calibrated model to see how closely it could match certain empirical features of housing markets. Martinez reported that the model was relatively successful in matching the distribution of down payments across the population of homeowners, as well as the homeownership rates for households of different age groups. The model's ability to match these factors with some accuracy provides a rationale for viewing the model as a useful representation of the real world.

Next, the authors examined how successfully households could self-insure in a world where income might fall without warning precisely when house prices are also falling, a potential disaster in a world in which households prefer to avoid risk. Despite

households' lack of explicit insurance opportunities in the model, the authors found that households were able to self-insure just as well in a model economy with housing risk as they were in an otherwise identical model economy without housing.

Martinez and his coauthors then used their model economy to analyze the effects of two policy experiments. In the first, they examined the effect of imposing a 20 percent down payment requirement for all mortgages. They found that this policy had only a modest effect on homeownership rates and led to a reduction in default rates and interest rates. While higher down payments reduced the well-being of renters and younger households, who were forced to wait longer to purchase a home, the authors argue that most households would gain from such a policy.

The second policy allowed lenders to garnish defaulting households' income above some predetermined floor. They modeled garnishment in a stylized way: Households can make binding pledges of future income to service debts without imposing large collection costs on lenders. This policy increased homeownership rates, reduced default rates, and lowered mortgage rates. Martinez suggested that this policy would be welfare-enhancing for nearly all households. Unlike a policy of minimum down payments, this policy increased the availability of mortgage credit for younger households who might not have sizable enough savings to make a down payment.

THE ADOPTION AND USE OF PAYMENTS INSTRUMENTS

Scott Schuh, of the Federal Reserve Bank of Boston, presented results from a study (with Sergei Koulayev, Marc Rysman, and Joanna Stavins) of the adoption and usage patterns of payments instruments — e.g., cash, check, and debit, among others — by

U.S. consumers. Schuh emphasized that the results were preliminary. He explained that payments systems are changing rapidly and that we know relatively little about what an optimal payments system might look like. Nonetheless, policymakers are making regulatory decisions that have an impact on the payment choices of consumers.

The authors estimated a structural model of consumer decision-making that explicitly separates adoption decisions (“Do I open a credit card account?”) and usage decisions (“Do I use credit or debit to buy this TV?”). This permitted the authors to analyze how households might respond to market-driven or regulatory changes that affect the cost or usefulness of various payment instruments. In particular, Schuh explained that they can use this model to examine some of the potential effects of regulatory ceilings on debit card interchange fees paid by merchants mandated under the Durbin Amendment of the Dodd-Frank Act of 2010.⁶ Schuh noted that some banks had increased debit card

Survey of Consumer Payment Choice, jointly constructed by the Federal Reserve Bank of Boston and the Rand Corporation. To construct this data set, the Boston Fed and Rand asked 1,500 households to fill out a detailed survey that asked which payment instruments the consumers used and for what types of purchases. Respondents also answered questions about their attitudes toward the various instruments, for example, the ease of adoption, the speed with which transactions could be completed, and the relative security of using an instrument. The data set also includes demographic information about the household, e.g., income, marital status, and education, among other factors. This is a continuing survey; the authors estimated the model using information from the 2008 survey. For this study, the authors limited their attention to households with a checking account, yielding a sample of 997 households.

In their modeling approach, Schuh and coauthors viewed households as making a two-stage decision. In the *adoption* phase, they choose to

Payments systems are changing rapidly and we know relatively little about what an optimal payments system might look like. Nonetheless, policymakers are making regulatory decisions that have an impact on the payment choices of consumers.

fees or reduced rewards for consumers in response to the regulatory change and that this model could be used to see how customers might respond and to measure how the change might affect their well-being.

The researchers estimated the model using a data set, called the

adopt a bundle of payments instruments, i.e., a checking account plus any or all of the following: cash, debit card, credit card, stored-value card, online bill payment, direct bank deduction, and income deduction. Households make the initial adoption decision knowing the various types of purchases they are going to make in the future and, thus, their future choice of payment instruments, the

⁶ Section 1075 of Pub. L. 111-203.

usage stage. The authors estimated two separate equations jointly: One equation represented the household's usage among the payment instruments from the bundle initially chosen, and a second represented the household's adoption decision, that is, the initial choice among bundles.

Schuh explained that their modeling approach was flexible, in the sense that it permitted a wide range of interactions among usage patterns by different households. A possibly significant limitation of their approach was the assumption that the adoption of one instrument does not affect the cost of adopting another instrument. While this may be an unrealistic assumption — made for technical reasons — the researchers' approach does permit the adoption of one instrument to affect the consumer's cost or value of *using* another instrument. So, in their model, adopting a credit card doesn't make it cheaper to also adopt a debit card, but it could make it easier to use the debit card.

Schuh then highlighted some of the insights from the model. Focusing first on the usage equation, Schuh and coauthors found that consumers' income was strongly positively related to usage of all payment instruments except for stored-value (prepaid) cards. Consumer ratings were also important determinants of usage, with ease of use and cost of use being particularly important, while security was a relatively unimportant concern for households. Schuh argued that this was an unexpected result, evidence of the value of the researchers' structural modeling approach.

Turning to the adoption equation, the authors found that credit cards were the least costly to adopt, followed by debit cards. The authors also found that adoption costs were negatively related to income for all instruments, but the negative relationship between income and credit card adoption costs

was particularly strong. Schuh suggested that this may reflect the role of underwriting in the supply of unsecured credit.

Schuh then discussed the effects of the Durbin Amendment, which placed a ceiling on debt card interchange fees paid by merchants.⁷ First, the authors estimated the usage benefits and adoption costs for debit cards. Schuh showed that usage benefits were roughly the same for consumers with different incomes, while adoption costs were significantly lower for higher-income consumers. Schuh and coauthors concluded that policies that increase debit adoption costs are likely to have a disproportionate effect on low-income households, at least those with checking accounts.

Next, the authors used their model to simulate how consumers might respond to an increase in adoption costs or an increase in usage costs that reduced the market share of debit cards by 1 percent. The authors considered both short- and long-term

similar. The authors also found that low-income customers with checking accounts would suffer larger declines in well-being compared with the declines experienced by consumers with higher incomes. That is because households with higher incomes tend to use more payment instruments, thereby incurring lower costs of adjusting to the new environment.

LIQUIDITY CONSTRAINTS AND BANKRUPTCY

Tal Gross, of Columbia University, reported the results of an empirical study (with Matthew Notowidigdo and Jialan Wang) of the effects of tax rebates on bankruptcy filings. Their main finding was that tax rebates increased Chapter 7 filings, evidence that many households without ready cash were unable to file bankruptcy unless they could pay the required court costs and lawyers' fees.

Gross noted first that a number of other empirical studies had found that liquidity constraints have significant

Schuh and coauthors concluded that policies that increase debit adoption costs are likely to have a disproportionate effect on low-income households, at least those with checking accounts.

effects of such changes. In the short run, in which consumers cannot immediately adjust their bundles of payment instruments, they shift a significant portion of their transactions to cash, with a somewhat smaller shift to checks and credit cards. The results for the long run, in which consumers can choose a different bundle, are

effects on consumption decisions. He and his coauthors explored whether liquidity constraints might also limit households' access to social insurance programs — programs designed to protect households against catastrophic declines in consumption levels — when these programs require a household to pay a fee. Bankruptcy is a particular type of social insurance program designed to reduce a household's debt payments when they become too large relative to income, but court fees are \$300 and Chapter 7 lawyers'

⁷ Note that in all simulations in this paper, it is assumed that merchants would continue to accept the forms of payment they accepted prior to the policy experiment.

fees fall between \$500 and \$1500. Gross suggested that these fees might represent a significant barrier to using bankruptcy for households in financial distress and without cash on hand.

The authors' approach was to use a natural experiment to examine the effects of the tax rebates of 2001 and 2008 on bankruptcy filings. They found that bankruptcy filings increased after households received the rebates for both episodes. But this increase occurred only for Chapter 7 filings and not for filings under Chapter 13.

The authors' approach exploited a feature of the tax rebates that make them an ideal natural experiment; the timing of the rebates was based solely on the last two digits of the recipient's Social Security number. The key is that the last two digits of a recipient's Social Security number are essentially random; it is a characteristic that is unrelated to any other factor that might plausibly affect the recipient's economic behavior, such as income, marital status, age, etc. The authors used court records to identify the Social Security number of households that entered bankruptcy in 2001 and 2008 from 72 of the 90 bankruptcy courts in the U.S., a sample that included 74 percent of the bankruptcy filings and 95 percent of the U.S. population.

The authors then used a difference-in-difference framework to determine whether tax rebates affected the number of households filing for bankruptcy. Specifically, in any two-week period, the authors added up the number of filings for those individuals whose Social Security numbers indicated that they might have received tax rebates in that two-week period and compared this with the number of households that could not have received tax rebates during that period. The authors found that for the 2001 rebate, the number of Chapter 7 bankruptcy filings was nearly 4 percent

higher for Social Security number groups that had received rebates. For the 2008 rebate, the comparable figure was even higher, nearly 5 percent. Gross noted that this was interesting because the 2005 bankruptcy act had been explicitly designed to make it more difficult for households with above-average incomes to qualify for Chapter 7.

The authors' results suggest that fees are ordeal mechanisms; that is, they pose a hurdle that makes it harder for liquidity-constrained households to file for bankruptcy.

In contrast, the authors found only a small negative effect on Chapter 13 filings in 2001 and no effect in 2008. Gross argued that this finding was consistent with the view that relaxed liquidity constraints were the true cause of the rise in bankruptcy filings, because only Chapter 7 filers are required to pay the filing fee immediately. Chapter 13 filers are permitted to pay fees over time as part of their repayment program.

The authors conducted a simple falsification test to ensure that their results could not have arisen by chance or because of some factor other than the tax rebates. They conducted identical experiments for each of the other years between 1998 and 2008 and found that there was no evidence of a similar timing effect in those years when tax rebates were not sent out. Furthermore, Gross noted that their empirical estimates of the effects of the rebates were probably conservative, because not all individuals with the same last two digits of their Social Security numbers actually received rebates.

Gross concluded by drawing out the policy implications of his research. He noted that one could not automatically conclude that policymakers should seek to make bankruptcy filings

easier. The authors' results suggest that fees are ordeal mechanisms; that is, they pose a hurdle that makes it harder for liquidity-constrained households to file for bankruptcy. In principle, this might be justified if it improves households' financial incentives to act prudently and to make decisions that lower the probability of bankruptcy. Nonetheless, if policymakers do not

want to penalize liquidity-constrained households by limiting access to the bankruptcy courts, the researchers' results suggest that simplified procedures that require lower out-of-pocket costs for filers might be desirable.

THE SUPPLY OF CREDIT TO BANKRUPT HOUSEHOLDS

Song Han, of the Federal Reserve Board, reported on the results of a study (with Benjamin Keys and Geng Li) of the supply of credit to bankrupt individuals. Using a data set that monitors credit card mailings to a sample of households to measure the supply of credit, their main results were that bankrupt individuals (*filers*) continued to receive offers of credit; the terms of the credit card offers were less favorable for filers than those offered to individuals who had not gone bankrupt (*nonfilers*); and recent filers were more likely to receive an offer of credit than filers who were about to have the bankruptcy flag in their credit files removed.

Han explained that it is typically difficult to empirically disentangle the effects of changes in the supply of credit from changes in the demand for credit simply by observing credit terms. Theoretically, the supply of credit to a

filer might decrease if the bankruptcy flag reveals higher credit risk. But it could also increase because bankruptcy eliminates existing debt and places legal limits on future filings. Han argued that it is essential to understand how the supply of credit is affected by bankruptcy to understand the bankruptcy decision.

To conduct their study, the authors used a data set that includes a more direct measure of the supply of credit. A sample of 3,000 households from July 2009 to August 2010 sent the data provider all credit card mailings they had received within the previous month. The information about the number and the terms of the offers was then linked to data from individuals' credit bureau files, which include the date on which some individuals filed for bankruptcy, as well as a range of other information about the individual's finances.⁸ The bankruptcy flag in the data set file did not distinguish whether the individual entered Chapter 7 proceedings — in which all debts are written off — or Chapter 13 proceedings — in which the individual agrees to a repayment plan.

Han first presented anecdotal evidence that bankrupt individuals received credit card offers targeted specifically to households that had just exited bankruptcy proceedings. He then presented summary statistics indicating that the percentage of filers who had opened an account was nearly the same as for nonfilers, while, on average, offered interest rates were substantially higher, credit limits substantially lower, and accounts substantially more likely to bear annual fees for filers.⁹ He said that these offers were typically of the "credit building" variety; that is, the offer had annual fees but without

the rewards typical of "premium rewards" offers.


The researchers then examined how the supply of credit evolved over time after a bankruptcy filing. One factor that might affect the supply of credit is the restriction that filers can't file for bankruptcy for eight years (while bankruptcy markers are dropped from credit files after 10 years). Unsecured lenders might view recent filers as a relatively lower risk, everything else equal, given the restrictions on filing again. Consistent with this view, Han and coauthors found that, over time, the probability of getting a card offer declined following bankruptcy. But among filers who did receive offers, interest rates and some other credit terms in those offers improved modestly as the time elapsed since the bankruptcy increased.

Han and coauthors then carried out a formal regression analysis, estimating the effects of filing on the probability of receiving an offer and on the credit terms received by filers. These regressions also took into account the individual's credit score,

⁹ In their analyses of differences in interest rates offered to filers and nonfilers, the authors focus on the "go to" rate, that is, the interest rate charged on revolving balances after any promotional interest rates have expired. This is a conservative approach, since nonfilers are much more likely than filers to receive generous promotional rate offers.

demographic information, and information about the individual's balance sheet. Broadly consistent with the summary statistics reported above, the authors found that filers were only 7 percentage points less likely than nonfilers to receive an offer in any given month and individuals who had filed in the previous two years were as likely to receive an offer as a nonfiler.

Conditional on receiving an offer, the probability that the offer required an annual fee was 13 percentage points higher — a large difference, since only 26 percent of nonfilers' offers contained an annual fee. In addition, filers were offered interest rates that were 77 basis points higher than rates offered to comparable nonfilers. Filers were offered a minimum credit limit that was \$470 (29 percent) lower than that offered to comparable nonfilers.

Finally, the authors examined the possibility that card issuers included less generous terms in the fine print of the mailing — where they were presumably less likely to be noticed — a practice known as *shrouding* in the economic literature. Indeed, they found that offers to filers were more likely to include higher fees or interest rates on balance transfers and higher minimum payments. Additional fees and other more onerous contract features were more commonly included in the fine print of the offers made to filers than to nonfilers. 

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⁸ Note that the data used by the authors were anonymized. No personally identifiable information is contained in the data set.