Monetary Policy: Stability Through Change

Based on a speech given by President Santomero to the Philadelphia Estate Planning Council, Philadelphia, November 18, 2003. This speech was adapted from his remarks at the third annual Philadelphia Fed Policy Forum, which was held on November 14, 2003.

BY ANTHONY M. SANTOMERO

The recent business cycle has been driven by two forces: a series of extraordinary events and some longer term secular trends. In this article, President Santomero discusses how these extraordinary events, including the bursting of the tech bubble, the aftermath of 9/11, the wars in Afghanistan and Iraq, and the corporate accounting and governance scandals, have affected the U.S. economy. He then turns his focus to the longer term trends, including rapidly changing technology and the increasingly integrated global marketplace, which he expects to be the key drivers of our economy in the future.

From an economic perspective, I believe 2004 will be a good year. We can expect growth in both GDP and employment to persist, though it will take some time before the economy reaches full potential output. Let me try to explain how we got here and how that path will influence the future direction of our nation's economy.

In my view, this business cycle has been driven by two distinct types of forces: first, a series of extraordinary events that buffeted the economy in rapid succession; and, second, some long-term secular trends that began working their way through the economy, disrupting the flow of activity as they went.

The first category — extraordinary events — includes the bursting of the tech bubble, a substantial stock market correction, a series of corporate scandals and governance issues, the events surrounding September 11, 2001, and, of course, the wars in both Afghanistan and Iraq. These disturbances, while painful, are shorter term and their economic impact continues to fade over time.

The second category, however — the long-term secular trends — brings long-lasting and far-reaching changes to the U.S. economy. They are transforming the way we live and work as a nation. I believe these trends, which include rapidly advancing technology and an increasingly integrated global marketplace, will be the key drivers of our economy in the future.

I will focus here on these long-term trends. However, since both features of our economy must be considered when setting appropriate public policy, I will conclude with some observations on the challenges that both forces of change have presented to monetary and fiscal policymakers.

THE CURRENT STATE OF THE ECONOMY

Let me begin with a little history. The recent business cycle marked a turning point in our economy. We moved from an era of irrational exuberance to a cycle filled with uncertainty and subject to continuous change.

As many people know, the U.S. economy lapsed into recession in March 2001. The recession officially ended in November 2001. But since that time, the overall economy has followed an uncertain, and at times unsteady, road to recovery. GDP growth has been slow and employment growth has proved elusive.

Anthony M. Santomero, President, Federal Reserve Bank of Philadelphia

Why has it taken so long for the economy to return to robust growth? Both the recession itself and the protracted recovery have been widely attributed to a confluence of three factors: weak growth in business spending; strong growth in labor productivity; and growing reliance on foreign outsourcing. Yet, in my view, these phenomena are all part of the same story — the story of the unfolding impact of the technological revolution on our economy.

WEAK GROWTH IN BUSINESS SPENDING

First, consider the impact of this revolution on aggregate demand. Fundamentally, the boom — and subsequent bust — of business spending on information and communications technology, or ICT, generated the most recent business cycle.

In retrospect, business technology spending in the late 1990s represented a mix of both good and bad judgments. Some of the ICT spending turned out to be wise and even prescient investment in productive new capital. Some of it was just investment pulled forward for fear that legacy equipment would malfunction in Y2K. And some of it — often combined with ill-conceived "dot com" business plans — reflected overconfidence about the viability of new business models.

In any case, it took the business sector three years, from 2000 through 2002, to digest those investments. From an accounting perspective, it took three years to depreciate the accumulated stock of hardware and software. From an economic perspective, it took three years to put existing capital to its most productive use: reallocating it across firms and fully exploiting its capabilities to boost productivity and cut costs within firms.

But that absorption process seems to have run its course. Businesses are exhibiting a renewed appetite for investment, and our national income accounts are showing evidence of renewed spending in this area. Looking ahead, I expect firms to maintain a healthy pace of ICT spending. As this plays out, growth in real business fixed investment should resume its role as a significant contributor to overall demand growth.

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As business investment spending picks up, aggregate demand growth will be more balanced and less dependent on consumer and fiscal stimulus to support the expansion. All else constant, this improved pace and pattern of growth in aggregate demand will mean stronger growth in demand for labor.

STRONG PRODUCTIVITY GROWTH

Of course, the caveat here is "all else constant," which brings us to the second chapter in the story: strong productivity growth.

While the impact of the technology revolution on business investment spending has been uneven, its impact on productivity has been consistently positive. With the late 1990s' acceleration in ICT investment came a marked pickup in the growth rate of labor productivity. In fact, strong growth in productivity has persisted, not only through the boom years but also throughout the recession and recovery. Simply put, the business sector continues to exploit the benefits of its investment in ICT at extraordinary rates.

Between 1973 and 1995 productivity growth in the nonfarm business sector averaged 1.4 percent per year. Between 1995 and the present, productivity growth has averaged 3 percent per year and has yet to show any signs of flagging. Indeed, it has been even stronger as of late.

Of course, this is good news for the aggregate economy. Higher trend productivity growth supports higher potential GDP growth and higher standards of living. It makes us more internationally competitive and supports higher salaries for workers. However, this strong productivity growth, combined with the slow demand growth, created a very weak job market over the past three years.

Undoubtedly, uncertainties associated with the string of unexpected disturbances curtailed businesses' willingness to add to their payrolls. In addition, slow growth in aggregate demand put downward pressure on prices. The result was stagnation in top-line revenue growth, which led firms to seek profit growth through cost-cutting. Often, this was achieved through reductions in labor force.

Nonetheless, from a growth accounting perspective, it was businesses' capacity to expand output while shedding workers, emanating from the remarkable gains in labor productivity, that allowed the recovery to proceed for so long without boosting payroll employment.

Indeed, the stagnation in the labor market was perhaps the most dis-

concerting feature of the current cycle. This was the second "jobless recovery," but it holds the dubious distinction of being the first "job *loss* recovery."

Most economists agree that innovation in, and application of, ICT will continue to drive productivity growth. During the first quarter of 2003, when we asked participants in our Survey of Professional Forecasters to project productivity growth over the next 10 years, their median response was 2.3 percent per year. My own view is that underlying productivity may continue to grow at an annual rate of 3 percent.

So, allowing for labor force growth of 1 to 1.25 percent, the economy's potential output would grow between 3.5 and 4 percent for quite some time, most likely closer to the upper end of this range. Put another way, to mirror capacity growth, including the new entrants to the labor force, we need sustained real GDP growth of around 4 percent. But to re-employ those who became unemployed or underemployed during the past three years, we will need a period of real GDP growth *above* 4 percent.

I believe this level of growth is achievable. At the same time, however, I acknowledge that the process of regaining and maintaining a full employment economy will be neither smooth nor painless. The ICT revolution has created changes in the labor market that present challenges, both near term and long term.

Near term, mismatches between workers' skills and businesses' requirements could be slowing the rate at which currently unemployed workers are re-absorbed, relative to previous recoveries. Longer term, the ICT revolution will surely mean significant restructuring in many industries, including the decline of some and the birth of entirely new ones. This has been our experience with previous technological revolutions, and there is little reason to doubt it will happen again this time.

History also tells us that such transformations benefit us as consumers. Prices are lower, wealth is increased, and welfare is enhanced for society as a whole. However, such transformations also create difficulties for many of us as workers when job requirements and job locations change. The transition is not necessarily easy.

Nonetheless, the U.S. economy is remarkably flexible. Over some reasonable horizon, the market will induce the required adjustments. Workers will learn new skills. Hardware and software engineers will develop new tools that match workers' skills and capabilities. Businesses will revise processes and locate operations to best deploy available labor pools. In the process, they will use both domestic and foreign labor.

FOREIGN OUTSOURCING

The increased use of foreign labor in production is the third factor behind our, thus far, sub-par recovery. It is important to recognize the fact that this phenomenon also emerged as a result of the ICT revolution. Improvements in information and communications technology, coupled with the decreasing cost of physical transportation, have not only facilitated but also dictated dynamic changes in the global nature of commerce. One noteworthy result is a globally integrated marketplace for goods and services. This, in turn, is creating a global market for labor.

Of course, "offshoring," as it is now being called, has been the trend in much of the production activity associated with manufacturing for a long time. But now it seems to be intensifying, particularly with the opening of the Chinese economy. It also seems to be spreading to the service sector.

Lower-skilled, call-center, and other service jobs have been migrating to India and elsewhere in the Far East for several years. More recently, the process has been moving up the value chain to higher level professional service jobs, such as accountants, financial analysts, and software engineers.

At this point, we have yet to accurately quantify the impact of the ICT revolution on the offshoring phenomenon. However, this may be less important than acknowledging that the ICT revolution is creating an increasingly integrated market for all types of goods *and* services.

In essence, the introduction of new and lower cost information and communications technologies is expanding the size of markets. Information can be disseminated and transactions effected between individuals and organizations located essentially anywhere around the world at lower cost than ever before. The bigger the market, the greater the opportunities for specialization and gains from trade.

In addition, new ICT is reducing the cost of coordinating activities between firms regardless of location. This allows for even greater specialization by firms, a more segmented value chain, and even more efficient ways of delivering goods and services.

Even within firms, ICT is reducing the cost of coordinating activities across sites. So internal processes, such as research and development, production, distribution, and service functions, can be further segmented, and each segment can be located at the site of greatest comparative advantage.

As a result of the technology revolution, the demand for labor in the U.S. will become more sensitive to labor market conditions and other economic considerations in a broad array of countries around the world.

The global context of these forces may be broader in scope and the competition more intense than we have experienced in the past, *but* they are not fundamentally different in kind. Again, I believe the U.S. economy is up to the challenge, given its agility, adaptability, and most relevant to current concerns, the flexibility of the U.S. labor market. Together these features will position our economy to take full advantage of the international gains from trade created by the ICT revolution.

CONSUMER SPENDING

I have been making the case that the ICT revolution has been a fundamental driver of our nation's recent economic performance — destabilizing business spending, accelerating labor productivity, and globalizing the marketplace — and that it will continue to shape our performance going forward.

While the business sector faltered, the consumer sector did an outstanding job of sustaining the economy.

That series of extraordinary events I mentioned at the beginning also buffeted the economy and took their toll on the business sector's willingness to spend. Fortunately, while the business sector faltered, the consumer sector did an outstanding job of sustaining the economy. Indeed, the downturn would certainly have been far worse were it not for the continued growth of consumer spending.

Why were consumers so willing to spend? Clearly, their actions were driven by extraordinarily stimulative fiscal and monetary policy. Tax cuts and low interest rates gave consumers both the means and the motive to spend their way through the downturn.

I expect consumer spending will continue to grow at a healthy pace in 2004. However, the fuel for that growth should be growth in employment and increasing real incomes. As this transpires, the role of policy will shift from providing additional stimulus to supporting sustained growth.

IMPLICATIONS FOR POLICYMAKERS

Finally, I'd like to touch on the implications of the current business cycle for the next round of decisions by monetary and fiscal policymakers.

First, let's consider monetary policy. Since the so-called Great Inflation of the 1970s, economists and central bankers around the world have held that a stable price environment is conducive to economic efficiency and long-run growth. What we learned in this business cycle is that price stability serves monetary policy well when it comes to short-run stabilization too. Indeed, I believe it was the Fed's 20-year investment in price stability that made monetary policy so effective in this cycle.

With inflation curbed, the Fed had the latitude to bring interest rates to historic lows in response to the decline in demand wrought by the recession. As a result, houses became more affordable, and durables were within reach. Household debt burdens are substantially lighter than they would have been without aggressive countercyclical monetary policy. Moreover, with inflation expectations well-anchored, the Fed's cuts in nominal rates were seen as declines in real interest rates, and rates were seen as low relative to expected future interest rates. This made mon-

etary policy more effective in stimulating current spending.

As the current expansion gains a firmer foothold, monetary policymakers will remain vigilant and will act to ensure the economy avoids momentum toward accelerating inflation or destabilizing shifts in long-term inflation expectations.

On the fiscal policy side, the Bush administration came into office intending to permanently reduce tax rates as a strategy for fostering stronger economic performance over the long term. As events unfolded, the tax reductions were accelerated and enhanced in order to provide the economy with much needed stimulus in the short term. Without a doubt, this application of countercyclical fiscal policy was extraordinarily well timed and effective. The aftermath, however, is a federal budget pushed into a deep deficit for the foreseeable future. As we move forward, fiscal policymakers will need to consider strategies for returning to a cyclically balanced federal budget.

Beyond that, federal dollars would be best spent on programs designed to increase our economy's ability to respond to changing market conditions, both secular and cyclical. Such investments, including programs to educate, train, and re-train workers, and programs to fund basic research and development, will have substantial benefits well into the future.

CONCLUSION

The current economic recovery is gaining traction, and a self-sustaining economic expansion ought to proceed at a healthy pace as we move further into 2004.

Households will benefit from renewed job growth and continued productivity growth, and their spending should continue to grow. Business spending on equipment and software has returned. As business confidence returns, the replenishment of inventories will further contribute to a more self-sustaining recovery.

As shorter-term economic shocks recede, the ICT revolution will remain as one of the primary drivers of the U.S. economy. I believe this technological revolution is well positioned to provide a solid foundation for sustained expansion in both output and employment in the U.S. It offers the prospect for the greatest growth in our nation's living standards in a generation.

Yet, the information and communications revolution — like all technological revolutions — has proven to be a positive and, at the same time, disruptive force on the economy both here in the U.S. and throughout the world.

Monetary and fiscal policymakers have gone to great lengths to mitigate its impact as well as the effects of other unexpected disturbances on the most recent business cycle. As economic conditions improve, we will need to re-position ourselves, so that we stand ready to respond to the next sequence of shocks, whenever they come and whatever their source.

This is how the Fed fulfills its role as our nation's central bank: anticipating and preparing for the inevitable changes that confront our economy. It is public confidence in the Fed's ability to do so that allows us to maintain stability through change.

The Fed must anticipate and prepare for the inevitable changes that confront our economy.

How the Fed Affects the Economy:
A Look at Systematic Monetary Policy

BY MICHAEL DOTSEY

When assessing the economic effects of monetary policy, economists have, until recently, emphasized the role of unanticipated changes in policy. But are these policy shocks likely to be the most important influence on the economy? Mike Dotsey believes not. It seems more likely that the Fed's systematic behavior plays a bigger part in what happens in the U.S. economy. In this article, Dotsey explains the ways in which systematic policy influences economic activity.

A great deal of attention has been paid to the economic effects of monetary policy. Until recently, the emphasis has been almost entirely on the consequences of unanticipated changes in policy, or what are referred to as monetary policy shocks. Specifically, if the Fed were to do something unexpected, how would the economy respond? Will output increase or decrease in response to the change in policy, or will the inflation rate rise or fall?

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Surprises, however, are unlikely to be the most important part of monetary policy. While no one has clairvoyance regarding what the Fed will do at a particular point in time, financial market participants, as well as firms and investors, pay close attention to how the Fed behaves. Generally, they are fairly good predictors of monetary policy. The Fed, on its part, regularly communicates its outlook on the economy through speeches and congressional testimony. Further, the language in FOMC policy statements usually gives a fairly clear indication of the current stance of policy. With all this communication and scrutiny, monetary surprises of any consequence are likely to be rare events, implying that the Fed's systematic behavior will be its primary method of affecting the economy — specifically, how the Fed moves the interest rate in response to economic variables such as inflation and output growth. This article explores the ways in which systematic policy influences economic activity.[1]

In doing so, I will analyze two different policies that have the same long-term goal: price stability. One policy is the long-held monetarist prescription of a constant growth rate of money; the other is an interest rate rule that attempts to keep the price level fixed. The economic response to an increase in the level of productivity relative to its trend is much different under these two policies. The interest-rate rule allows the economy to take full advantage of the increase in productivity. The constant-money-growth-rate rule does not and, instead, dampens the effects of increased productivity, leading to what appears to be a much smoother path for output and employment. This smoother behavior reduces economic welfare in the sense that everyone is less well-off and highlights one important lesson of this article, namely, that smoothing output fluctuations is not necessarily good policy.

Given that different monetary policy designs affect the way the economy reacts to economic disturbances, it would be interesting to examine how well, in theory, a rule that approximates current Federal Reserve behavior performs. As I will show,

[1] Recent articles that also emphasize the role of systematic policy are my 1999 and 2002 articles and the one by Jordi Gali, David Lopez-Salido, and Javier Valles.

it appears that the design of policy is actually quite good.

CHANGES IN PRODUCTIVITY

In exploring the importance of systematic monetary policy, I will concentrate on how changes in productivity influence economic activity and, in turn, how monetary policy affects that influence. The level of productivity determines how much output can be produced from a particular amount of labor and capital. The more that can be produced, the more productive the economy is. Multi-factor productivity is a broad concept that includes not only technological innovations such as new inventions or improved machines that increase production but also advances in management practices or ways of organizing labor that enhance efficiency.

In addition, changes in government regulation or the legal environment can influence how many goods or services can be produced from a given amount of labor and capital. Basically, anything that affects the efficiency of productive inputs falls under the heading of a change in productivity.

With respect to various types of shocks, the economic effects of changes in productivity are perhaps the best understood and most clearly delineated of all economic shocks. Economists have described the importance of productivity changes for business-cycle behavior, and indeed, more scientific attention has been paid to the effects of changes in productivity than to the effects of any other economic disturbance.

To get an idea of the importance that changes in productivity have for movements in output, Figure 1 graphs changes in productivity, measured as a deviation from trend growth (productivity shocks), along with output growth in the United States from 1948 to 2000. As you can see, the changes are quite variable, sometimes exceeding 2 percent. A positive change in productivity of 2 percent means that 2 percent more output can be produced using the same amount of capital and labor. The other important feature shown in Figure 1 is the high degree of co-movement between changes in productivity and economic growth. When the change in productivity is positive, output tends to grow strongly; when it's negative, output growth is often negative as well. The correlation coefficient between productivity shocks and output growth is 0.83.[2] Thus, changes in productivity appear to be quite important to economic growth. Given their importance, how does monetary policy affect the way these productivity shocks influence economic activity?

As Satyajit Chatterjee describes in his 1995 article, when productivity is high, output, employment, and investment are also high.

Economists have described the importance of productivity changes for business-cycle behavior.

Figure 2 examines the behavior of four very important variables following a shock to productivity. This behavior is based on a simple theoretical model known as a real-business-cycle model. The key point about this model is that it describes the correlation of these

[2] The correlation coefficient measures the degree to which variables move together. A correlation coefficient of 1 means that the variables move in lock step; a correlation coefficient of 0 implies that the variables are unrelated; and a correlation coefficient that is negative means that the variables move in opposite directions.

FIGURE 1

Productivity Shocks and Output Growth

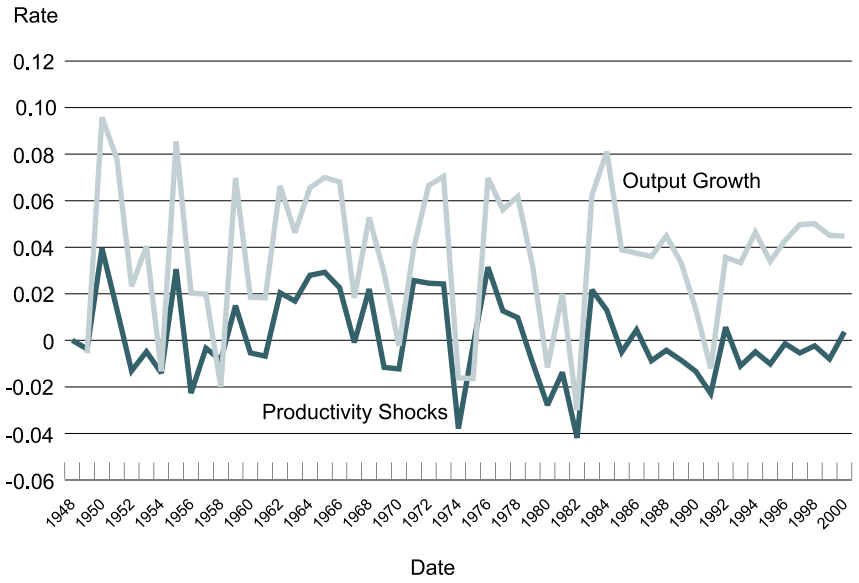
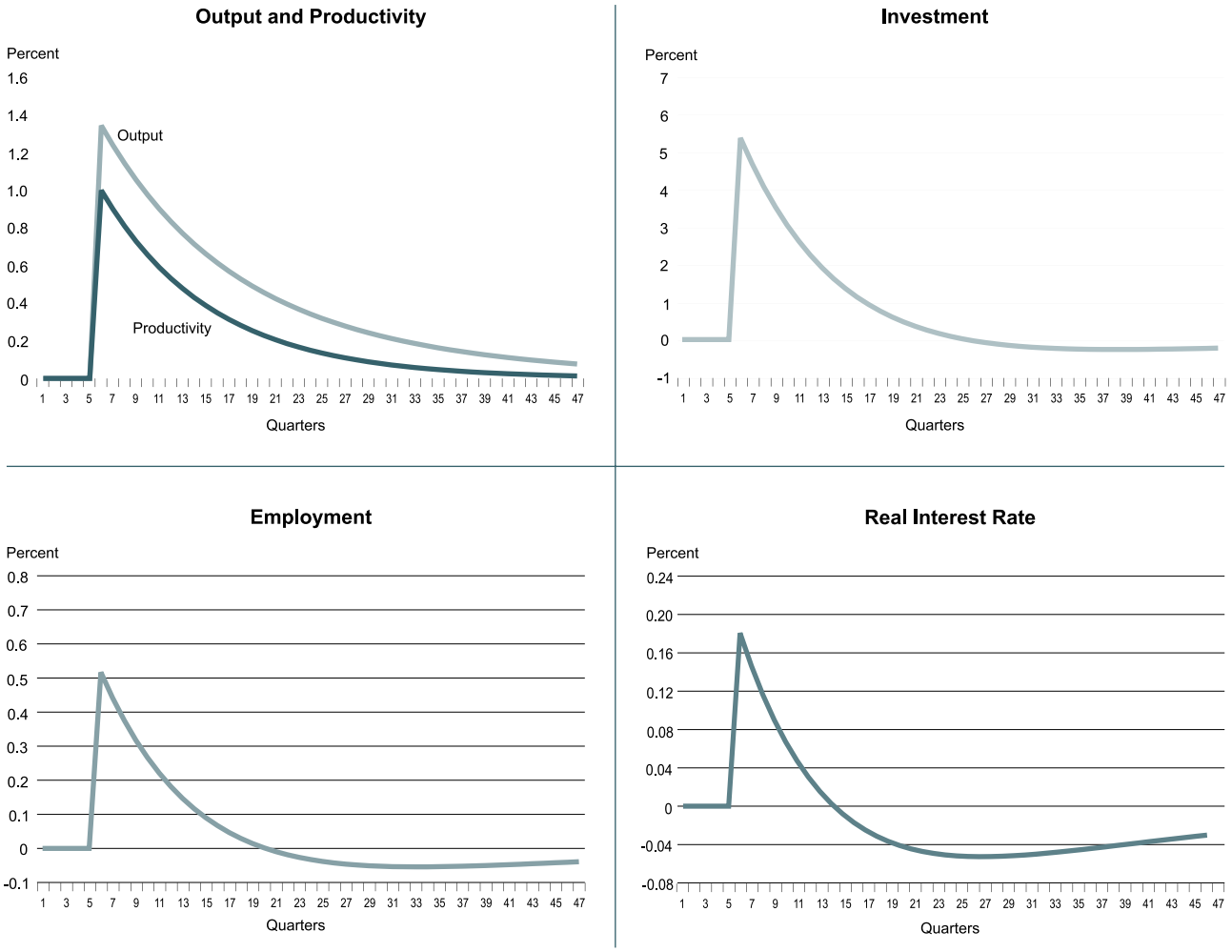


FIGURE 2

Real-Business-Cycle Model



important variables and gives us a theory as to why productivity affects the economy the way it does.

An important feature of the model is that there are no impediments to allocating resources or changing prices. All prices are flexible and changed costlessly. Specifically, the price of a good changes whenever the marginal cost of producing the good changes. Similarly, the wage rate and the rental rate on capital change whenever there is a change in productivity. Although not totally realistic, the model provides a necessary and important benchmark for evaluating the effects of monetary policy in a more realistic environment.

First, examine the behavior of the productivity shock itself and output. The two variables are graphed in the upper left part of Figure 2. Each variable is plotted relative to its normal level.

Take productivity, for instance. A value of 0 means that productivity is at its normal level, not that there is no productivity. A value of 1 implies that productivity has increased 1 percent above its normal level. The shock to productivity we examine is one that dies out slowly over time and is the type of productivity shock that

is typically studied in business-cycle analysis.

Because higher productivity implies that more output can be produced from the same amount of capital and labor, it is not surprising that output should be high when productivity is high and that as the shock to productivity dissipates, so does the increase in output. It is important to note, however, that output rises a good deal more than productivity. For this to occur, other factors of production — that is, inputs such as capital and labor — must increase as well. If they did not, the behavior of output would exactly mirror the behavior of productivity. The magnified increase in output is primarily due to an increase in hours worked or employment.

This increase is depicted in the bottom left panel of Figure 2. Why should people work harder when productivity is high? When productivity is high, so is the amount of output that can be produced from an hour of work. Higher labor productivity translates into an increased demand for labor by firms and into higher real wages. Higher real wages induce people to work more. For example, in times of very high productivity, firms often ramp up production and increase the amount of overtime paid to workers.

The other avenue that leads to an increase in output that is greater than the increase in productivity is investment. Higher productivity not only makes labor more productive, it also makes capital more productive. As a result, there is a greater demand for capital and a higher return to owners of capital. This higher return spurs investment, which results in a larger capital stock.

The higher return to capital is reflected in a higher real interest rate, which is displayed in the bottom right panel of Figure 2. The real interest rate is the difference between the nominal rate of interest – the rate at which each of us borrows and lends – and the expected rate of inflation. It indicates how many more goods can be consumed in the future if one sacrifices current consumption and saves a bit more. Similarly, the marginal product of capital indicates how many more goods will be produced when the capital stock is increased by one unit. The way to increase the capital stock is to forgo some consumption and invest. Therefore, a higher marginal product of capital implies that more goods can be consumed in the future if current consumption is sacrificed in favor of more investment. Thus, a higher marginal product of capital is associated with a higher real interest rate. The rise in the real interest rate is beneficial. It is a consequence of greater productivity and encourages saving, which, in turn, provides the means for greater investment.

There is substantial evidence that firms do not adjust prices instantaneously.

Finally, a very important point to understand about the cascade of effects that occurs because of an increase in productivity is that these effects are optimal from the standpoint of every individual in the economy. The increases in output, hours worked, investment, and the real interest rate result from individuals and firms taking advantage of the rise in productivity. The increase in productivity has created additional opportunities for producing, raised wages, and raised the return on investing. All the decisions made by households and firms are voluntary and reflect the efforts of each entity to maximize welfare and profits. Further, there is nothing to prevent the economy from responding fully and flexibly to the increase in productivity.

EFFECTS OF MONETARY POLICY WHEN PRICES DO NOT ADJUST INSTANTANEOUSLY

In the previous discussion, the economic response to an increase in productivity was instantaneous. Notably, the prices of all products adjusted immediately. In such a setting, monetary policy is irrelevant. Such an environment is, however, unrealistic. That lack of realism implies that to understand the importance of monetary policy, we must provide a better description of the economy.

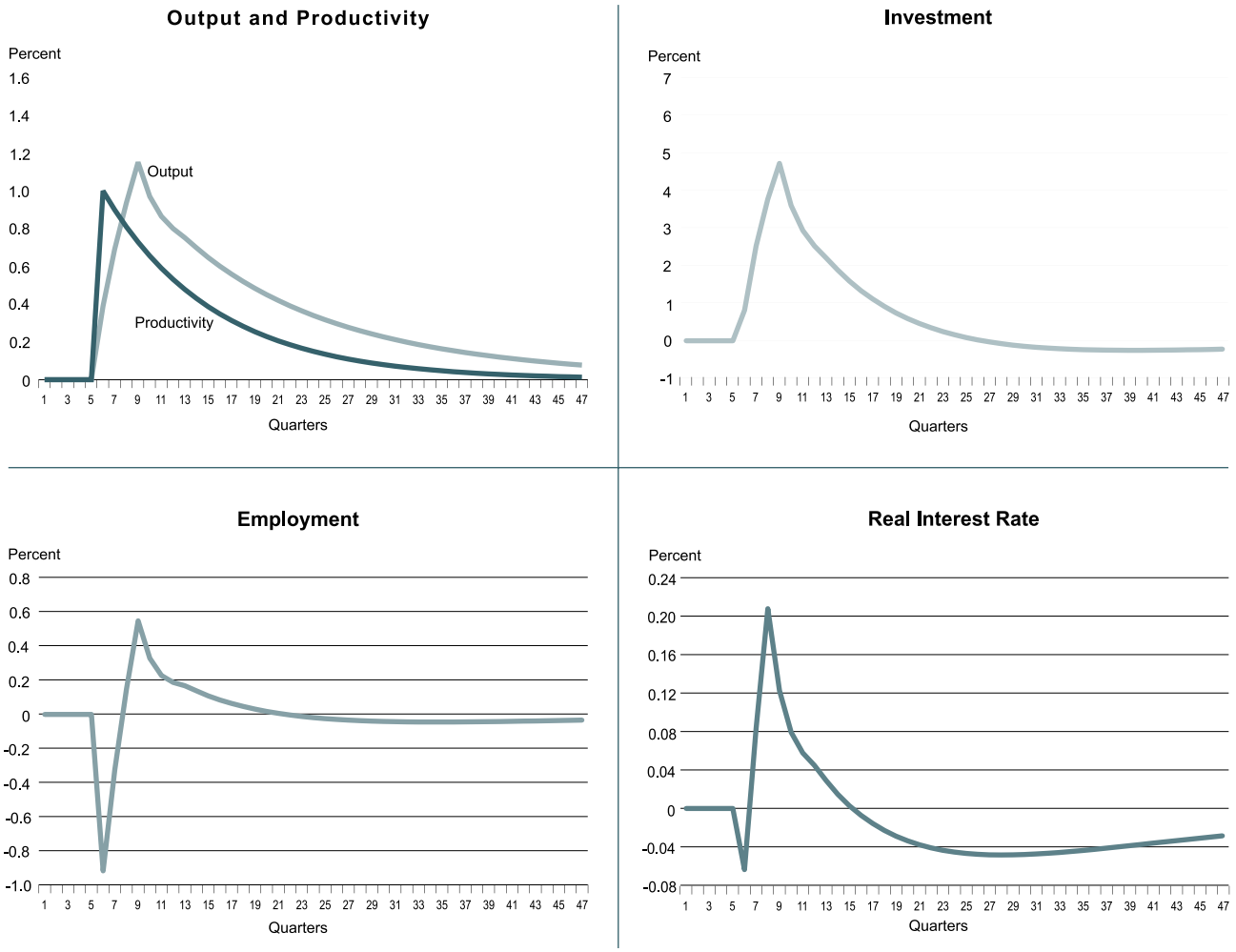
The major change will involve altering the assumption of perfect flexibility in prices. There is substantial evidence that firms do not adjust prices instantaneously. For example, Alan Blinder and co-authors have surveyed firms and found that many firms do not change the price of their products for up to a year. Mark Bils and Peter Klenow, in their recent and detailed look at price changes of goods and services, examined the price behavior of more than 350 products and documented how frequently the price of each good changed. They found that many prices remain fixed for up to six months, although 30 to 40 percent of prices do change each quarter.

To capture this facet of behavior, we will assume that each firm adjusts its price once a year, with 25 percent of all firms adjusting prices in each quarter.[3] That is, in any given

[3] A more rigorous treatment of price adjustment, like the one I developed with Robert King and Alex Wolman, can be used without changing the main thrust of the results presented in this section.

FIGURE 3

Sticky Prices and Constant-Money-Growth Rule



quarter, 25 percent of firms adjust their price and 75 percent of firms charge the same price they charged in the previous quarter. This type of price adjustment is referred to as a Taylor contract because it is based on the work of John Taylor.

When price setting is sluggish, economic behavior depends on monetary policy. The policy I examine first is constant money growth. This particular policy, which has a long tradition in monetary theory, is most notably associated with Milton Friedman. The main justification for prescribing this policy is that it controls the rate of long-run inflation while at the same time providing enough money, on average, for the economy to efficiently carry out the desired amount of transactions.

However, as a response to a persistent increase in productivity, this policy does not look like a good one. Even though this policy makes the economy behave in a smoother, or less volatile, fashion than occurs in the real-business-cycle model, individuals are less well off. The sluggishness in price setting translates into an overall sluggishness in activity.

First, examine output, as shown in the top left panel of Figure 3. Now, it increases only by about half the increase in productivity. The reason for this lack of responsive-

ness is seen in the bottom left panel, which shows that employment actually falls. In contrast to what happens in the flexible-price real-business-cycle model, the increase in productivity is actually causing employment to decline. Thus, workers are losing out on a big portion of potential gains. Investment is also comparatively less responsive, and the real interest rate declines.

Why does the economy behave so differently? The key reason is the sluggishness of price adjustment. The inability of firms to lower their prices in response to increased productivity and the resulting lower costs of production interact with monetary policy, producing the economic outcome depicted in Figure 3. The key reason the economy does not expand as vigorously as in the real-business-cycle model is that overall demand is linked to the amount of money in the economy. With money growing at a prefixed rate, demand does not increase as fast as productivity; instead, demand increases at the same prefixed rate as money. That means the dollar amount of goods bought is not growing fast enough to take advantage of the economy's increased productive capacity. Because prices are more or less fixed, the number of goods purchased is well below what the economy is capable of producing. With greater production efficiency, less labor is needed to satisfy the modest increase in demand. Rather than benefiting from being more productive, workers actually lose out.

Over time, as firms are free to lower their prices, output continues to increase, and eventually, employment increases as well. After every firm has adjusted the price of its product, the behavior of the economy begins to look like the behavior of the real-business-cycle economy. Output, employment, investment, and the real interest rate return to their average values as the increase in productivity dies out.

An important point of this exercise is that the constant-money-growth rule actually smoothes the economic response of output to the increase in productivity. Output does not immediately rise as much in response to a change in productivity and increases only gradually. This smoothing of output's behavior is not a good thing and results in additional volatility of employment. Individuals would be better off if they could respond more aggressively to the increase in productivity and take maximum advantage of productivity when it is at its highest.

> Rigidity in price setting has serious consequences for economic behavior.

The basic lesson of this section is that rigidity in price setting has serious consequences for economic behavior. The fact that firms are unable to change prices flexibly means that the optimal degree of economic expansion cannot take place under the constant-money-growth rule. If monetary policy were more expansionary in the face of the opportunities afforded by the increase in productivity, nominal output — that is, output measured in current dollars — could increase and so could real output — output measured in constant dollars, that is, adjusted for inflation. Such policy could, in principle, help the economy achieve an outcome more similar to what would occur if prices were in fact flexible. In doing so, that policy would increase economic welfare.

BETTER MONETARY POLICY

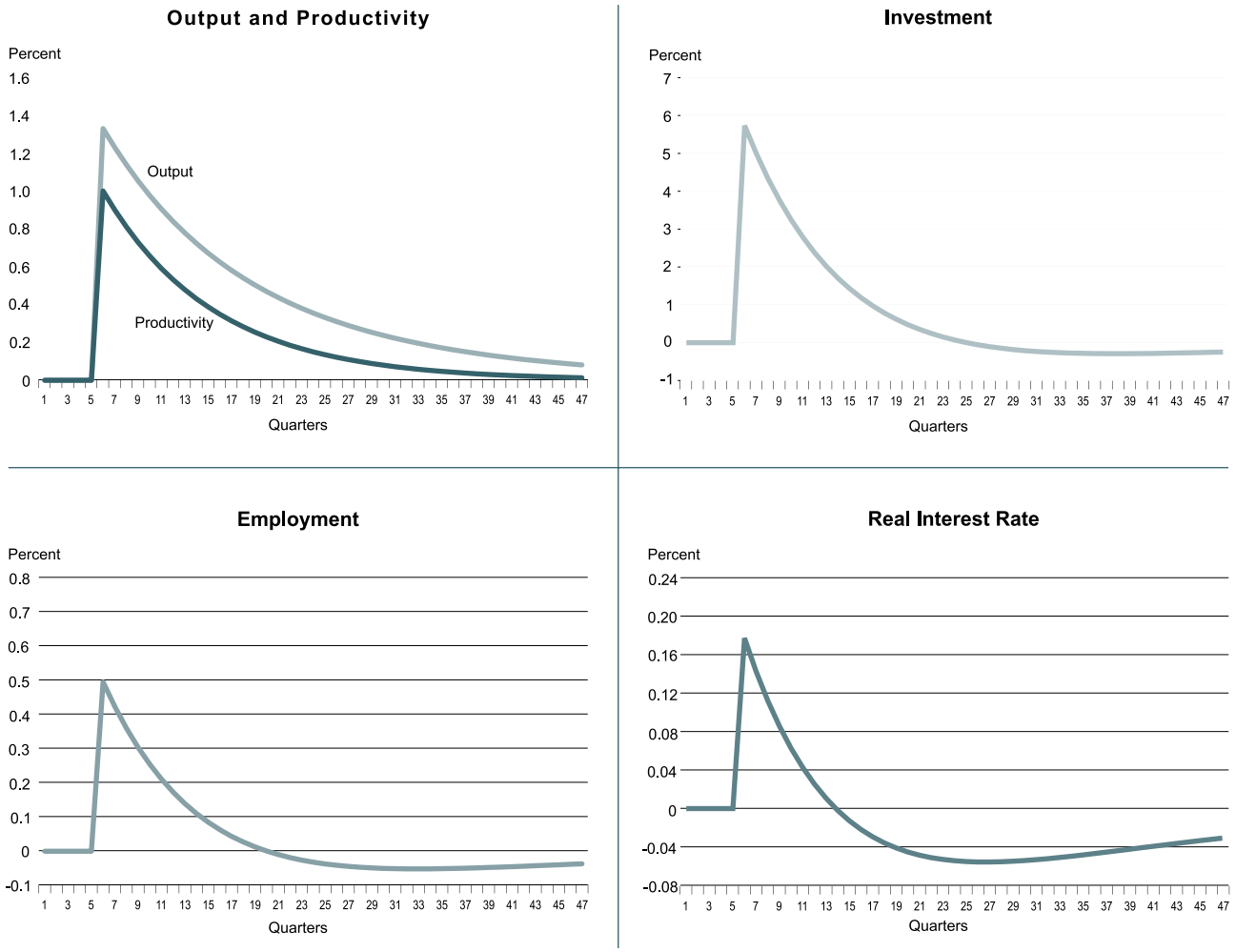
We just witnessed how sluggishness in price adjustment can impair the economy's response to a productivity shock. Can a central bank do something about this? For example, what if the central bank could make it desirable for firms to keep their prices constant even if they could freely change them? Then the lack of price flexibility might not present any impediment, and a better economic outcome would follow.

For example, suppose that firms thought the central bank could keep the overall price level from moving. A firm would then want to keep its prices in line with what other firms were expected to charge and not raise its price today. If a firm has no desire to change its prices, the fact that prices are inflexible will be of no consequence. One might guess that in such circumstances, the economy would behave very much like a flexible-price economy. The key question is whether the central bank can engineer this type of behavior in response to a change in productivity.

The answer is yes. The central bank can, in fact, make this happen by following an interest-rate rule, aggressively raising the interest rate if prices start to rise or aggressively lowering the interest rate if prices start to fall. In our model economy, this policy leads to the economic outcomes depicted in Figure 4.

FIGURE 4

Sticky Prices and Interest-Rate Rule



First, if we compare Figures 2 and 4, it is clear this policy duplicates the flexible-price outcome. The combination of the interest-rate rule the central bank is following and the initial desire for firms to lower their prices leads to a drastic increase in the supply of money. Basically, the interest-rate rule implies that the central bank will supply enough money so that the demand for goods and services (output) increases exactly as much as the supply of goods and services would increase under flexible prices. The result is that demand and supply are equal at the initial price level and there is no incentive for firms to change their price. Prices remain fixed, and the increase in output is identical to what happened when money was fixed and prices fell. Under flexible prices, real output rose 1.4 percent and prices fell 1.4 percent, leaving the demand for money unchanged at its fixed supply. Under the interest-rate rule, prices remain the same, output again rises 1.4 percent, and the supply of money increases 1.4 percent to support the increased output.

Because there is no change in prices, the nominal interest rate does not have to react to a change in the price level. Any pressure for the price level to fall ends up pumping money into the economy to keep the price level from moving. The nominal

interest rate moves one for one with the underlying real interest rate, and an optimal use of economic resources ensues. The latter point is one of the main messages in recent work by Robert King and Alexander Wolman.

A question that naturally arises from this analysis is: Why don't central banks follow this rule in practice? The answer is that for other types of shocks, such as demand shocks (for example, changes in government spending), this policy would not produce the best economic outcome. A different policy, generally one that accommodated some short-run increase in inflation, can make people better off. In our simplified experiment, we assumed the monetary policymaker knew the exact nature of the economic disturbance. In practice, that would not be the case; so the central bank may not be able to react in as precise a fashion as it does in the particular example discussed here. Also, accurate contemporaneous knowledge of what is happening to the economy as well as the fact that economic variables are often measured with error further complicates the design of actual policy. However, one key element of the analysis presented above does carry over to more complicated and richer investigations of policy: The central bank should not try to smooth economic activity but rather let the economy efficiently allocate resources in response to whatever shock has occurred.

ACTUAL POLICY

The lesson from the previous section is that it's possible for monetary policy to induce an optimal economic response to changes in productivity even in the presence of sluggish price adjustment. In reality, the economy is buffeted by many types of shocks. For example, changes in fiscal policy or changes in private demand, perhaps induced by large swings in equity or housing prices, are all recognizable features of the real world. Designing the optimal response to all of these types of shocks is a difficult proposition, which recent advances in theory are beginning to address.

Policymakers, however, do not have the luxury of waiting for theorists and must do the best they can in an uncertain environment. It would, therefore, be an interesting exercise to examine how well a policy rule estimated over the period 1987Q1 through 2000Q4 under Alan Greenspan's chairmanship does in response to a persistent productivity disturbance.

Accurate contemporaneous knowledge of what is happening to the economy as well as the fact that economic variables are often measured with error further complicates the design of actual policy.

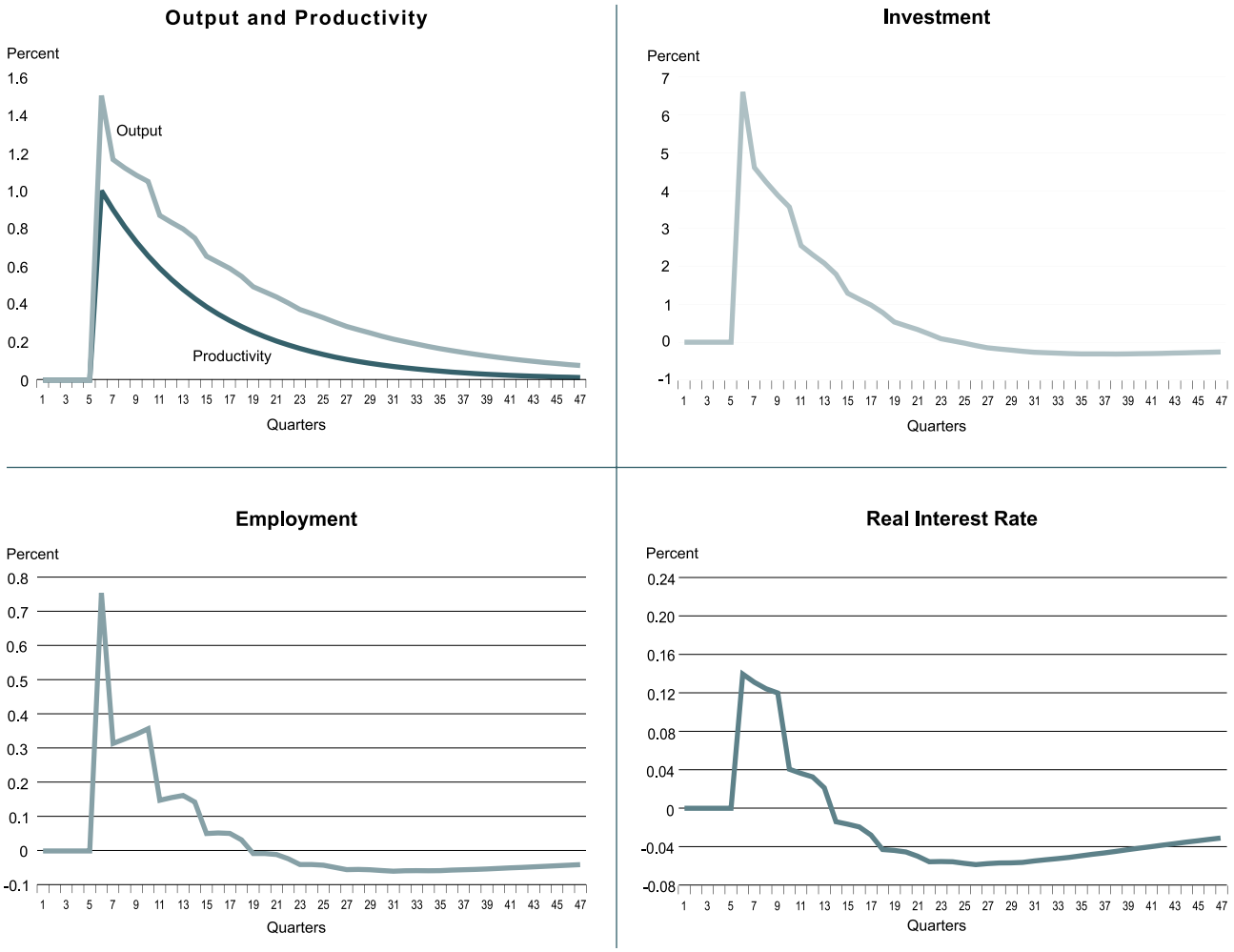
Because policy should be designed to respond well to all types of shocks, a central bank's behavior should not be expected to mimic the simple rule in the preceding section. But if designed appropriately, actual policy should not do too badly with respect to any particular shock. The rule I investigate, which is the one estimated by William English, William Nelson, and Brian Sack, involves tightening policy in response to inflation above a specified target and when output is above its trend growth rate. One should not interpret the latter response as an attempt to smooth activity, but rather as a recognition that when the economy is growing strongly, real interest rates should be high. The rule also involves a significant degree of interest-rate smoothing or inertia in policy, reflecting a concern on the part of the Fed for moving interest rates too rapidly or by sizable amounts in any one quarter.

The economy's response to the changes in productivity under a realistic estimation of policy is displayed in Figure 5. In fact, an estimated rule meant to capture the way the Fed responds to the economy implies that policy does fairly well in the sense that the response of output, employment, and investment is similar to that which would occur if prices were flexible.

In comparing the behavior of output, employment, and investment, one sees a slightly stronger response than occurs when prices are flexible. However, the overall pattern of activity is quite close to what is optimal, and it appears that an estimate of actual policy is fairly well designed for dealing with persistent changes in productivity. That is what one should expect if the Fed is doing a proper job of responding to underlying changes, or shocks, to the economy. The reason the economy responds slightly more aggressively is that monetary policy is a little bit easier. That is, the interest rate is slightly lower than what would be optimal if changes in productivity were the only type of shock that affected the economy. The Fed actually eases policy a bit, and the nominal interest rate is lower under the estimated rule than under an interest-rate rule that targets the price level. This relative easing of policy pumps more money into the economy, which, in turn, supports a higher level of activity.

FIGURE 5

Sticky Prices and Fed Policy Rule



SUMMARY

The systematic portion of monetary policy has an effect on economic activity because it influences the price-setting behavior of firms and the level of demand. A constant-money-growth rule drastically inhibits the economy's ability to respond efficiently to a change in productivity, whereas an interest-rate rule that targets the price level allows the economy to respond efficiently. Further, an estimated interest-rate rule fitted to the period corresponding to Alan Greenspan's chairmanship supports efficient use of resources in our model economy when it is subjected to a persistent increase in productivity.

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Liquidity and Exchanges, or Contracting with the Producers

BY YARON LEITNER

Liquidity is a desirable feature of a well-functioning market. In this article, Yaron Leitner explains how exchanges can provide liquidity. He also discusses his recent research, which explains some contractual problems that may arise in very liquid markets, as well as the potential role of an exchange in overcoming these problems.

Liquidity — a characteristic of a well-functioning market — refers to the ability to trade easily and costlessly. In liquid markets, investors should be able to execute their trades immediately – or nearly so — without incurring significant transaction costs. This should be true for small trades as well as large ones.

In practice, trading involves some costs; that is, markets are not perfectly liquid. In this article, I will describe some of these costs and outline some of the ways in which exchanges can increase liquidity. Then I will discuss results from my recent working paper. In particular, I will show that liquid markets in which transaction costs are very low can raise a new sort of contractual problem: When an individual can easily find trading partners, he can promise the same commodity to multiple counterparties and subsequently default. I will also discuss two ways to overcome this contractual problem: The first is through collateralized trade; the second is through a very simple type of an exchange with a very minimal role.

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HOW DEALERS CAN PROVIDE LIQUIDITY

When you want to sell an asset (for example, a share of stock), you need to find an individual who wants to buy that asset. One option is to wait until such an individual arrives, then trade directly with him. Another option is to sell the asset to a dealer who will later sell the asset to that other individual. This second option allows you to execute your desired trade immediately.

Dealers help provide liquidity by being ready to buy and sell whenever the market is open. In other words, they make a market, and that's why they are also called market makers. Dealers can operate on an organized exchange, such as the New York Stock Exchange, or *over the counter* – a term that refers to a decentralized trade that does not occur on an organized exchange. Each dealer quotes two prices: a bid price and an ask price. The *bid* is the price at which the dealer is willing to buy an asset, and the *ask* is the price at which he is willing to sell the asset. The dealer can revise either price at any time, and the difference between them (ask minus bid) is called the *bid-ask spread.* For example, suppose the dealer thinks the true value of the asset is $100. To make a profit, he can quote an ask price that is higher than $100, say $102, and a bid price that is lower than $100, say, $99. This leads to a positive bid-ask spread of $3.

A large bid-ask spread may represent profits for the dealer, but it imposes costs on the individuals who buy from and sell to the dealer. In contrast, a low bid-ask spread means there are almost no transaction costs from trading. Thus, the bid-ask spread is one measure of how liquid a market is: The smaller the spread, the more liquid the market because the transaction costs of each trade are smaller.

A positive bid-ask spread does not necessarily mean that the dealer makes a profit because, as in any business, there are costs involved in being a dealer. In addition to the standard costs (for example, the dealer's time, setting up a telecommunication network, and so forth), economists have

suggested two additional costs: the cost of holding inventories and the cost of asymmetric information.

Cost of Holding Inventories. To perform his job — that is, to buy and sell upon demand — a dealer needs to hold some shares of the stock in which he makes a market.[1] In other words, he needs to hold an inventory of the stock. (This distinguishes a dealer from a broker, who does not buy or sell stocks on his own account and whose only role is to match buyers with sellers.) After he buys shares from an individual who wants to sell, the dealer needs to hold these shares until another individual who wants to buy arrives. This imposes some risk on the dealer. In particular, the dealer might lose money if the stock's value drops. Of course, any individual who holds stocks takes some risk. The main difference between the dealer and other individuals is that the dealer does not have full discretion in choosing the amount of shares he holds. He buys and sells in order to satisfy other individuals' needs. For example, a dealer might be forced to sell a particular stock at a time when the price is low because of a large buildup of buy orders. To compensate him for the fact that the amount of shares he holds may subject him to more risk than he would choose on his own, he needs to charge fees. Otherwise, being a dealer would be unprofitable.[2]

[1] The discussion that follows refers to dealers on a stock market, but the ideas apply to dealers in other markets, for example, currency markets, futures markets, options markets, and so forth.

[2] To see how a monopolist dealer (that is, a dealer who faces no competition from other dealers) optimally sets his bid and ask prices taking into account the costs of holding his inventory, read the 1981 article by Thomas Ho and Hans Stoll. Another interesting article is the one by Yakov Amihud and Haim Mendelson, who studied the behavior of a monopolist dealer who faces a constraint on the maximum number of shares he can hold.

Cost of Asymmetric Information. Sometimes an individual may have access to information before it is made public. Such an individual is called an informed trader or an informed investor. His private information may be important in determining the value of an asset. For example, after discussions with a technology firm's engineers, an industry analyst may conclude that a new computer system is likely to be highly successful. Since this information is not publicly available to all traders, we can think of this analyst as an informed trader.[3] An informed trader can benefit from his private information. If he thinks, based on his information, the price of the stock will rise, he will buy shares of that stock (and if he is correct, the price will eventually rise). Similarly, if he thinks the price is about to fall, he will sell. In other words, an informed trader buys assets that are underpriced and sells those that are overpriced.

Since different market designs may have different effects on liquidity, one may ask which market design provides traders with the most liquidity.

Now think about the dealer who stands ready to buy and sell. The dealer cannot distinguish between those who have private information and those who are buying or selling shares for other reasons, such as rebalancing a portfolio or financing the purchase of a house. But he knows that, on average, he loses money when he closes a deal with an informed investor.[4] Remember, informed traders sell when they believe a stock is overpriced and buy when they believe it is underpriced. This means that, on average, the dealer is buying overvalued stocks and selling undervalued stocks, surely a recipe for losing money. To make up for this loss, the dealer needs to make a profit when he trades with those who are not informed, and the way to do that is to set a positive bid-ask spread. In other words, when there are individuals who have information superior to that of the dealer, a positive bid-ask spread does not necessarily mean that the dealer makes a profit.[5]

[3] Certain types of trading based on superior information are precluded by law.

MARKET STRUCTURE AND LIQUIDITY

Market structure varies across different dealer markets. Since different market designs may have different effects on liquidity, one may ask which market design provides traders with the most liquidity. As we will see, the answer is not that obvious, even if we limit ourselves to structures that are relatively simple.

Thomas Ho and Hans Stoll showed that competition among dealers can lead to a more liquid market in which individuals face lower transaction costs. The basic idea is that if a dealer quotes fees that are

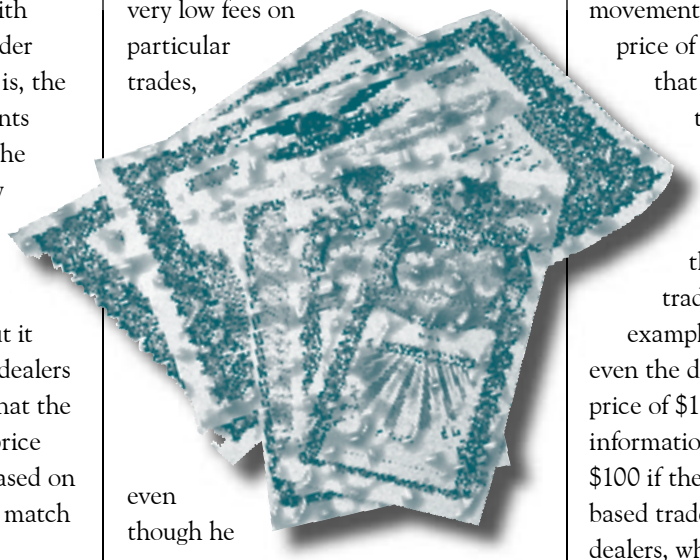
[4] The idea that a dealer may trade with individuals who have superior information is an example of what economists call an adverse selection problem.

[5] In their article, Lawrence Glosten and Lawrence Harris provide some empirical evidence consistent with the hypothesis that a significant amount of the New York Stock Exchange common stock spreads are due to asymmetric information.

too high, he loses customers to other dealers who quote prices based on their true costs.

In Ho and Stoll's model, all individuals have the same information regarding the value of the stock, so there are no informed investors to worry about. Dealers, however, take into account the costs of holding inventories. These costs may be different across dealers and may vary when the levels of their inventories vary. In particular, the dealer with the largest inventory may be under pressure to quote the best (that is, the lowest) ask price because he wants to get rid of his inventory, and the dealer with the lowest inventory can quote the best (that is, the highest) bid price. Interestingly, competition can lead to a more liquid market, but it does not necessarily imply that dealers just break even. The reason is that the dealer who can quote the best price does not need to quote prices based on his true costs. He only needs to match his nearest competitor's fee.[6]

In contrast, Lawrence Glosten suggests that in some cases, a monopolist dealer, who faces no competition from other dealers, may actually provide more liquidity than competing market makers. Glosten's model applies to specialists on the New York Stock Exchange, where each specialist is the only one who has access to the order book, listing buy and sell orders for a particular stock. Glosten ignores the costs of inventories and emphasizes the cost of asymmetric information. In his theoretical model, when dealers compete with one another, they don't have much flexibility in setting their bid-ask spreads — they always quote the lowest fees they can. In addition, each dealer needs to make sure that he does not lose money on any individual trade because if he does, he cannot make up for his losses later. Thus, each dealer quotes prices so as to break even on each trade. In other words, each dealer expects to make zero profit on each trade. In contrast, a monopolist market maker can sometimes set very low fees on particular trades, even though he expects to lose money, because he can make up for his losses later.



To see why a monopolist market maker can provide a more liquid market, consider a period in which the potential for information-based trade is very high, for example, the period in which a firm is considering a merger.[7] Competing market makers may need to set very high bid-ask spreads to compensate for the money lost to informed investors. This, however, may make trading very costly for all individuals (both informed and uninformed), who, in extreme situations, may simply choose not to trade. The result is that the market essentially shuts down until the relative number of better informed to less informed investors declines, perhaps because the firm announces that it will merge.

A monopolist dealer can also set a very high bid-ask spread, thereby preventing any trade from happening, but he need not do so. By setting a lower spread, he induces individuals to trade, so that some of the private information is revealed through price movements. (For example, the rising price of a firm's stock may indicate that investors have information that the firm will be purchased by another.) This reduces the cost of asymmetric information, thereby making subsequent trades more profitable. For example, suppose that to break even the dealer needs to set an ask price of $110 if the potential for information-based trade is high and $100 if the potential for information-based trade is low. Unlike competitive dealers, who must set a price of $110 in the first case and $100 in the second case, a monopolist dealer can quote a price of $107 in both cases. In the first case, he will lose money ($3 per trade), but he will make it up in the second case, in which he will gain $7 per trade.

In practice, market structures are usually more complex, so the choice is not just between one dealer or many dealers who compete with one another. For example, the specialist on the New York Stock Exchange has some monopoly power, but he also faces competition from individuals who submit limit orders.[8] (For example, if an individual wants to buy shares if

[6] An interesting implication of Ho and Stoll's model, consistent with evidence provided by Oliver Hansch, Narayan Naik, and S. Viswanathan, is that the behavior of each dealer depends not only on his own inventory but also on the inventories of other dealers.

[7] If a firm is contemplating a merger, it may be very difficult for it to keep information from leaking to some investors for whom trading is not illegal.

[8] Limit orders are price-contingent orders to sell if the price rises above or to buy if the price falls below a prespecified price.

the price falls below $50 per share, the specialist will be able to buy only if he quotes a bid price higher than $50.) In addition, the choice may become even more difficult because different types of investors may prefer different market structures. For example, Duane Seppi showed that it is possible that given the choice between a hybrid specialist/limit order market (like the New York Stock Exchange) and a pure limit order market (like the Paris Bourse), small retail and large institutional investors would prefer the first market, while some mid-size investors would prefer the second.

LIQUIDITY AND STRATEGIC DEFAULT

Contracting with Bialystock and Bloom. Up to this point, we have focused on the role of dealers in providing liquidity, that is, making trade easier and less costly. But when transaction costs are very low (that is, markets are very liquid), a new sort of contractual problem may arise. In particular, when it is very easy to find trading partners, an individual can promise the same commodity to multiple counterparties and subsequently default.[9]

The risk of default exists whenever an individual promises to pay or deliver cash or some other commodity in the future. For example, when I give you a loan, I face the risk that you will not pay me back. Similarly, when you and I enter a forward contract according to which in some cases I pay you (for example, if the dollar appreciates against the yen next month), and in other cases, you pay me (if the dollar depreciates against the yen next month), both of us face the risk that the other one will not pay what he promised.

An individual may default simply because he does not have the asset he's supposed to deliver. This can be either because of bad luck or because the individual did not make enough effort to ensure that he would have the cash or the asset for delivery. But default can also be strategic, that is, deliberate. In particular, when penalties are not harsh enough, an individual may default even when he has the asset he needs to deliver.

Liquid markets can exacerbate the problem of strategic default by making trading *too* easy. When an individual can easily find partners to trade with, he may have greater temptation and opportunity to promise the same asset to multiple counterparties and subsequently default. The inability to credibly pledge an asset or cash to one and only one party (or, more generally, the inability to engage in contractual relationships with one and only one party) is called *nonexclusivity.*[10] For example, in a forward market (a market where individuals enter forward contracts), nonexclusivity could induce individuals to promise too much relative to their resources, thereby creating liabilities that might exceed their income.

When an individual can enter only one contract, a punishment such as losing his reputation or losing future trading partners can induce him not to default. But when he can enter multiple contracts, losing one's reputation or even going to prison may not be a big enough threat to ensure performance because the potential gain from cheating can be very large. The following dialogue from the movie (and Broadway hit) "The Producers" illustrates this:

- Bloom: "If he were certain that the show would fail, a man could make a fortune...If you were really a bold criminal, you could have raised a million dollars, put on a $60,000 flop, and kept the rest."
- Bialystock: "But what if the play was a hit?"
- Bloom: "Well, then you'd go to jail...Once the play is a hit, you'd have to pay up all the backers, and with so many backers, there could never be enough profits to go around."

The threat of default because of nonexclusivity can make everyone worse off. Individuals may simply be afraid to trade with one another when they expect their contracting partners to default. In my working paper I suggest two mechanisms for enforcing exclusivity: collateralized trade and an exchange.

Collateralized Trade Enforces Exclusivity… Exchanges often require that individuals put up some collateral in the form of cash or other financial securities, such as stocks and bonds. (These are referred to as margins.) Over-the-counter trades often require collateral, too.

We often think of the *direct effect* of collateral on reducing strategic default: Since you lose the collateral, you have less to gain from defaulting. But collateral also has an *indirect effect:* Since individuals have limited resources, collateral requirements limit the number of bilateral contracts they can sign. (We are assuming that in pledging the collateral, the individual gives it over to a third party for safe keeping — like an escrow account — which limits his ability to pledge the

[9] The discussion that follows applies to individuals as well as to dealers who trade among themselves in the so-called inter-dealer market. Dealers often do so to balance their portfolios.

[10] To learn more about some recent work that emphasizes nonexclusivity as a contractual problem, read my working paper as well as the articles by Alberto Bisin and Adriano Rampini; David Bizer and Peter DeMarzo; Charles Kahn and Dilip Mookherjee; and Christine Parlour and Uday Rajan.

same collateral for multiple contracts.) This, in turn, limits the potential gains from a strategy of signing lots of contracts and defaulting on all of them. In other words, collateral requirements help achieve exclusivity. As we have seen, with exclusivity, existing punishments (for example, losing future trading partners) become more effective in reducing strategic default. Therefore, an individual may credibly promise to repay more than the amount of cash he posts as collateral.

…But Collateral Is Costly. While it is true that collateral can reduce default, collateral also has economic costs. Probably the most important of these costs is that the cash posted as collateral could have been invested elsewhere, for example, in some promising project. Economists refer to this type of cost — the opportunities forgone — as an *opportunity cost.* In other words, posting cash as collateral is costly because individuals could have made better use of the cash.

While the opportunity cost of collateral is likely to be more significant, there are also out-of-pocket costs involved in posting collateral, such as the legal costs of establishing clear rights of ownership and the monitoring costs of safekeeping the collateral to ensure it is not used for other purposes. The bottom line is that although collateral requirements can enforce exclusivity — thereby reducing strategic default — this may be too costly a solution.

CREATING AN EXCHANGE TO ENFORCE EXCLUSIVITY

Another way to control for the fact that individuals may make too many trades relative to their capital is to set up an exchange that imposes limits (called position limits) on the number of contracts individuals can enter.[11] Interestingly, to carry out its role of enforcing exclusivity, the exchange does not need to play other roles many real world exchanges play, such as matching buyers and sellers, acting as a dealer, or guaranteeing performance in the event of default. The exchange in my research paper is simply an institution to which pairs of individuals can report the fact that they have entered a bilateral contract. Even though its *only* role is to set limits on the number of contracts individuals can report, it can make everybody better off.[12]

Even though its *only* role is to set limits on the number of contracts individuals can report, [an exchange] can make everybody better off.

Clearly, if everyone obeyed the position limits set by the exchange, the problem of nonexclusivity would not arise and everybody would be better off. But how can the exchange make sure that everyone obeys these limits? While it may be easy for the exchange to monitor the number of contracts individuals enter through the exchange, it may be difficult and sometimes even impossible to monitor contracts that individuals may choose to enter off the exchange.

Reporting Trades May Be Voluntary. One of the main results in my working paper is that the exchange can enforce exclusivity, even if it can monitor only the contracts individuals choose to enter through the exchange. In fact, individuals will *choose* to let the exchange know about *all* their trades, even if they do not have to and even if there is some small fee involved in doing that.

Why would this be so? Keep in mind that when you and I agree not to report a trade, I'm not the only one keeping a secret from the exchange – so are you. By not letting the exchange know that you and I have signed a contract, I give *you* the opportunity to enter more contracts than permitted by the position limits. For example, if the position limit is three, and I agree to enter a contract with you without reporting it to the exchange, you now have the opportunity to enter a total of four contracts. But your incentive to default deliberately on all your contracts – including the one you have signed with me – is greater when you can sign four contracts rather than three. This is because in my model the potential benefit if you don't need to deliver on any of your contracts is unlimited (and gets higher the more contracts you enter), but the potential loss if you do need to deliver is limited because of individuals' limited liability (that is, you lose the same amount of cash whether you enter three contracts or four). Therefore, to prevent your

[11] There are other reasons why real-world exchanges impose position limits. For example, position limits are sometimes intended to prevent investors from manipulating prices.

[12] Of course, this does not mean that other roles are less important. It simply means that the role of enforcing exclusivity can be analyzed separately. Real-world exchanges almost universally carry out more than one function. However, it is often helpful to think about the minimal conditions for an institution — like an exchange — to be useful. This is one of the motivations for my working paper. Understanding the logical foundations of an exchange (as well as other financial institutions) may be important in addressing some practical questions, such as what the effect of competition among exchanges is or whether exchanges should be regulated.

default, I will insist on reporting our trade to the exchange.[13]

Position Limits Need Not Be Binding. Surprisingly, to make sure that individuals do not have the incentive to cheat by not letting the exchange know about some of their off-exchange trades, the exchange may need to set position limits that are nonbinding. For example, the exchange may need to allow each individual to enter three contracts, even though he actually enters only one. To see why, remember the example above in which everyone reported all his trades to the exchange except for you and me — we were thinking of cheating by not reporting our trade. And suppose that you would choose to strategically default only if you could enter four contracts or more, and that if you do not sign contracts with an intention to default deliberately, your best choice is to sign one contract and deliver as promised.

Now think about the effects of different position limits on your incentives. If the position limit is three and you and I sign a contract without reporting it, you will have the opportunity to enter a total of four contracts. You will do so and default on all of them — including our contract — so I will insist that we report our trade to the exchange. Now suppose the position limit is lower, say, one. If we don't report our trade, you will have the opportunity to enter a total of only two contracts, so I am assured you will not strategically default. Since I'm not worried that you will default on our contract, it makes sense for us to trade off the exchange and avoid the reporting cost. But this means that the position limit was *too low.* The position limit must be high enough so that every potential cheater stays honest because he knows his partner will double-cross him. That is, position limits need to be low enough to enforce exclusivity, but not too low.[14]

CONCLUSION

In the first part of this article, I explained how dealers can help provide liquidity and mentioned some of the costs of doing that (the cost of holding inventories and the cost of asymmetric information). Implicitly, the goal was to allow individuals to trade as easily and costlessly as possible. I also showed that it is not obvious what the best way to do that is. For example, competition among market makers can increase liquidity, but in some cases, a monopolist dealer can actually provide more liquidity.

In the second part of this article, I showed that liquid markets, in which it is very easy to find partners for trade, can raise a new sort of contractual problem: nonexclusivity. In particular, individuals can make too many trades relative to their capital and subsequently default. Then I showed how an exchange with a very limited role can overcome that problem. In particular, I demonstrated that by setting limits on reported trades, the exchange can make everyone better off — even if reporting is voluntary. I also showed that sometimes position limits must be nonbinding in the sense that traders will always choose to trade fewer contracts than permitted.

Models like mine may be useful in thinking about other complicated real-world issues, such as the information the exchange should reveal to its members regarding other members' trades or the types of markets in which it will be most valuable to form an exchange.[15] Of course, an exchange is only one type of financial intermediary. Concerns about how to enforce contracts with nonexclusivity may also be useful for thinking about the design of other types of financial institutions.

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[13] You might ask: "How do I know you will stop at four contracts? Why not five, or six, or more?" My discussion relies on the assumption that when two individuals are trying to decide whether to cheat by not reporting their trade, they simplify their decision-making problem by assuming that all other individuals report all their trades to the exchange. If I assume that everyone else is reporting all trades to the exchange, the maximum number of contracts you can enter increases by exactly one when you and I trade off the exchange. So we basically show that if everybody reports all their trades to the exchange, no one can gain by not reporting. Students of economics (as well as other fields) may recognize this as an example of Nash equilibrium. (To learn more, read a book on game theory, such as those by Robert Gibbons; Martin Osborne and Ariel Rubinstein; or Drew Fudenberg and Jean Tirole.)

[14] Usually, the concept of Nash equilibrium refers to deviations (that is, cheating) by single individuals. Here I extend the concept to include deviations by *pairs* of individuals, and I add the requirement that deviations by a pair of individuals will be self-enforcing, so that no individual of a deviating pair will double-cross his partner.

[15] For example, my model shows that in some cases the exchange should not reveal the exact number of contracts an individual has entered — it should reveal only whether the limit was reached. My model also shows that the benefits from an exchange are higher when the market becomes more liquid or when individuals have more intangible capital, such as reputation.

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What Accounts for the Postwar Decline in Economic Volatility?

BY KEITH SILL

Over the past 20 years, the U.S. economy has had fewer and shorter recessions. In addition, over time, swings in the growth of many macroeconomic variables, such as gross domestic product, have become smaller. Why this decline in economic volatility? In this article, Keith Sill highlights some of the facts about the increased stability of the U.S. economy and assesses the contribution of policy and other factors to the decline in volatility.

The U.S. economy appears to have become much more stable in the 1990s and early 2000s than it was in the 1950s, 1960s, and 1970s. We have fewer and shorter recessions, and the swings, over time, in the growth of real gross domestic product (GDP), unemployment, inflation, and a host of other macroeconomic variables have become smaller. Many explanations have been offered for this lower volatility in economic activity. Some are related to changes in the structure of the economy, such as better inventory management and the shift in employment from manufacturing industries to service industries. Some focus on the contribution of changes in monetary and fiscal policy to the increase in economic stability.

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This increase in economic stability is beneficial if it means that households face lower risk. Generally, people are risk-averse — they prefer a sure thing to an uncertain outcome. A more stable economy with fewer recessions means that employment and incomes are likely more stable. Fewer households may face the severe consequences of long-term job loss. Households, especially those that have difficulty borrowing, have less variable consumption and face less uncertainty when making their spending plans.

In this article I will highlight some of the facts about the increased stability of the U.S. economy and assess the contribution of policy and nonpolicy factors in accounting for the decline in economic volatility. We will see that a change in monetary policy since the early 1980s seems to be an important part of the story behind the increased stability of the U.S. economy.

DOCUMENTING THE DECLINE

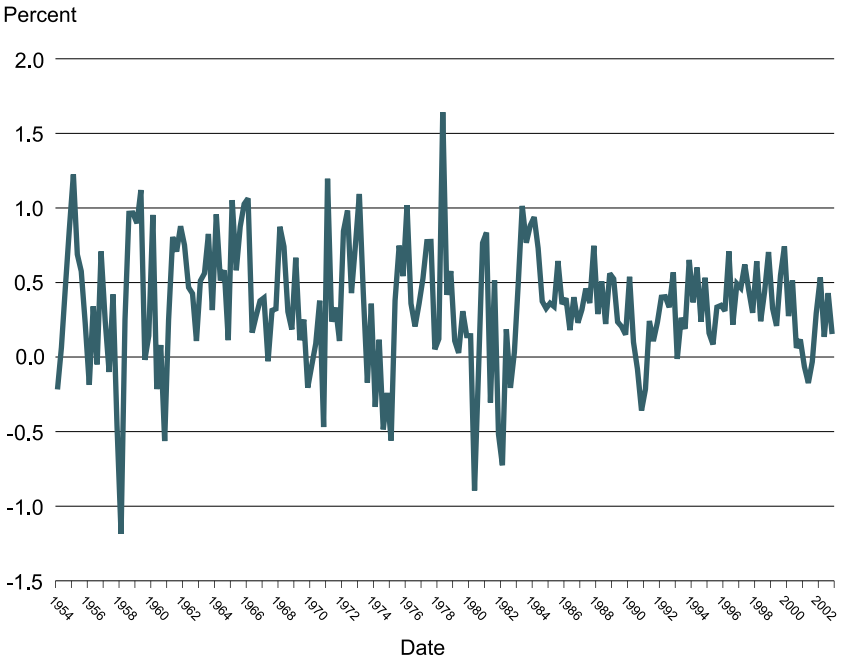
The U.S. economy has become much more stable since the 1980s. Examining the growth rate of real GDP in the U.S., we can easily see this increased stability (Figure 1). From the mid-1950s to the 1980s, quarterly growth of real GDP mostly moved in a range from about -1 to +1.25 percent. In the 1990s and 2000s, real GDP growth did not exceed 0.75 percent or fall below 0.5 percent. It is clear that swings in real GDP growth have become much smaller over the last 20 years or so.

The volatility of real GDP growth can be measured using the standard deviation, which quantifies how much a variable moves up and down around its average value. By this measure, the volatility of real GDP growth is much lower in the 1990s and 2000s than before. The table shows volatility measures for several variables by decades. In the 1960s, volatility was somewhat lower than the postwar average, before jumping up in the 1970s. Volatility was about as high in the 1980s as it was in the 1970s, then fell dramatically during the 1990s.

The table also shows the coefficient of variation for each variable by decade. The coefficient of variation adjusts the standard deviation for changes in the mean level of the variable. We see the same general pattern as with the standard deviation:

FIGURE 1

Quarterly Real GDP Growth



volatility was lower in the 1990s.

Figure 2 shows how the volatility of real GDP growth has evolved over time.[1] From the mid-1950s to the mid-1960s, volatility largely fell from a high of about 0.7 percent to a low of about 0.3 percent. From the mid-1960s to the mid-1980s, volatility generally increased, reaching almost 0.6 percent in 1982. But from the mid-1980s on, volatility has dropped dramatically, falling to below 0.27 percent by the early 2000s. On balance, it appears that the volatility of real GDP growth since the mid-1980s is, on average, about half of what it was prior to that time.

The increased stability of the U.S. economy is apparent in many macroeconomic series, not just real GDP growth. A recent paper by James Stock and Mark Watson examined the volatility of 168 macroeconomic variables, including output, employment, consumption, and investment. They find that volatility has declined broadly across many measures of economic activity. Typically, standard deviations are 30 percent to 40 percent lower now compared with what they were in the 1970s and early 1980s. In addition to the volatility of real variables, the volatility of inflation has also fallen. For example, the volatility of inflation, as measured by the standard deviation of the GDP deflator, averaged 0.39 percent in the 1960s, then rose to 0.53 percent in the 1970s and 0.60 percent in the 1980s, before falling to 0.24 percent in the 1990s.

State-level data for the U.S. show a similar decline in volatility over the postwar period. My recent work with Gerald Carlino and Robert DeFina investigated the volatility of employment across U.S. states and industries. We found that employment volatility has declined for virtually all states and across major industries

[1] The volatility of real GDP growth is measured using a 20-quarter rolling standard deviation. That is, each point on the graph represents a standard deviation calculated using the previous 20 quarters of data.

TABLE

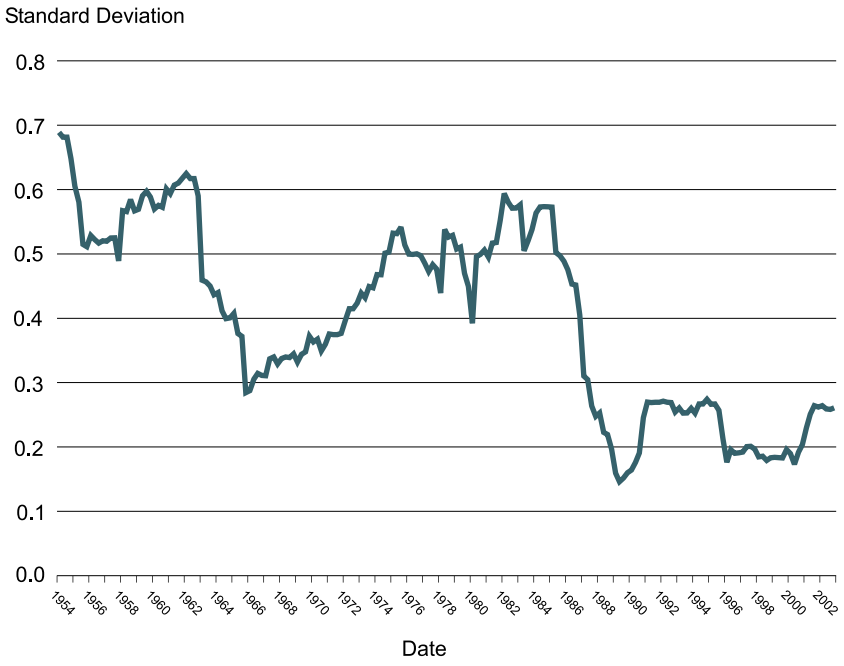
Volatility by Decade

		1950s	1960s	1970s	1980s	1990s
Real GDP Growth	Std %	0.63	0.38	0.48	0.42	0.25
	cv	1.47	0.83	1.35	1.31	0.74
Unemployment	Std %	1.28	1.08	1.16	1.48	1.05
	cv	0.28	0.23	0.19	0.20	0.18
GDP Deflator Inflation	Std %	0.74	0.39	0.53	0.60	0.24
	cv	1.18	0.63	0.32	0.53	0.43

cv is the coefficient of variation, defined as the standard deviation divided by mean.

FIGURE 2

Standard Deviation of Real GDP Growth (percentage points)



within states. Greater stability has occurred across all regions of the country and across different industries and sectors of the economy. In short, the decline in volatility is a widespread phenomenon for the U.S. economy.

Figure 2 suggests that volatility dropped abruptly in the 1980s, and much of the analysis on the increased stability of the U.S. economy suggests that the drop in volatility can be characterized as a sharp break that occurred in the 1980s. In fact, various statistical methods suggest that the drop in volatility occurred sometime around the first quarter of 1984.[2] But one might argue instead that the decline in volatility is a long-term phenomenon. Perhaps volatility was declining in the 1950s and 1960s, was interrupted in the 1970s, then resumed in the 1980s. Olivier Blanchard and John Simon (2001) suggest that the drop in the volatility of real GDP growth over the postwar period is best described by such a long-term trend phenomenon. Whether the decline in the volatility of real GDP growth is best described as a long-term trend or a sharp one-time break remains an open question.

Since the swings in real output growth have become smaller over time, the declines in real GDP growth during recessions are not as large (see Figure 1). Chang-Jin Kim and Charles Nelson calculated the average growth rate of real output in recessions and in expansions. They found that the difference in average growth rates between recessions and expansions has declined over time. Thus, recessions are not as severe and booms are not as pronounced today as they have been in the past.

Blanchard and Simon's calculations demonstrate that recessions have become shorter. They estimated models for the pre-1981 and post-1981 U.S. economy, then simulated these models to generate many alternative histories for the U.S. economy in the pre-1981 and post-1981 eras. Their estimated models imply that, on average, expansions would have lasted 17 quarters in the pre-1981 period and 51 quarters in the post-1981 period. In the data, the average length of expansions was 19 quarters before 1981 and 36 quarters after 1981. Their analysis suggests that it is more than just an absence of large shocks hitting the economy, such as sharp increases in oil prices, that is responsible for the lower volatility experienced since the mid-1980s. Something is structurally different about the economy or monetary or fiscal policy.

WHY HAS ECONOMIC VOLATILITY DECLINED?

There are many theories about why the economy has become more stable. Economists have been attempting to quantify the contribution of these potential causes to the decline in volatility. Research to date indicates that improved monetary policy accounts for perhaps 20 percent of the decline in real output growth volatility since the mid-1980s. The remainder of the drop in volatility can be attributed to various non-policy factors and to plain good luck in the form of smaller shocks. Fiscal policy has not been found to be a factor in the decrease in volatility.

Inventories. A prominent hypothesis about the drop in volatility of real output growth is that improvements in information technology have

[2] Research that puts the break in volatility as occurring right around 1984 includes that of Chang-Jin Kim and Charles Nelson, Margaret McConnell and Gabriel Perez-Quiros, and James Stock and Mark Watson.

allowed firms to better manage their inventories, thereby making production and output less volatile. Inventory behavior is a natural avenue to explore when looking for root causes of the increased stability of the economy because inventories appear to play a large role in the business cycle. For example, almost half of the fall in U.S. production during recessions can be explained by a reduction in net inventory investment, even though net inventory investment is, on average, only about 0.5 percent of GDP.[3]

Evidence presented in recent work by James Kahn, Margaret McConnell, and Gabriel Perez-Quiros suggests that most of the reduction in the volatility of real GDP can be explained by a reduction in the volatility of output in the durable goods sector. Further, the volatility of durable goods output — that is, production — dropped much more than did the volatility of durable goods sales. Changes in inventory management must account for this difference, since production equals sales plus inventories. Changes in demand now appear to lead to smaller swings in production than they did 30 years ago, which implies that swings in inventory investment now contribute less to swings in production. Kahn, McConnell, and Perez-Quiros argue that inventory investment is now better able to anticipate sales and thus has led to less volatile production.

Other researchers are unconvinced by the theory that inventory management has improved to the extent that the economy is now more stable. They find statistically significant drops in the volatility of total sales *and* the volatility of sales of durable goods. In addition, the finding that the variance of production has fallen more than the variance of sales is sensitive to how longer run trends are removed from the data. On balance, the contribution of inventory management to the decline in volatility of real output growth remains unsettled. For example, recent work by Aubhik Khan and Julia Thomas shows how just-in-time-inventory methods can actually increase the volatility of real output. Firms that hold low levels of inventories have to adjust production more frequently, which, in their model, tends to increase the volatility of real GDP.

> The contribution of inventory management to the decline in volatility of real output growth remains unsettled.

Employment Shift from Manufacturing to Services. The changing structure of the U.S. economy away from manufacturing and toward services is often cited as another potential explanation for the increased stability of the economy. Historically, the manufacturing sector of the economy has been more volatile than the services sector. However, manufacturing's share of total employment has declined relative to services' share of total employment.[4] For example, manufacturing's share of total employment was 26 percent in 1950 but had fallen to 17 percent by 1990. Services' share of employment rose from 12 percent in 1950 to 24 percent in 1990. In the early 1950s, the volatility of manufacturing employment was about 1.7 times that of services employment. By the mid-1990s, this volatility gap had fallen, though manufacturing employment was still 1.25 times as volatile as services employment.

We might expect that the overall economy would become less volatile as employment shifted from manufacturing to services. Carlino, DeFina, and I found that the shift in employment toward services played a role in the decline in employment volatility, though the role appears to be small. Adherents of the view that volatility dropped sharply in 1984 are unlikely to accept the manufacturing-to-services-shift theory because it doesn't get the timing right. We saw that the volatility of real output growth dropped sharply in the early 1980s. But the shift in employment from manufacturing to services has been a gradual process over the last 50 years. So the industry-shift theory would more likely support the notion of a gradual decline in output volatility rather than a sharp drop.

Oil Prices. Another potential factor contributing to the increased stability of the U.S. economy is the behavior of oil prices. Sharp increases in oil prices have been shown to be associated with most postwar recessions.[5] Prior to the mid-1980s, there were major oil supply disruptions associated with the Suez crisis in 1956, the Arab-Israeli war in 1973, the Iranian revolution in 1978, and the Iran-Iraq war in 1980. Since the

[3] See the *Business Review* article by Aubhik Khan for a discussion of the role of inventory investment in business cycles.

[4] However, manufacturing's share of total output has stayed at about the same level over the postwar period. Although manufacturing's share of employment has decreased over time, manufacturing workers have become relatively more productive.

[5] See the 1983 paper by James Hamilton.

Iran-Iraq war, the only significant supply disruption occurred in 1990 just prior to the Persian Gulf war. However, it is also the case that oil prices have been much more variable since 1980 than before, which makes it difficult to analyze the effect of oil prices on the post-1980 economy. This is because, in the post-1980 period, demand conditions have much more of an immediate effect on oil prices than they did pre-1980. As a consequence, it is more difficult to identify the types of oil-price shocks that can lead to downturns in economic activity.

James Stock and Mark Watson, using a statistical model, found that oil-price shocks are not a major contributor to the decline in output growth volatility. In fact, because the price of oil has been more variable in the post-1980 period, they found that oil prices tend to push up economic volatility after the mid-1980s. Sylvain Leduc and I used a model of the U.S. economy with an oil sector to examine the decline in economic volatility since the mid-1980s. We also found that oil-price shocks played almost no role in the increased stability of the economy.

Productivity Shocks. Economists have identified productivity growth as a factor that plays an important role in the lower volatility of real GDP growth. The relevant measure is total factor productivity (TFP), a broad measure of technical change. TFP growth, growth in capital stock (plant and equipment), and growth in total hours worked in production are combined to determine output growth. So TFP is the part of output growth unexplained by growth in capital stock and hours worked. If the volatility of both capital growth and hours worked is unchanged, lower volatility of TFP growth translates into lower volatility of real output growth. Indeed, a plot of the volatility of TFP growth shows a pattern that broadly mimics that of real output growth volatility (Figure 3). Volatility of TFP growth was high in the 1970s, then fell dramatically after the early 1980s.

How much does the volatility of TFP growth contribute to the decline in real output growth volatility? Estimates vary. Leduc and I found that lower TFP volatility accounted for about 80 percent of the drop in real output volatility in our model of the U.S. economy. Using state-level employment data, Carlino, DeFina, and I set TFP's contribution to the decline in employment volatility at a minimum of 4 percent to a maximum of 36 percent. Stock and Watson attributed about 15 percent of the decline in real GDP volatility to the decline in volatility of labor productivity in their model. These results suggest that the volatility of productivity is an important part of the story of the decline in real output volatility. But it is not the whole story.

Economists have identified productivity growth as a factor that plays an important role in the lower volatility of real GDP growth.

THE CONTRIBUTION OF FISCAL AND MONETARY POLICY TO INCREASED STABILITY

The nonpolicy factors discussed above are unable to account for the entire drop in the volatility of real output growth since 1984. It is possible that better monetary and fiscal policy since the mid-1980s has played a measurably important role in the increased stability of the U.S. economy. It turns out, though, that any role for policy in the recent stabilization of the economy most likely came through monetary policy, since most observers find little role for fiscal policy.

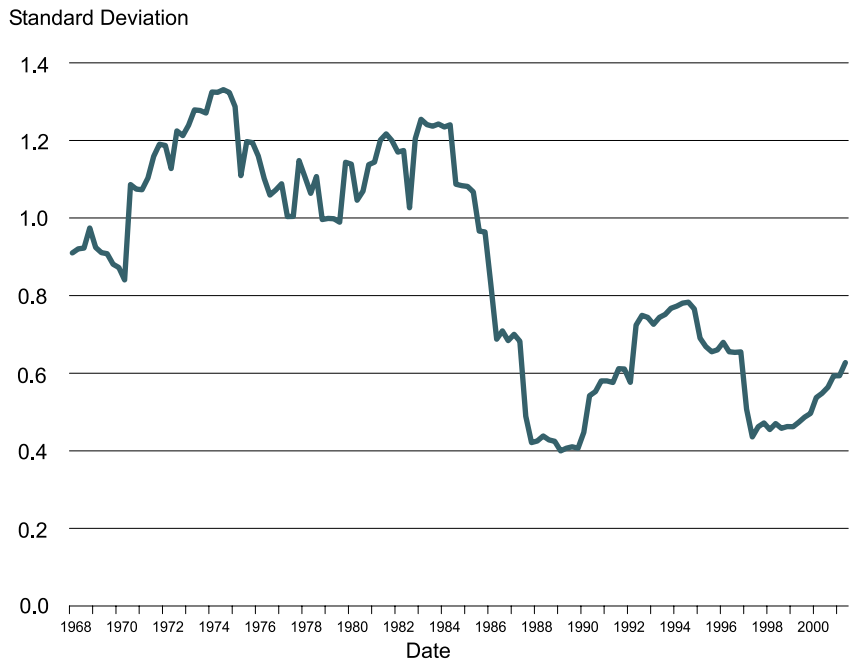
Fiscal Policy. The primary ways in which fiscal policy could play a role in stabilizing the economy are through taxing and spending. Income taxes can work like an automatic stabilizer. When incomes are high, taxes are high, and after-tax incomes are relatively low. When income is low, taxes are low, and after-tax income is relatively high. Thus, income taxes have a stabilizing effect on after-tax incomes and so may be an influence that stabilizes spending. However, fiscal stabilizers such as taxes were at about the same level in 1995 as they were in the 1960s. So, tax policy is unlikely to be much of a factor in the economic stabilization that occurred from the 1960s through the 1990s.

Fiscal policy may also help stabilize the economy through countercyclical spending policies — increasing government spending when economic growth is weak and cutting back on government spending when economic growth is strong. However, countercyclical fiscal policy does not seem any more a factor in the economy's performance after the mid-1980s than before. For example, the discretionary stimulus packages submitted by Presidents Bush and Clinton in 1992 and 1993 were defeated by Congress. In addition, discretionary stimulus packages are not a usual feature of the federal budget in nonrecessionary times. On balance, there is little prima facie evidence that fiscal policy has played a significant role in the increased stability of the U.S. economy since the mid-1980s.

Monetary Policy. Monetary policy underwent a significant change in the early 1980s as part of an effort

FIGURE 3

Standard Deviation of TFP Growth (percentage points)



to bring high and rising inflation under control. Could this anti-inflation monetary policy also lead to a more stable overall economy? In the 1980s and 1990s, it appears that the Fed responded more aggressively to movements in inflation. By not letting inflation get too high, the Fed may have mitigated, or eliminated, boom-bust cycles that led to wide swings in real GDP growth in the pre-1980s period and hence a more unstable economy.

The more aggressive monetary policy response to inflation can be seen in Figure 4, which plots the CPI inflation rate and the federal funds rate, the interest rate the Fed controls in setting its policy. Note, for example, that the federal funds rate was 4.8 percent in 1968 when the inflation rate had accelerated to 4 percent. Compare this with 1989, when inflation had again accelerated to 4 percent, but the federal funds rate was 9.7 percent. Thus, the same level of inflation was associated with a fed funds rate that was twice as high, suggesting that monetary policy was conducted differently after 1980. Monetary policymakers were willing to raise interest rates more aggressively to combat rising inflation to try to rein it in before it got too high. The Fed was trying to avoid the simultaneous high inflation and low real output growth that occurred in the 1970s.

More thorough analysis of the data suggests that indeed monetary policy shifted toward more aggressive inflation fighting around 1979, roughly coinciding with the start of Paul Volcker's tenure as Chairman of the Federal Reserve. A recent paper by Richard Clarida, Jordi Gali, and Mark Gertler found that the Fed did not raise interest rates enough in response to rising inflation in the pre-1979 era to keep from feeding inflationary pressures. Post-1979, they found that the Fed moved interest rates much more strongly in response to changes in inflation. Sylvain Leduc, Tom Stark, and I also found that easy monetary policy before 1979 contributed to persistently high inflation. Our analysis showed that, after 1979, the Fed was much more effective in using monetary policy to keep inflation under control.[6]

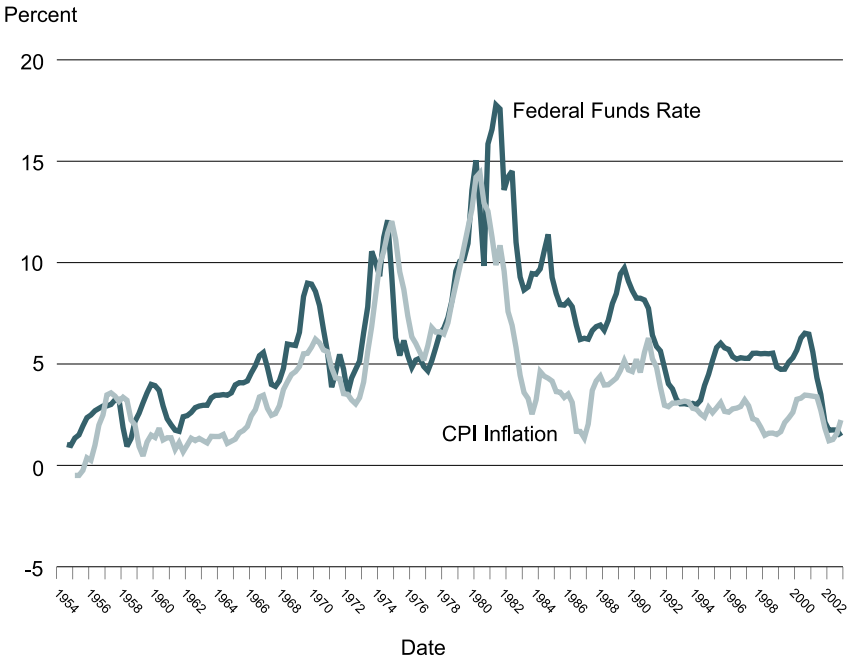
However, a recent paper by Chris Sims and Tao Zha argues that the only period since 1950 with a noticeably different monetary policy is the monetarist experiment of 1979-82, in which the Fed targeted monetary aggregates. Otherwise, monetary policy in the 1970s and post-1982 looks very similar. Sims and Zha do find that the period since 1982 is characterized by a decrease in the volatility of shocks hitting the economy. But their analysis suggests that if the volatility of shocks increases, the volatility of the overall economy could return to its pre-1980s level.

A somewhat different story is told in a recent paper by Athanasios Orphanides. He found that the Fed overstimulated the economy in the pre-1979 era, largely because it had difficulty in measuring how much real output was above or below the level it would be with everyone fully employed, that is, its potential level. If output is above its potential, monetary policymakers might decide to raise interest rates in order to slow down the economy. If output is below potential, policymakers may want to lower interest rates to stimulate growth. However, monetary policy cannot keep output growing above its potential rate indefinitely. Such a policy would eventually result in rising inflation. Orphanides

[6] See also Sylvain Leduc's *Business Review* article.

FIGURE 4

CPI Inflation and Federal Funds Rate



suggests that the Fed believed the economy was performing much worse than its potential in the 1970s and so engaged in a stimulative policy that resulted in high inflation. The Fed mismeasured the gap between actual output and potential output because it had not yet realized that potential output growth had slowed from what it was in the 1960s.

These studies found that monetary policy contributed to the high inflation of the pre-1979 era. Could such a policy have destabilized the economy and resulted in higher volatility of real output growth? If monetary policymakers do not raise short-term interest rates at least as much as the expected increase in inflation, the result can be even higher inflation that must eventually be reined in by higher interest rates and, most likely, slower economic growth.

To see this, consider the effect of interest rates on the economy. A lower real interest rate — that is, the difference between the nominal interest rate and the expected rate of inflation — can help stimulate the economy because it gives people less of an incentive to save today and more of an incentive to spend today.

Suppose the nominal interest rate is 5 percent and expected inflation is 3 percent, so that the real interest rate is 2 percent. A dollar saved today will be worth $1.05 in one year. But since prices are expected to rise 3 percent, $1 saved today will buy only 1.02 units of goods and services in one year ($1.05/$1.03 = 1.02 units). If expected inflation rises to 4 percent and the nominal interest rate stays at 5 percent, the real interest rate falls to 1 percent. Then $1 will buy only 1.01 units of goods and services in one year ($1.05/$1.04 = 1.01 units). So a dollar saved today will buy less in the future. Hence, lower real interest rates suggest a smaller incentive to save and a greater incentive to spend. Note that if the nominal rate had increased the same amount as expected inflation, there would have been no change in the real rate and no change in the units that could be purchased.

Back to monetary policy. Suppose that expected inflation rises 1 percent, and, in response, policymakers raise the federal funds rate 0.5 percent. As a consequence, the real federal funds rate — the federal funds rate less expected inflation — falls 0.5 percent. This stimulates spending and tends to reinforce inflation.

Research by Clarida, Gali, and Gertler, and research that I carried out with Leduc and Stark found precisely this type of policy behavior in the U.S. prior to 1979: Policymakers increased short-term nominal interest rates less than one-for-one with the rise in expected inflation. If policymakers truly want to slow down the economy, the fed funds rate must increase more than one-for-one with the rise in expected inflation, so that the real interest rate rises. The higher real interest rate then helps slow current spending and economic growth. After 1979, short-term nominal interest rates rose more than one-for-one with a rise in expected inflation.

These findings suggest that monetary policy was destabilizing for the economy in the earlier period and stabilizing in the later period. This change in monetary policy that occurred around 1979 could be a significant factor in explaining the drop in economic volatility in the 1980s.

Several studies have attempted to quantify how much the change in monetary policy contributed to the increased stability of the U.S. economy after the mid-1980s. Stock and Watson used a model called a structural VAR to estimate how much monetary policy matters for increased economic stability. Under various

assumptions about how certain features of the model match features of the U.S. economy, they find that from 20 percent to 30 percent of the drop in the volatility of real output growth can be attributed to the change in monetary policy. Carlino, DeFina, and I used a statistical model to measure how much monetary policy matters for the decline in U.S. employment volatility. We put an upper bound of 60 percent on monetary policy's contribution to the variation in employment volatility.

In recent work, Sylvain Leduc and I took a different approach by simulating a fully calibrated model of the U.S. economy under different assumptions about the behavior of monetary policy. Our model is a more explicit description of the economy than Stock and Watson's VAR, but it does not capture the short-run dynamics of the data as well. The benefit of our approach is that the way in which people respond to changes in monetary policy can be fully worked out in the model, so policy's contributions to the change in volatility can be more precisely quantified. We found that the change in monetary policy accounts for only about 15 percent of the drop in the volatility of real output growth — a contribution smaller than that reported by Stock and Watson.

HOW MUCH IS UNEXPLAINED?

The policy and nonpolicy factors discussed above are among the principal channels economists have looked at in trying to determine why the economy has become more stable since the mid-1980s. Measuring the contribution of these factors to the decline in volatility depends on the model used, but to use a rough measure, we might say that these factors account for much of the decline in the volatility of real output growth since the mid-1980s. Still, a significant part of the decline in volatility remains unexplained. Stock and Watson refer to this remainder as "unexplained good luck." It means that the economy was not buffeted by large and variable shocks in the 1980s and 1990s as it had been before.

> Several studies have attempted to quantify how much the change in monetary policy contributed to the increased stability of the U.S. economy after the mid-1980s.

What are these shocks? They are unexpected and unmeasured events that affect the economy, such as weather, domestic and foreign political outcomes, and labor disputes. By their very nature, these shocks are difficult to identify and measure. A consequence of this large, unexplained good luck component of the decline in volatility is that the increased stability experienced by the U.S. economy since the mid-1980s may be a temporary phenomenon. If the bad luck of the pre-1980 period were to return, economic volatility would, to some extent at least, increase.

The finding that improved monetary policy contributed to the increased stability of the economy suggests, though, that even if the unexplained bad luck of the pre-1980 period returns, the economy would not experience the same degree of volatility as before. Monetary policymakers seem more attuned to the dangers of the boom-bust cycles that may occur if inflation is not kept low and stable.

CONCLUSION

The shift in monetary policy toward stabilizing inflation seems to be an important part of the story behind the decline in economic volatility. The data indicate that keeping inflation low and stable seems to reduce economic volatility. Inflation-fighting policies appear to help reduce boom-bust cycles for the economy and promote steadier economic growth.

However, to the extent that a substantial fraction of the decline in economic volatility remains unaccounted for, it remains uncertain whether lower volatility is a permanent feature of the U.S. economy. It appears, though, that even should shocks that hit the economy become more variable, inflation-fighting monetary policy will help promote stability so that even if shocks similar to those of the pre-1980 period return, the economy would likely experience less overall volatility.

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