De-Leveraging and the Financial Accelerator: How Wall Street Can Shock Main Street*

BY SATYAJIT CHATTERJEE

The severity of the recent economic downturn raises questions about the role of financial markets in modern market economies. Why did rising defaults in a relatively small portion of the U.S. housing market cause a financial crisis? Why do financial crises have outsized adverse effects on the rest of the economy? As a general rule, a decline in economic activity in the nonfinancial sector, such as occurs during a typical recession, induces greater restraint on the part of the financial sector and that restraint — manifested usually in a pullback of credit and funding — in turn causes further setbacks to the nonfinancial sector. In the academic literature, this feedback effect is called the financial accelerator. In this article, Satyajit Chatterjee looks at what underlay the financial shock that emanated from Wall Street in the fall of 2007. Then he focuses on the channels through which the financial accelerator works and how the accelerator can turn a financial market disruption into a deep recession.

In the first quarter of 2006, when delinquencies on subprime mortgages first began their sustained rise, the unemployment rate in the United States stood at 4.75 percent. Under the impact of the ensuing financial crisis, the U.S. economy fell into recession in December 2007, and the unemployment rate shot up to 9.5 percent within a year and a half. What began as a problem in the subprime segment of the U.S. mortgage market snowballed into a full-blown financial crisis and one of the worst recessions of the postwar era.

The severity of the current downturn raises questions about the role of financial markets in modern market economies. Why did rising defaults in a relatively small portion of the U.S. housing market cause a financial crisis? Why do financial crises have outsized adverse effects on the rest of the economy?

As a general rule, a decline in economic activity in the nonfinancial sector, such as occurs during a typical recession, induces greater restraint on the part of the financial sector and that restraint — manifested usually in a pullback of credit and funding — in turn causes further setbacks to the nonfinancial sector. In the academic literature, this feedback effect is called the financial accelerator. The terminology alludes to the fact that greater financial restraint can cause a downturn to gather additional speed or lesser financial restraint can cause an upturn to do the same. When the initial shock is a shock to the financial sector itself, the financial accelerator can combine with the shock to produce a particularly steep decline in economic activity.

First we'll look at what underlay the financial shock that emanated from Wall Street in the fall of 2007, and then we'll focus on the channels through which the financial accelerator works and how the accelerator can turn a financial market disruption into a deep recession.

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

SOME BACKGROUND ON THE FINANCIAL CRISIS

The financial crisis that erupted in the fall of 2007 has its origins in subprime mortgages, that is, loans made to risky borrowers for the purposes of buying a house. The subprime segment of the U.S. housing market is relatively small, so it is puzzling that default on these loans could become the source of a major financial crisis.

One reason is *leverage*. The financial firms (commercial banks, investment banks, and hedge funds) that bought the risky mortgages funded these purchases by borrowing from other financial market participants. Thus, when these mortgages began failing, it was not just the financial firms that had bought the mortgages that got into trouble, so did the entities that had lent money to the financial firms. These entities, typically other financial firms, in turn had borrowed money to fund *their* loans; so the creditors of these other financial firms also got into trouble. Leverage is the reason that a relatively small pool of failing assets can cause a systemic problem. Leverage makes the insolvency of one financial institution a trigger for the insolvency of other financial institutions.

But leverage alone can hardly be the culprit for the financial crisis. Leverage is at the heart of efficient financial intermediation and has been a fact of life in industrial economies for centuries. A more important proximate cause of the crisis was the manner in which financial firms leveraged their purchase of risky mortgages. They funded their purchases by borrowing short term. They promised their investors that they could have their funds back within a short period of time. Since the mortgages bought would not mature until many years into the future, the cash flow from the investment was insufficient to pay off the maturing debt. The financial firms made up the shortfall by issuing *new* short-term debt. In most cases, the new debt was absorbed by existing investors. In other words, the financial firms were relying on their investors to "roll over" their loans as the loans matured. The mode of operation of financial firms was to fund purchases of long-term assets (risky mortgages) with a sequence of short-term debt. That is, they engaged in *maturity transformation.*

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While maturity transformation is part of a well-functioning financial system and financial firms will engage in it (as well as in leverage) to generate value for their investors, maturity transformation entails some risks. The danger is that if investors become nervous about a firm's solvency, they can refuse to renew their loans to the firm and thereby put the firm in a real bind. This is called a *rollover crisis*. Bank runs are a famous example of this sort of crisis. In a bank run, depositors rush to withdraw their deposits from the bank because they fear the bank will fail. Banks are subject to rollover crises because they engage in maturity transformation. They borrow very short term (in effect they tell their depositors they can withdraw funds at any time), but they use the deposits to purchase assets that pay off gradually over time. If all depositors (or a good many of them) attempt to withdraw deposits at the same time, it becomes impossible for the bank to meet its obligations.

Rising defaults on subprime mortgages in 2006 led investors to reassess the risks inherent in assets based on subprime mortgages. As the market value of these assets declined, investors became worried that *future* investors might refuse to issue new loans against these suspect assets. If that happened, the firm would be unable to pay off the new loan it was issued *today*. This lack of confidence led to a rollover crisis in which current investors refused to renew their loans to financial firms. Of course, as investors refused to renew their loans, financial firms holding suspect assets began to experience great difficulty in meeting their short-term obligations. In some cases, the firms simply went bankrupt. In other cases, the firms suffered huge losses in equity, since they had used their own funds to service their short-term obligations.

Leverage and maturity transformation were the main proximate causes of the financial crisis. But it is important to understand that these are *proximate* causes. The reasons why large financial firms engaged in this type of leveraging remain a matter of controversy. As researchers and analysts probe into the ultimate causes of the crisis, they will uncover some of the deeper reasons as to how and why financial firms got themselves into this bind. Also, it is important to remember that leverage

and maturity transformation are not problems *per se*. Perhaps the catalyst that turned these well-known forms of financial intermediation into a recipe for financial ruin was the unwelcome *concentration of financial risk* within a handful of very large financial firms. It appears that the considerable default risk of subprime mortgages was not passed on to ultimate investors such as households, corporations, pension funds, and insurance companies but was instead absorbed by a few large financial firms. Although the subprime segment of the U.S. housing market is relatively small, the concentration of the default risk of subprime mortgages in a few large financial firms ended up causing a problem for the entire financial system.

Now let's turn to a discussion of the main channels through which a loss in equity in the financial sector retards economic activity in the nonfinancial sector. The goal is to provide some perspective on the severity of the downturn that followed in the wake of the financial crisis.

DE-LEVERAGING AND THE CREDIT CRUNCH

There are several channels through which a loss in equity of financial firms has adverse effects on the nonfinancial sector. Some of these channels involve direct effects and others, indirect effects. Among the direct effects is a pullback in the supply of credit that results from *de-leveraging* by financial firms.[1]

To understand the role of de-leveraging, we need to understand the balance sheet of a financial firm. Table 1 gives a simple example of an investment bank's balance sheet. On the asset side of the balance sheet are loans made by the investment bank. Typically, these loans are made to the nonfinancial sector, which includes businesses, households, and the government. In the example, the investment bank has bought mortgages from households worth $100 and has business-sector loans worth $200. On the liability side of the balance sheet, the investment bank has debt worth $250 in the form of commercial paper and equity worth $300-$250, or $50.[2] What the balance sheet says is that the investment bank has invested $50 of its own money and $250 worth of borrowed money to purchase $300 worth of assets.

An important aspect of the balance sheet is the *leverage ratio*, defined as the ratio of the value of assets to equity; in the example, the leverage ratio is 6 (300÷50). An investment bank likes to maintain a *target leverage ratio* that is low enough so as to assure investors who lend it money that there is a high probability their loans will be repaid. In the example, the investment bank can sustain losses of up to $50, or one-sixth of the value of its assets, and still be in a position to pay off its creditors. The higher the leverage ratio, the less capacity the investment bank has to absorb losses without affecting its creditors.[3] It stands to reason that an investment bank's target leverage ratio will ultimately depend on investors' perception of risk in the financial system. During periods of low perceived risk, the target can be expected to rise, and during periods of high perceived risk, the target can be expected to fall.

The important point is that an adverse shock to the market value of assets causes the leverage ratio to rise above its target. To understand why, suppose the market value of the mortgages held by the bank declines by 20 percent. In dollar terms, this is a loss of $20. Generally accepted accounting principles (GAAP) require the investment bank to record the value of mortgages on its books at current market value. Thus, the bank is required to mark down the value of mortgages on its books from $100 to $80. This means that the bank's equity (which is simply the difference

[1] The role of de-leveraging in the pullback of credit is discussed at length in the article by Adrian Tobias and Hyun Song Shin.

[2] Commercial paper is an unsecured promissory note issued by large banks or corporations with a maturity date of less than one year. Since the loan is not backed by collateral, only highly reputable firms can issue commercial paper.

[3] A target leverage ratio is not directly observable (since financial firms do not announce it), but its value can be inferred from the observed behavior of financial firms. See the article by Allen Berger, Robert DeYoung, Ozde Oztekin, and David Lee for evidence in support of target leverage ratios.

TABLE 1

Assets		Liabilities	
Mortgages	$100	Commercial Paper	$250
Business Loans	$200	Equity	$50
Total	$300	Total	$300

between the value of its assets and the value of its liabilities) drops from $50 to $30 ($280-$250) and its leverage ratio rises to 8 1/3. If the bank's target leverage ratio was 6 to begin with, the loss in the market value of assets results in a leverage ratio higher than the target.

An increase in the leverage ratio above its target value makes investors less eager to lend to the investment bank. Investors will demand a higher interest rate on any new commercial paper issued by the investment bank (to compensate for the higher risk of loss) or stop buying the bank's commercial paper altogether. Thus, market forces make it hard for the bank to maintain the same level of short-maturity debt as before.[4] At this point, the investment bank must either raise more equity or reduce its assets (both of which will lower its leverage ratio). Raising equity is usually not much of an option for banks in the midst of a financial crisis, although some financial firms did raise equity in the early phase of the current crisis and have returned to equity markets in recent months. Typically, in a crisis, the adjustment in the leverage ratio is accomplished by reducing assets. For instance, in the example above, the bank might bring its leverage ratio back to 6 by reducing its loans to the business sector from $200 to $100, with a corresponding $100 reduction in commercial paper (from $250 to $150). The bank's balance sheet after this adjustment will be as shown in Table 2.

The amount by which the investment bank must reduce its assets is closely related to the leverage ratio it would like to maintain, in this case 6. For every dollar decline in equity, the bank must reduce assets by $6. Therefore, a $20 decline in equity requires the bank to shrink its assets by $120. Taking into account the fact that the $20 decline in equity was triggered by a $20 decline in the value of mortgages, the bank must reduce its assets by an additional $100 ($120-$20).

This process of reducing the leverage ratio by reducing assets in the wake of a loss in equity is called *de-leveraging*. The important point to note is that since the leverage ratio is a number quite a bit greater than one, de-leveraging can convert any given decline in equity into a much larger decline in investment bank assets. Since a bank's assets are mostly loans to the nonfinancial sector, de-leveraging results in a constriction in the flow of credit to nonfinancial firms. A reduction in the supply of credit, in turn, raises the firm's cost of credit, thereby reducing firms' demand for investment goods and consumer spending by households and, ultimately, lowers employment.

Two additional points are worth making. First, how much assets have to fall because of de-leveraging also depends on what happens to the target leverage ratio following the initial shock to equity. At the start of the current crisis, the rise in uncertainty caused investors to look for lower leverage ratios than was customary in the recent past. This, in turn, led investment banks to lower their target leverage ratio and that became an additional factor in the de-leveraging engaged in by financial firms. To continue with our example, suppose that the new target leverage ratio is 4 instead of 6. Then, starting from the position shown in Table 2, the new balance-sheet position might look like the one in Table 3. To get its leverage ratio down to 4, given equity of $30, the firm must reduce its asset holdings to $120 ($30 times 4). Thus, it must reduce its assets by $60 ($180-$120). In the example in Table 3, the reduction is accomplished by reducing mortgages and business loans by $30 each. On the liability side, the bank's commercial paper declines by $60 (from $150 to $90).

Second, a reduction in investment bank debt (in the example, commercial paper) goes hand-in-hand with the de-leveraging. Given this, it is important to ask: What happens to the funds that investors were formerly lending to this bank? In a crisis, the funds end

[4] It is worth pointing out that the leverage ratio is closely related to a bank's *capital ratio*, a ratio that plays an important role in bank regulation. The capital ratio is simply the ratio of bank equity (capital) to a risk-weighted sum of bank assets. As such, it is closely related to the inverse of the leverage ratio. A rise in the leverage ratio will be accompanied by a decline in the bank's capital ratio. If a bank's capital ratio falls below the level determined by regulation, the bank is required by law to take steps to increase its capital ratio. Thus, an increase in a bank's leverage ratio resulting from a drop in asset values may force a bank to take steps to lower its leverage ratio for regulatory reasons.

TABLE 2

Assets		Liabilities	
Mortgages	$80	Commercial Paper	$150
Business Loans	$100	Equity	$30
Total	$180	Total	$180

up in the hands of entities that can borrow with very low risk of default. Economists refer to this re-allocation of funds from risky borrowers to safe borrowers as a *flight to quality*.[5] Of course, the safe assets are bought from existing holders of these assets, who are likely to use the proceeds from their sale to obtain other safe assets, such as deposits at commercial banks. So the process of de-leveraging during a crisis is likely to increase deposits at commercial banks, and if commercial banks do not lend out this new inflow of funds, it will also increase the reserves that the banks hold with the Fed. Thus, during a crisis, the process of de-leveraging tends to move funds out of circulation and into reserves, which also puts downward pressure on the inflation rate as money in circulation tends to fall (or grow more slowly).[6]

FALLING PROPERTY VALUES, DEBT CAPACITY, AND THE FINANCIAL ACCELERATOR

The decline in the flow of credit resulting from de-leveraging also has adverse consequences for property values. The reason is that the value of many properties, such as residential homes and office buildings, is sensitive to the free flow of credit. When credit is not easily available, people and businesses cannot easily buy houses and commercial property. This causes a drop-off in the demand for such property and results in a fall in their market price. For instance, when a homeowner who wishes to sell his or her house cannot find many buyers who can get financing (to buy the house), he or she may be tempted to drop the asking price. The same is true for commercial properties.

A decline in the value of residential and commercial properties has further consequences for the level of aggregate spending. The reason is that a decline in property values reduces the *debt capacity* of businesses and households — which is the maximum amount they are permitted to borrow — and thereby reduces business investment and consumer expenditures (and, ultimately, aggregate output). Thus, falling property values lead to a decrease in credit offered to the nonfinancial sector. This effect is what economists call the *financial accelerator*. To understand how the financial accelerator works, we need to understand why there is a debt capacity and why it declines with property values.[7]

Commercial and residential properties often serve as collateral in business and household borrowing. For instance, a business that wishes to expand its operations could finance the expansion by taking out a loan from a bank using its property as collateral for the loan. What this means is that if the business cannot repay the loan, the bank (the lender) takes ownership of the property offered as collateral against the loan. Banks typically only make loans against collateral because doing so makes the loans less risky and encourages borrowers to spend the borrowed funds wisely (poor use of the funds results in the loss of the collateral). Naturally, there is a close connection between the value of the collateral and the size of the loan offered against it. Banks are typically willing to lend up to some fraction of the value of the property offered as collateral. The maximum amount that banks are willing to lend against the borrower's property is the borrower's debt capacity. When there is a decline in the value of property that can be offered as collateral, there is a decline in the debt capacity of the nonfinancial sector.

The reduction in debt capacity reduces the flow of credit to firms with productive uses for funds. Even in the midst of a severe downturn, there will be businesses that can put funds to good use. There will also be some financial intermediaries (the ones unscathed by the crisis, perhaps)

TABLE 3

Assets		Liabilities	
Mortgages	$50	Commercial Paper	$90
Business Loans	$70	Equity	$30
Total	$120	Total	$120

[5] See the article by Evan Gatev and Philip Strahan and the article by William Lang and Leonard Nakamura for evidence on the "flight to quality" during earlier contractionary episodes.

[6] A consequence of de-leveraging is that safe borrowers get to borrow at a lower interest rate. This could potentially mitigate the contractionary effects of de-leveraging except that the primary beneficiary of the flight to quality tends to be the government, not the private sector.

[7] This discussion draws upon the ideas in the article by Ben Bernanke and Mark Gertler and the article by Nobuhiro Kiyotaki and John Moore, especially the latter.

that will be eager to lend. But when the debt capacity of businesses is lowered by a decline in property prices, businesses with good uses of funds cannot borrow as much as they would like. This financial constraint curtails business investment and eventually leads to an output level that is lower than it would be in the absence of a decline in debt capacity.

A decline in debt capacity is also the reason a decline in home equity depresses consumer spending. As has been remarked upon many times during the current crisis, households borrow against their home equity to pay for all kinds of consumer expenditures. These expenditures go well beyond home improvement projects (which remain a main motivation for home equity loans) and encompass expenditures for which it would be hard to get a loan directly. A decline in residential property prices reduces how much households can borrow because the property (the house in this case) being offered as collateral is worth less.[8] Once again, even in the midst of a crisis, there will be households that would like to borrow more than their (reduced) debt capacity, and these households will have to reduce their spending. To the extent that the decline in household debt capacity constrains business investments by small businesses that rely on the owners' assets to get loans, the decline will have deleterious effects on future output and employment as well.

Every decline in property prices reduces the debt capacity of the nonfinancial sector and thereby adds fuel to the financial accelerator. The downturn gathers further speed and feedback effects kick in: As unemployment rises and economic activity declines, property prices decline even more, which leads to further decreases in debt capacity and further decreases in expenditures, output, and employment.

Eventually, this downward spiral in property prices and economic activity comes to a halt, in part because the financial accelerator begins to lose its potency. Recall that the accelerator works through a reduction in debt capacity, which is the maximum level of debt the nonfinancial sector can borrow (given existing property prices). But when economic activity is quite low, debt capacity is not what constrains investment on the part of firms and households. They reduce their investment simply because investment is not remunerative when the general level of economic activity is low. When that stage is reached, a further decline in property prices and debt capacity does not cause additional reductions in expenditure and output because there are very few entities (businesses or households) that would want to borrow more than their debt capacity allows. The downward spiral is also arrested in part because of policy actions. Accommodative monetary and fiscal policies shore up expenditures and therefore offset, to some extent, the decline in expenditures that stems from the operation of the financial accelerator.

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OTHER FACTORS FEEDING THE ACCELERATOR

The previous section began with the observation that the credit crunch adversely affected property prices because property prices are sensitive to the free flow of credit. Given the magnitude of the financial shock and the consequent de-leveraging, the credit crunch is probably an important factor in the decline in property values. However, other factors have played a role in the decline in property values as well and have therefore fed the financial accelerator. We discuss the more important channels here.

As already noted, declines in residential house prices result in declines in home equity and therefore a decline in debt capacity. If the household already has an existing mortgage, the decline in house values can lead to home equity becoming negative. That is, the value of the debt owed becomes larger than the value of the property. In this situation the homeowner may choose to default on his or her mortgage. In the run-up to the crisis, many families bought homes with very low down payments. Consequently, the decline in house prices has resulted in many families having negative home equity. The result has been a huge rise in foreclosures.[9] Foreclosures, in turn, depress house prices. Foreclosed properties are sold at a heavy discount because lenders (banks) that end up

[8] If the household has a mortgage against the property already, only the value of the house in excess of the outstanding mortgage — the owner's *home equity* — can be offered as collateral against the new loan. A decline in the value of residential property reduces home equity dollar for dollar.

[9] For an excellent discussion of the connection between negative home equity and mortgage defaults, see the article by Ronel Elul.

owning them find it costly to hold on to the houses. As the number of foreclosures rises, the increased presence of sellers willing to sell homes at low prices puts downward pressure on the price of *all* properties, including those not in foreclosure.

In addition, foreclosures reduce the demand for housing space because families who lose homes in a foreclosure end up renting less space than they owned. They end up renting because they cannot get a new mortgage after defaulting on the previous one, and they rent less space than they owned because renting does not have the tax advantages that homeownership does. Thus, the overall demand for housing space declines with foreclosures. This puts further downward pressure on house prices.[10]

The decline in house prices also reduces the *household net worth* of families who do not go into foreclosure. Household net worth is the difference in the value of all household assets and all household liabilities. It is a measure of household wealth. As house prices decline, the value of household assets declines. But there is no immediate change in household liabilities (if the household does not choose to default on the mortgage), and therefore, there is a decline in household wealth. Lower wealth translates into lower spending because families feel poorer and spend less. Economists refer to this as the *wealth effect*. The negative wealth effect of a decline in household net worth lowers consumer spending, which lowers output and employment and further depresses property prices.

Increased uncertainty about the future also plays a role in reducing current output and depressing property prices. Greater uncertainty (higher probability of both good and bad outcomes) makes firms and households delay decisions that cannot be easily reversed. Most investment decisions fall into this category so that uncertainty reduces expenditures on business fixed investment.[11] Greater uncertainty (especially uncertainty regarding future earnings prospects) increases a household's desire for precautionary savings (a rainy-day fund), which reduces aggregate consumer spending. Overall, uncertainty can be a potent force for lowering business and household investment and is undoubtedly an important factor in the current downturn.[12] It should be noted that the increase in the precautionary savings on the part of households and firms (firms that delay investments park their funds in safe financial assets) also means that these entities allocate more of their funds to safe assets, and this is another factor putting downward pressure on the yield on safe assets and, ultimately, causing funds to move out of circulation and into bank reserves.

In sum, there are a host of factors working to reduce property prices in the wake of the crisis. The severity and speed of the current downturn reflects, in part, the operation of the financial accelerator. The good news is that the financial accelerator works both ways. As economic activity begins to revive, perhaps because of accommodative government policy or some good shock, desired investment on the part of firms begins to rise. At first, firms that desire to borrow less than their debt capacity (unconstrained firms) are the ones that can get funding to undertake their investment. But new investment (and rising economic activity more generally) puts upward pressure on property prices. As property prices begin to recover, *constrained* firms (firms that would like to borrow more than their debt capacity) can borrow more as well because the increase in property prices increases their debt capacity. Of course, additional investment increases aggregate output in the short run and, eventually, in the long run, as well. Thus increases in property prices provide extra impetus to the rise in economic activity in the same way that declines in property prices provided extra impetus to the decline in economic activity at the start of the downturn.

Increased uncertainty about the future also plays a role in reducing current output and depressing property prices. Greater uncertainty makes firms and households delay decisions that cannot be easily reversed.

CONCLUSION

In the wake of the financial crisis, the U.S. economy has suffered one

[10] The interaction between the foreclosures, the tax code, and the demand for housing space was investigated in my recent paper with Burcu Eyigungor.

[11] The role of uncertainty in delaying investment is discussed in the article by Ben Bernanke and in the book by Avinash Dixit and Robert Pindyck.

[12] A discussion of how uncertainty affects consumer spending can be found in my recent *Business Review* article. It is worth noting that there has been a sharp increase in the personal savings rate in the U.S. since the crisis began. The savings rate averaged less than 2 percent in 2007 but rose to around 4.5 percent in 2009 and remains elevated.

of the worst recessions of the post-World War II era. There is little doubt that this episode will be the focus of research and analysis for a long time to come and our understanding of the origins of the crisis and its aftermath will evolve over time. At this point, we can only give provisional answers to the question: Why did rising defaults in the subprime mortgage market cause a financial crisis that led to such a severe downturn?

This article suggests that leverage and maturity transformation are the proximate reasons as to why defaults in a relatively small segment of the U.S. housing market led to a financial crisis. And the severity of the downturn is most likely the result of an interaction between declining property prices — brought on by de-leveraging in the financial sector — and the consequent decline in the debt capacity of the nonfinancial sector. This interaction, called the financial accelerator in the academic literature, has the potential to feed on itself and cause a large — and more or less simultaneous — decline in property prices and economic activity. This diagnosis has implications for the future: If the financial accelerator played a role in making the downturn steep and quick, we may expect it to play a role in the recovery as well. When the recovery takes root, the workings of the accelerator will tend to make it sharp and rapid.

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Monetary Policy in a Liquidity Trap*

BY MICHAEL DOTSEY

In the United States, the Federal Reserve sets monetary policy by targeting the federal funds rate. This process usually involves lowering short-term interest rates when economic growth is weak and raising them when economic growth is strong. A wide class of economic models has shown that, in theory, conducting policy in this way allows the economy to employ resources efficiently. In addition, many empirical studies have shown that most central banks actually behave in this manner. In normal times, it is fairly easy for the central bank to conduct policy in this fashion. But there is one instance when conducting policy in this manner becomes problematic: when the economy finds itself in a "liquidity trap," a situation in which the short-term nominal interest rate is zero or very close to zero. In this article, Mike Dotsey analyzes the difficulties a central bank faces in such circumstances and discusses the tools available to monetary policymakers. Policy as usual is not an option, and the central bank's framework for conducting policy must change.

Monetary policy typically operates by targeting a short-term interest rate. For example, in the United States, the Federal Reserve targets the federal funds rate. In order to conduct monetary policy, central banks generally vary the short-term interest rate target in response to economic conditions. They do so because setting the short-term interest rate at a level consistent with economic fundamentals generally attains both the most efficient level of output[1] and an inflation rate consistent with long-run inflation objectives.

This process usually involves lowering short-term interest rates when economic growth is weak or inflation or expected inflation is below some desired rate and raising them when the economy is growing strongly or when inflation or expectations of inflation are high. It has been theoretically shown in a wide class of economic models that conducting policy in this way allows the economy to employ resources efficiently. Low and stable inflation is a desirable feature of a well-managed economy, and setting the interest rate in a pro-cyclical manner is consistent with economic efficiency.

This way of conducting monetary policy is not just theoretically sound. Many empirical studies have shown that most central banks actually behave in this manner. This description of monetary policy — varying the interest rate in response to inflation and economic activity — is called a Taylor rule or a Taylor-type rule, named after John Taylor, who first described these types of policies.

In normal times it is fairly easy for the central bank to conduct policy according to a Taylor-type rule. But there is one instance when conducting policy in this manner becomes problematic: when the economy finds itself in a "liquidity trap," which is defined as a situation in which the

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

[1] The efficient level of output is the output that would occur if all prices and wages were continuously adjusted in response to changes in economic conditions.

short-term nominal interest rate is zero or very close to zero.

Because the nominal interest rate is generally bounded below by zero, the central bank cannot lower interest rates further even if it would be desirable to do so, as it would be if the economy were in a deep recession. Furthermore, as I'll discuss below, in this situation, trying to stimulate the economy by injecting more money or liquidity through open market operations may have little or no effect on output. Therefore, it may appear that monetary policy is impotent under these conditions.

This article analyzes the difficulties a central bank faces in such circumstances and discusses the tools available to monetary policymakers. Policy as usual is not an option, and the central bank's framework for conducting policy must change. Importantly, it must change in ways that alter individuals' expectations of what policy will be like when the zero lower bound on interest rates is no longer binding.

Thus, the conduct of monetary policy becomes quite subtle and depends on the credibility of proposed future actions. Further, economists have been concerned about the design of appropriate monetary policy in a liquidity trap for quite some time, and in what follows, I will draw heavily on the work of Gauti Eggertsson and Michael Woodford; Alan Auerbach and Maurice Obstfeld; and Paul Krugman.

ECONOMIC PROBLEMS ASSOCIATED WITH A LIQUIDITY TRAP

To understand the economic problems that ensue when an economy is in a liquidity trap, we must first understand the concept of the real interest rate and its role in efficiently allocating economic resources. What follows will be a fairly abbreviated analysis.[2]

The real interest rate, defined as the nominal interest rate less expected inflation, plays an important role in determining what fraction of output is consumed and what fraction is invested. In a perfectly competitive economy, the movement of the real interest rate in response to economic shocks is consistent with the optimal allocation of economic resources. That is, the real rate responds in such a way that the level of output and its allocation between consumption and investment is the one that provides the highest level of economic welfare. This interest rate, which is associated with perfect competition, is generally referred to as the economy's natural interest rate. For example, strong economic growth is associated with an opportune time to make investments, especially if that growth is generated by increased productivity. At such times, consumers are also wealthier and hence desire more consumption. In order to induce enough saving for financing the optimal quantity of investment, the real interest rate rises. Thus, resources are allocated toward increasing the capital stock, which, in turn, results in higher future output, higher future consumption, and higher wages. Analogously, when the economy is weak, the real interest rate falls, and when the economy is very weak, the real interest rate may even become negative. A negative real interest rate is sometimes observed during recessions.

Generating a Liquidity Trap. If the economy is sufficiently weak that a real interest rate below zero is desirable, it is possible for the economy to enter a liquidity trap. As indicated above, the real interest rate is defined as the nominal interest rate minus the expected rate of inflation. But this means that the nominal interest rate is the sum of two components: the real interest rate and the expected rate of inflation. This relationship is known as the Fisher equation. Importantly, the nominal interest rate cannot be negative because no one would lend at a negative rate. If they did, they would get less money back than they lent, and they would be better off putting their money in their mattress. Thus, in a liquidity trap, when the nominal interest rate is zero and a negative real interest rate is also desirable, the Fisher equation implies that expected inflation must be equal and of opposite sign to this negative real interest rate. Therefore, the desirability of a negative real interest rate implies the desirability of positive expected inflation.

If features of the economy prevent prices from adjusting flexibly, expected inflation may, in the end, not be high enough to generate a sufficiently low real interest rate. The monetary authority is also unable to lower the nominal rate below zero. Thus, in addition to the economic shocks that are

The real interest rate, defined as the nominal interest rate less expected inflation, plays an important role in determining what fraction of output is consumed and what fraction is invested.

[2] For a more detailed discussion, see my 2004 *Business Review* article.

responsible for the recession, interest rates cannot adjust in an optimal way. The presence of the liquidity trap places the economy in even greater jeopardy. Furthermore, because money and bonds are now perfect substitutes — each is earning a zero rate of interest — the inflation rate is not a current monetary policy phenomenon. The fact that both assets are now earning the same zero rate of interest implies that the public is indifferent between the relative amounts of money and bonds in its portfolio.[3] Therefore, current open market operations that alter the amount of bonds and money in public hands have no impact on inflation. Second, with no opportunity cost for holding money, the public is willing to hold just about any amount of money the central bank supplies. Thus, current injections of money have little effect on prices or inflation. This is why the occurrence of a zero nominal interest rate is called a liquidity trap.

However, future monetary policy can prove effective in the current environment, but understanding the subtle and indirect way in which that happens requires an understanding of how monetary policy affects prices in more normal times.

Controlling the Price Level and Inflation. In normal times, standard economic models suggest that a central bank should adjust the short-term nominal interest rate one-for-one with perceived movements in the real interest rate. This type of policy engenders an efficient economic response to the various types of disturbances that affect economic activity. Moreover, this type of policy is consistent with a policy of low and stable inflation. Only policy changes that move the real interest rate by larger amounts than dictated by underlying economic fundamentals have a substantive effect on inflation and economic activity. For example, a severe tightening of policy raises the short-term real interest rate above its efficient or natural level, temporarily choking off consumption and investment. The tightening of policy also brings down inflation. A good example is the disinflation during the tenure of Fed Chairman Paul Volcker, when the Fed maintained very high nominal and real interest rates. This policy contributed to the two ensuing recessions and a significant lowering of the inflation rate. The opposite occurs when the central bank reduces the real interest rate below its natural rate. The result is temporarily higher output and an increase in the inflation rate.

In normal times, standard economic models suggest that a central bank should adjust the short-term nominal interest rate one-for-one with perceived movements in the real interest rate.

However, a liquidity trap is a time when the central bank would like to bring the real rate down. Therefore, in theory, the central bank should desire an increase in near-term inflation that makes the real interest rate negative enough so that the economy is able to best cope with the fundamental factors that have reduced output growth. For example, suppose the natural real interest rate is -3.0 percent and inflation expectations are 1.0 percent. The zero lower bound on nominal interest rates implies that the real interest rate in financial markets can, at best, be lowered to -1.0 percent. To lower the real rate to the natural rate would require a nominal rate of -2.0 percent, which is impossible.

This higher-than-natural real rate will serve to choke off aggregate demand beyond what occurs due to economic disturbances, and the economy will be in for a deeper recession than it otherwise would be. This is the situation in which the liquidity trap has *severe* consequences and why all central banks endeavor to keep the economy out of these circumstances.

As discussed, this is also the situation in which the nominal rate cannot be lowered further, and standard monetary policy that relies on simple Taylor-style interest rate rules is helpless in ameliorating the weakness in the economy. Unfortunately for Japan in the 1990s and the U.S. economy today, this is where we find ourselves. Fortunately, there are policies the central bank can follow that will mitigate the effects of the liquidity trap, but policies in this situation involve departing from normal operating procedures and the rules that normally govern monetary policy. As a result, these alternative policies may be difficult to communicate, and because liquidity traps are rare events, these policies may not be deemed fully credible since the public has little experience with these situations, as well.

MONETARY POLICY IN THE LIQUIDITY TRAP

Credibility is an essential feature of the simple policy I will discuss and a feature of any successful

[3] Currency earns a zero rate of interest and other types of money, such as bank reserves, have, until quite recently, earned a zero rate of interest. When short-term bonds, such as Treasury bills, earn a positive rate of interest, holding money incurs an opportunity cost in terms of forgone interest.

monetary policy during a liquidity trap, and it may be an even more important ingredient than when the economy is functioning under normal circumstances.[4] The reason is that the central bank must depart from its normal behavior, and the public, having little experience with a liquidity trap, may not believe that policy has actually changed. Absent perfect credibility, the policies described below would lead to very different and much less beneficial economic outcomes.

If the economy is in a liquidity trap and the weakness in the economy is significant, it may be desirable to generate an increase in inflation expectations. In our previous example, lowering the financial real interest rate to a desirable -3.0 percent requires inflation expectations to increase to 3.0 percent. However, doing so requires the public to believe that future inflation will indeed reach 3.0 percent.

The success of altering future policy also requires that the economy not be in the liquidity trap forever. Historically, all instances of actual liquidity traps have been temporary. The current crisis appears to be temporary as well, and it appears that the public believes this to be the case. That inference is based on the fact that long-term interest rates are currently positive. Because long-term interest rates are an average of current and future short-term interest rates, a positive long-term interest rate implies that at some point in the future short-term interest rates will be positive as well. Hence, the evidence from long-term bond markets indicates that the zero lower bound will not last indefinitely. Liquidity traps, fortunately, appear to be temporary phenomena.

Role of Nominal Interest Rate in a Liquidity Trap. We have emphasized that there is nothing current monetary policy can accomplish while the economy is in a liquidity trap. However, once economic activity recovers to the point at which the nominal interest rate is positive, monetary policy can influence the level of economic activity. So at some point in the future, a lower-than-normal future short-term nominal interest rate will stimulate future economic activity.

Generating increased output growth in the future can have consequences for current output. Investment now becomes more attractive, and firms may be reluctant to lay off as many workers if they are confident that higher than normal output is around the corner. Expectations of better times ahead will also stimulate current consumption. The cost of the future monetary stimulus will be that future inflation would be higher than it otherwise would have been.

Thus, in a standard theoretical model a commitment by the central bank to temporarily increase future inflation above what it would be in the absence of a liquidity trap is a beneficial policy response when the economy is in a liquidity trap. The central bank makes such a commitment because the gain in economic activity more than offsets the cost of somewhat higher inflation. But because the commitment pertains to future actions, it will have an effect only if the policy is believed. This feature is an important component of the influential work of Gauti Eggertsson and Michael Woodford, who have analyzed the liquidity trap in great depth. An important theme resonating throughout their analysis is policy's ability to influence expectations and, importantly, inflationary expectations over long horizons. By doing so, the monetary authority influences the term structure of real interest rates and thereby influences current aggregate demand.[5] So, even in an environment where both prices and inflation respond slowly to economic shocks and monetary policy, the policies prescribed by Eggertsson and Woodford have substantial effects.

In a standard theoretical model a commitment by the central bank to temporarily increase future inflation above what it would be in the absence of a liquidity trap is a beneficial policy response when the economy is in a liquidity trap.

In their work, Eggertsson and Woodford show that the zero bound can cause a significant problem for monetary policy in the case in which the interest rate rule does not change when the economy exits the liquidity trap. That is, a Taylor-type rule that works fine in normal times may not work so well when there is a zero lower bound problem.

[4] For a discussion of the importance of credibility in general, see my 2008 article and the Federal Reserve Bank of Philadelphia's 2007 annual report.

[5] The term structure of interest rates describes the relationship between interest rates on bonds of varying maturities.

A particularly important result of their analysis is that many policies advocated in the popular press when the economy is in a liquidity trap with zero nominal interest rates are not useful. In particular, in their framework, not only are current open market operations, which exchange short-term bonds for money, irrelevant, but temporarily providing additional bank reserves through increased open market operations will have no effect on the economy, irrespective of the types of assets the monetary authority purchases.

This last result occurs because efficient pricing of, say, long-term bonds that are currently yielding a positive interest rate can have an effect on behavior only if those purchases imply a change in the path of short-term rates. This is because, as mentioned, long-term rates are merely an average of short-term rates.[6] Thus, any policy response today that does not also reflect a change in future policy will not affect future economic activity. Therefore, it will not affect future short-term interest rates and hence should not affect the long-term bond rate in any meaningful way.

Two features of their model are responsible for the ineffectiveness of large-scale increases in central bank liabilities, often called quantitative easing: (1) any increases in money at the zero bound is done through open market operations and, therefore, does not affect the value of government liabilities, and (2) any increase in money, even if it is accomplished via government transfers, is transitory. Thus, as in the analysis by Alan Auerbach and Maurice Obstfeld, for increases in money to be beneficial, the increase must be permanent. By necessity, the underlying interest rate rule must change once the economy escapes from the zero lower bound. If policy returns to a normal interest rate rule, the money injected during the liquidity trap will have to be withdrawn to ward off an increase in the inflation rate. But this action would be inconsistent with the higher inflation promised while the economy was in the liquidity trap. Hence, if the public believes that upon exiting the liquidity trap the central bank would immediately return to normal policy, the promise of additional near-term inflation would not have been believed in the first place.

Thus, a policy that permanently changes the monetary base today must also be associated with a change in the interest rate rule if it is to have effects. It is not just the current setting of the interest rate that is important, but the path that policy sets for future short-term interest rates matters as well. This is analogous to saying that the systematic component of policy is important and that more importance should be attached to what will be done in the future than what is done today.

But there is an additional subtlety here. As mentioned, a change in future policy implies that the central bank must tolerate additional inflation in the future even after the zero bound is no longer a problem. This policy leads to less deflation at the zero bound and greater output growth in the future. The increase in future output growth implies greater output growth in the present, when the zero lower bound is binding, and implies that the natural interest rate is somewhat higher in the current environment than it would be absent the promise of future inflation. Thus, Eggertsson and Woodford show that the economic losses associated with a real interest rate that is too low can be reduced.

A policy that permanently changes the monetary base today must also be associated with a change in the interest rate rule if it is to have effects. It is not just the current setting of the interest rate that is important, but the path that policy sets for future short-term interest rates matters as well.

A SPECIFIC POLICY

Eggertsson and Woodford provide specific policy advice for the central bank when a liquidity trap occurs. The specifics of their proposal are complex and particular to their model. However, they suggest that dealing with the public's expectations when the economy is in a liquidity trap will take some skill on the part of any central bank. Interestingly, in their framework, a simple price-level targeting rule comes very close to achieving the best outcome, and such a policy should be relatively easy to communicate. Rather than targeting inflation per se, as is typical of most central bank behavior, in a liquidity trap, the central bank should actually target the path of prices.[7] The

[6] Eggertsson and Woodford's argument is in fact more general and encompasses the government's purchase of any asset.

[7] For a detailed discussion of price-level targeting, see the article by Alexander Wolman.

important distinction is that a price path implies that should inflation be relatively low today so that the price level is below its target, future inflation must increase to get the price level back on track. Therefore, the occurrence of deflation would require higher future inflation, and as we have seen, somewhat higher than normal inflation is a useful mechanism for ameliorating the adverse effects of a liquidity trap.[8]

A price-level target is a way of formalizing that policy prescription. Because no central bank employs a price-level target, that could make credibility for this option problematic. The proposal could be couched as a time-varying inflation target, whereby the targeted inflation rate would be the rate that would get prices back to the price-level path. But, again, the public has little experience with such a rule. Thus, establishing credibility for future expansionary policy is an essential, but perhaps difficult, feature of successful policy at the zero lower bound.

Thus, a central message of Eggertsson and Woodford's research is that the monetary authority must be able to commit to expansionary policy once the zero-lower-bound problem is alleviated. In particular, it must commit to higher inflation than would otherwise occur if the zero bound had not been reached. A proposal of raising the price of long-term debt or, equivalently, lowering long-term interest rates is consistent with the optimal lower future path of short-term rates. It could, therefore, be useful for a central bank to buy large quantities of long-term debt as a way of signaling its intention to increase near-term inflation and inflation expectations. In this case, not carrying through on its implied promise would result in a fall in bond prices and a capital loss for the central bank.[9]

A LARGE INCREASE IN THE FED'S BALANCE SHEET

However, a potential challenge from the standpoint of the monetary authority is that once higher short-term inflation is realized, the public will alter its expectations of inflation and the central bank will now be facing an inflation scare and the problems that accompany a departure of inflation expectations from target.

A lack of perfect credibility, which may be an unavoidable reality, acts as a two-edged sword that makes dealing with a liquidity trap difficult.

Problems such as these have been well documented in Marvin Goodfriend's study and discussed in my essay with Charles Plosser.

Thus, a lack of perfect credibility, which may be an unavoidable reality, acts as a two-edged sword that makes dealing with a liquidity trap difficult.

Without full credibility, it is hard to generate an increase in inflation beyond what the public would normally expect, and if that inflation is generated, it subsequently may be difficult to return expectations of inflation to ones that are consistent with price stability. As discussions in the media suggest, the current large increase in the Federal Reserve's balance sheet could represent such a threat to the credibility of the Fed's long-run inflation target.[10]

The concern being expressed is that if it becomes difficult to unwind some of the assets currently on the balance sheet, the future money supply could be permanently higher. However, with interest rates returning to normal levels, the demand for money will not be permanently higher. A permanent increase in the money supply without a permanent increase in money demand can only lead to higher prices and higher inflation.

Currently, there is every expectation that the Fed will successfully reduce its balance sheet as the banking system recovers, and survey data on inflation expectations confirm this belief. Managing that expectation is thus an important part of policy, as evidenced in a number of speeches by Federal Reserve policymakers, including Philadelphia Fed President Charles Plosser.[11] It has become increasingly important for the Federal Open Market Committee (FOMC) to articulate an exit strategy and to indicate to the public that it will follow an exit strategy that does not ignite future inflation.

[8] In other models, such as the one in the study by Andrew Levin, David Lopez-Salido, Edward Nelson, and Tack Yun, a price-level target does not duplicate optimal policy nearly as well. Their model calls for even more aggressive policy, which leads to a permanent increase in the price-level path.

[9] Alternatively, as Lars Svensson has suggested, the central bank could deflate the value of the currency using an exchange-rate peg. Doing so would require purchasing foreign assets, and this policy may also be useful in establishing credibility for higher inflation. If higher inflation is not forthcoming, the home currency would appreciate, and the foreign assets on the central bank's balance sheet would depreciate, resulting in a capital loss for the central bank.

[10] The size of the Federal Reserve's balance sheet has more than doubled from $954 billion on September 17, 2008, to slightly more than $2 trillion as of August 26, 2009.

[11] See, for example, the speech by Charles Plosser.

Indeed, the FOMC has been quite explicit concerning its intentions for maintaining long-run price stability.

SUMMARY

This article describes the difficulties of conducting monetary policy when there is a liquidity trap. A very weak economy can require negative real interest rates, and rates that are sufficiently negative can be hard to achieve when the short-term nominal interest rate is bounded below by zero. Although, in theory, generating increased expectations of future inflation is helpful, this may be difficult to achieve because standard monetary policy that targets a nominal interest rate is ineffective once nominal interest rates have reached zero. Achieving the necessary increase in expected inflation falls on promises of future policy, but successfully accomplishing this goal may require credibility for temporarily deviating from the central bank's long-run inflation target. Furthermore, that deviation, if successful, could result in the public's no longer believing in the long-run target. The central bank could face a future destabilization of inflation expectations and all the problems that ensue when that occurs.

Thus, a liquidity trap is a perilous place for the economy and a central bank. Successfully navigating a liquidity trap requires open communication and transparency because it requires the public to understand not only current policy but future policy as well.

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Hiring, Job Loss, and the Severity of Recessions*

BY R. JASON FABERMAN

The hiring and firing decisions of individual businesses are one of the drivers behind movements in the unemployment rate during expansions and recessions. Whether a recession is driven by large job losses or weak hiring will greatly affect the composition and consequences of the unemployed and can have important policy implications. The extent to which recessions are times of weak hiring or high job loss depends in large part on the severity of the downturn. A recession is a time when the fraction of businesses that are expanding goes down and the fraction of businesses that are contracting goes up. A severe recession is one in which the shift in this distribution is more dramatic. In this article, Jason Faberman discusses how the severity of a recession determines whether high job loss or weak hiring will be the more important source of declining employment and rising unemployment through disproportionate changes in the distribution of business-level employment growth.

What drives movements in the unemployment rate during expansions and recessions? Obviously, much of it is driven by the hiring and firing decisions of individual businesses. When businesses hire more workers than they lose (whether those workers leave voluntarily or involuntarily), employment expands and the unemployment rate tends to go down. When businesses lose more workers than they hire, employment contracts and the unemployment rate rises. This does not mean, though, that boom times are driven entirely by hiring and recessions are driven entirely by job losses. For example, if firms cut back sharply on their hiring with little change in the number of workers they lose, the unemployment rate would rise because people would find it harder to find new work.

Whether a recession is driven by large job losses or weak hiring will greatly affect the composition and consequences of the unemployed and can therefore have important policy implications. Laid-off workers can come from a variety of backgrounds. Oftentimes, these workers lose valuable human capital in the process, especially if the laid-off employees are older, more experienced workers with a lot of job-specific skills. Weak hiring affects all individuals looking for work: those who were recently laid off, those just entering the workforce (e.g., recent graduates), and those who are currently employed but want a new job. Weak hiring implies that there are fewer jobs to apply for, which makes it more difficult for the unemployed to find work.

The recessions of the 1970s and 1980s, as well as the most recent downturn, saw steep declines in employment and sharp increases in unemployment. At the same time, the pace of layoffs was very high but relatively short-lived. In comparison, the fall in employment and the rise in unemployment during the 1990-91 and 2001 recessions were much less severe. During these recessions, there was a moderate rise in job losses but a rela-

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

tively steep drop in hiring, particularly during the 2001 recession. Furthermore, the 1990-91 and 2001 recessions had declines that persisted well after the official end of the recession.[1]

In academic circles, the contrast in behavior has led to two diverging views on recessions and the labor market. Some economists, such as Robert Hall and Robert Shimer, focus on the more recent downturns and take the view that rising unemployment during recessions is driven by weak hiring and hence a low probability that the unemployed will find a job. Others, such as Shigeru Fujita and Garey Ramey, and Michael Elsby, Ryan Michaels, and Gary Solon, cite the historical evidence and argue that rising unemployment is driven by high rates of job loss.

In reality, the extent to which recessions are times of weak hiring or high job loss depends on the severity of the downturn. Severe recessions are typically characterized by a sharp drop in output and large amounts of job loss, while moderate recessions are characterized by smaller declines in output and relatively weak hiring. These results come about because, at any point in time, there is a *distribution* of businesses that are expanding, contracting, or keeping their employment steady. A recession is a time when the fraction of businesses that are expanding goes down and the fraction of businesses that are contracting goes up. A severe recession is one in which the shift in this distribution is more dramatic. Furthermore, when businesses expand or contract by a certain amount, they tend to do so with a fairly consistent mix of hiring, quits (voluntary worker separations), and layoffs (involuntary worker separations). Fast-growing businesses tend to have mostly hires, fast-declining businesses tend to have mostly layoffs, and businesses with smaller employment changes tend to have a mix of hiring, quits, and layoffs that occur simultaneously. During a severe recession, the number of businesses with large contractions increases sharply. As a result, the layoff rate at the national level increases drastically. In contrast, a mild recession generally has a smaller increase in the number of contracting businesses, so the resulting drop in hiring at the national level can outweigh the more modest rise in the layoff rate.

HIRES, SEPARATIONS, AND BUSINESS GROWTH

The Difference Between Gross and Net Employment Changes. To understand how the above findings come about, we need to start with the basic fact that the *net* change in employment that we observe from the Employment Situation Report of the Bureau of Labor Statistics (BLS) each month is the result of literally millions of workers either starting or leaving a job at thousands of businesses.[2]

We can examine *gross* changes in employment in two ways: by tracking the movements of the workers or by tracking the employment behavior of the businesses that employ them. Shigeru Fujita details the first approach in an earlier *Business Review* article, and he shows that following the *flow* of workers between employment, unemployment, and nonparticipation in the labor force provides much more information on the state of the labor market than looking at, say, the unemployment rate or employment growth alone.

The second approach provides more insights as well, and it turns out to be more useful for our purposes. Using it allows us to relate what are often called *worker flows*, which are the gross amount of hires or separations occurring in the economy, to the employment growth (or decline) at individual businesses. Separations are the sum of all quits, layoffs, and any other type of separation, such as a retirement, and the change in a business's employment is simply the difference between its total hires and total separations. For example, if a business hired three people and had one separation, its employment will have expanded by two jobs. Given that businesses can have hires while contracting and separations while expanding, one can have complex interactions between worker flows and business-level employment growth.

Movements in National-Level Worker Flows over Time. Next, we need to know what the national-level patterns of the worker flows look like. The Job Openings and Labor Turnover Survey (JOLTS) of the BLS reports the total amount of hiring, quits, and layoffs at all businesses in the economy each period. The data measure the monthly rates of total hiring and total separations as a percent of total employment, with the latter broken out into quits (those who leave their jobs voluntarily), layoffs (those who are separated involuntarily), and other separations (e.g., retirements).[3] The JOLTS time series begins only in December 2000 but now covers two recessions.

[1] Here, "official" dates refer to the business cycle peaks and troughs as designated by the National Bureau of Economic Research (NBER).

[2] The statistics in the Employment Situation Report come from two surveys: a monthly payroll survey, Current Employment Statistics, which surveys businesses about their employment, and a monthly household survey, the Current Population Survey, which queries households about the employment behavior of their members.

[3] Other separations are a very small fraction of total separations and vary little with the business cycle, so I ignore them in this article.

Figure 1 illustrates how the JOLTS aggregate estimates behave over time. The 2001 recession officially started in March and ended in November of that year, but employment losses (as measured by the BLS payroll survey) continued until August 2003. The current recession began in December 2007. Figure 1 shows a clear decline in both hiring and quits during these downturns, suggesting that these two flows are *procyclical*; that is, they rise and fall in sync with economic activity. It also shows a very modest rise in layoffs during the 2001-03 period and a more noticeable increase in the 2008-09 period, suggesting that layoffs are at least somewhat *countercyclical*: Layoffs go up when economic growth goes down.

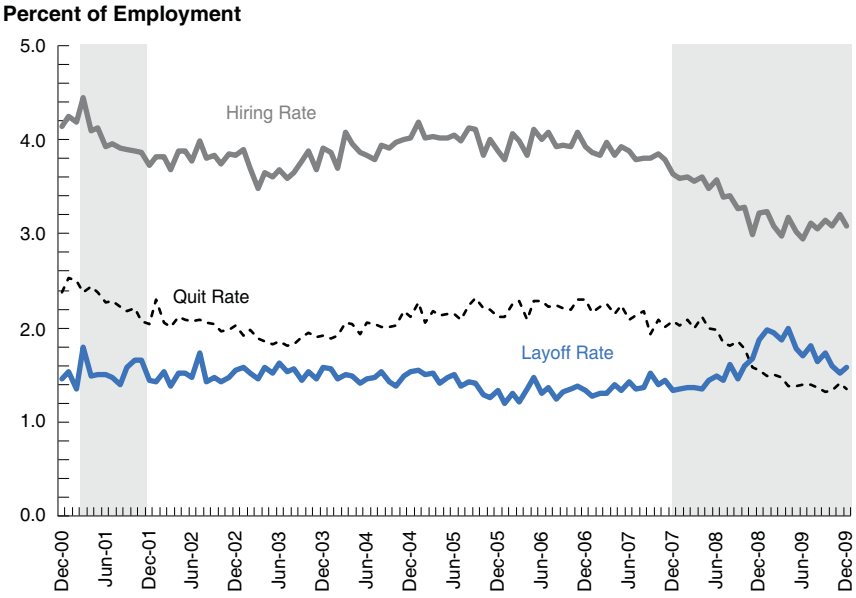
Figure 2 illustrates that other measures of job loss, such as the job destruction rate (a summary measure of employment losses at all contracting businesses) for manufacturing employment reported in the BLS Business Employment Dynamics (BED) data, and the Department of Labor's data on initial unemployment insurance (UI) claims by the recently laid-off, provide stronger evidence of the countercyclicality of job loss. They also show that the rate of job loss spikes sharply during the deep recessions of the 1970s, 1980s, and the current downturn relative to the rises in the 1990-91 and 2001-03 periods.

How Business-Level Changes Relate to the National-Level Data. Finally, we need to know how the hires and separations at the business level aggregate to the national-level statistics observed in Figures 1 and 2. To do so, it is useful to think of the national-level worker flow statistics in Figure 1 as weighted averages of each worker flow rate across individual businesses. The key insight from the weighted average approach will be that movements in worker flows at the national level can come from one of two sources: changes in business-level worker flow rates or changes in the *distribution* of business-level activity.

For our purposes, we want to relate the worker flows to the business-

FIGURE 1

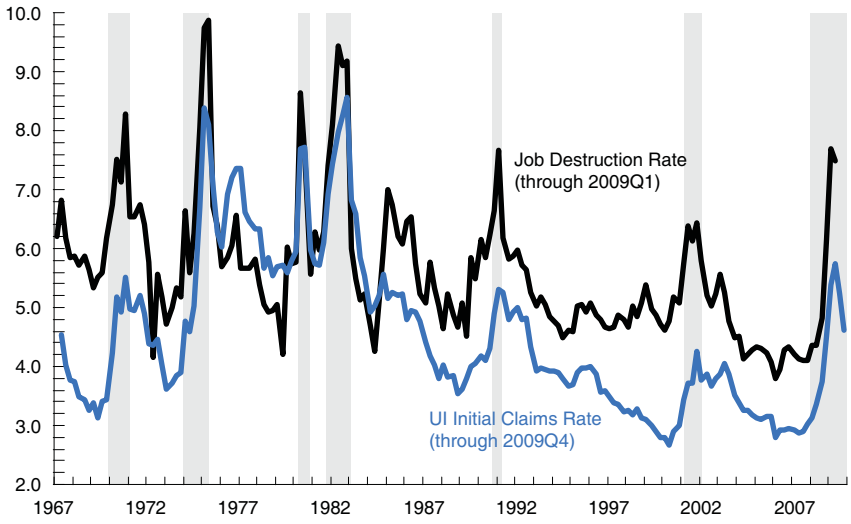
Hiring, Quits and Layoffs, 2000-2009, JOLTS Data



Source: Author's tabulations from published JOLTS statistics

FIGURE 2

Quarterly Job Destruction and Unemployment Insurance Initial Claims, 1967-2009



Source: Job destruction rates are estimates for manufacturing from my working paper, updated through 2009 with published BED data. The UI claims rate is total weekly claims (in all sectors) during the quarter as a percent of total employment, from published UI claims statistics.

level employment growth rates, and the example below illustrates the relationship. It splits all businesses into contracting, stable, and expanding businesses and then calculates the average worker flow rates and employment shares for each group. Suppose that, for a given period, estimates from the business-level micro-data provided us with the employment shares and worker flow rates shown in Table 1.

In Table 1, 25 percent of businesses are losing workers on net, 45 percent have no change in their employment, and 30 percent are adding workers on net. All three groups have some amount of both hiring and separations (defined as the sum of quits and layoffs here). At the contracting businesses, the average separation rate must be higher than the average hiring rate (both measured as percentages of the businesses' employment); otherwise, they would not be contracting. The opposite is true of the expanding businesses. At the stable businesses, the hiring and separation rates exactly offset each other. As we will see below, the numbers in this example are similar to what we observe in an average month in the U.S. data. Stable businesses have the lowest average hiring and separation rates because many of them have no employment changes at all in a given month.

Putting the data in our example together, we get the following formulas for deriving what the national-level hiring and separation rates will be in this case:

$$\textit{National-Level Rate} = \left(\begin{array}{c}\text{Share of}\\ \text{Contracting}\\ \text{Businesses}\end{array}\right)\left(\begin{array}{c}\text{Avg. Rate at}\\ \text{Contracting}\\ \text{Businesses}\end{array}\right) + \left(\begin{array}{c}\text{Share of}\\ \text{Stable}\\ \text{Businesses}\end{array}\right)\left(\begin{array}{c}\text{Avg. Rate at}\\ \text{Stable}\\ \text{Businesses}\end{array}\right) + \left(\begin{array}{c}\text{Share of}\\ \text{Expanding}\\ \text{Businesses}\end{array}\right)\left(\begin{array}{c}\text{Avg. Rate at}\\ \text{Expanding}\\ \text{Businesses}\end{array}\right)$$

National-Level Hiring Rate = (0.25)(2.0)+(0.45)(1.0)+(0.30)(12.0) = 4.550 percent

National-Level Quit Rate = (0.25)(4.0)+(0.45)(0.5)+(0.30)(2.0) = 1.825 percent

National-Level Layoff Rate = (0.25)(7.0)+(0.45)(0.5)+(0.30)(1.0) = 2.275 percent

In each case, we see that the national-level estimates average across the hiring or separation rates of the three groups using their share of total employment as a weight. The difference between the national-level hiring rate (4.55 percent) and the national-level quit and layoff rates (1.825+2.275 = 4.10 percent) implies that total employment grew, *on net*, by 0.45 percent. Just as it is in the actual JOLTS data, this is a much smaller number than the 4.55 percent of workers who were just hired this month.

Now, if we were to expand our example to include finer growth rate intervals (e.g., businesses that grow or contract less than 1 percent, 1 to 2 percent, etc.), we would get the following formula:

$$WF_t = \sum_g s_{gt} wf_{gt},$$

where WF_t is the national-level worker flow rate (i.e., hiring, quits, or layoffs) in period t, s_{gt} is the share of employment at businesses with a growth rate of g in period t, and wf_{gt} is the average worker flow rate for businesses with a growth rate of g in period t. Thus, the weighted average expression shows that movements in worker flows at the national level can come from either changes in business-level worker flows (i.e., changes in wf_{gt}) or changes in the distribution of business-level employment growth (i.e., changes in the business-level weights, s_{gt}).

THE EVIDENCE ON BUSINESS-LEVEL EMPLOYMENT BEHAVIOR

Figures 3 and 4 illustrate what the "real-world" equivalents of the business-level worker flow rates, the wf_{gt}, look like. The figures show estimates of the average hiring, quit, and layoff rates as a function of the business-level employment growth rate built from the JOLTS business-level micro-data in my paper with Steven Davis and John Haltiwanger. Figure 3 shows that the hiring rate rises proportionately with the growth rate when growth is positive and

TABLE 1

	Contracting Businesses	Stable Businesses	Expanding Businesses
Share of Employment (Employment in Group/ Total Employment)	25.0	45.0	30.0
Average Hiring Rate (Hires/Employment)	2.0	1.0	12.0
Average Quit Rate (Quits/Employment)	4.0	0.5	2.0
Average Layoff Rate (Layoffs/Employment)	7.0	0.5	1.0

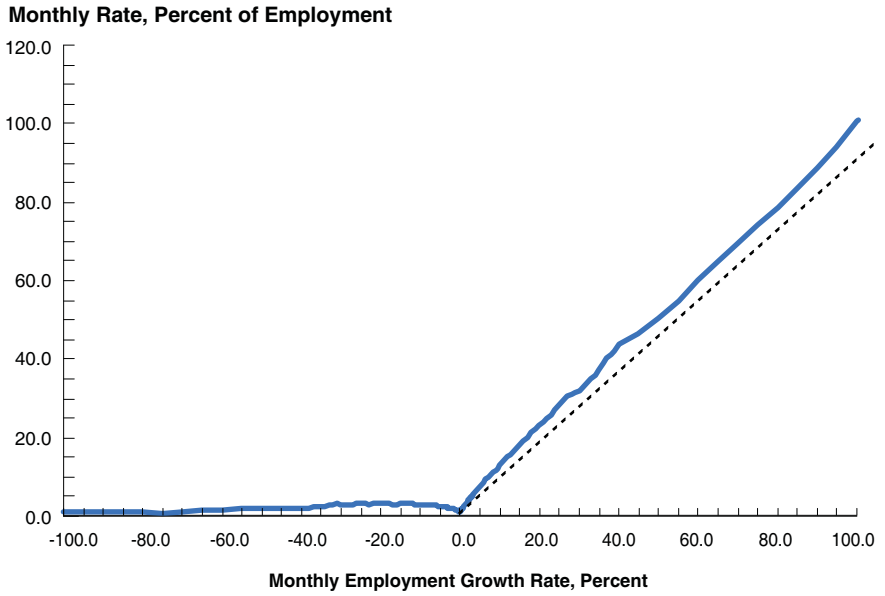
is essentially flat when growth is negative. Figure 4 shows that the layoff rate increases proportionately with the size of a contraction when growth is negative but layoffs are essentially flat when growth is positive. It also shows that the quit rate increases when a contraction is relatively small and that quits are essentially constant (albeit at a higher rate) during larger contractions. Like the layoff rate, the quit rate is essentially flat when growth is positive. Comparing Figures 3 and 4, we see that the hiring and layoff rates at the business level exhibit opposing "hockey-stick" patterned relationships to business-level growth.

The two figures tell us that when a business expands employment by, say, 10 percent, it tends to do so with a hiring rate of 13.5 percent because, on average, 2.5 percent of its workforce will quit and another 1 percent will be either laid off or discharged as it tries to expand. Similarly, when a business wants to contract by, say, 10 percent, it will lay off only 5 percent of its workforce because, on average, 7.9 percent will leave, of which the business will replace 2.9 percent, on average, to counteract some of the turnover.

Figure 5 shows how the shares of employment at businesses with different growth rates, the s_{gt} terms, change over time by showing the business-level employment growth rate distribution at two points: one for a period of high national-level employment growth (i.e., an expansion) and one for a period of low national-level employment growth (i.e., a recession). As the economy moves from expansion to recession, the distribution shifts to the left, meaning that the s_{gt} shares for growing establishments go down and the s_{gt} shares for contracting establishments go up. While the shift may appear subtle, the statistics listed in the figure

FIGURE 3

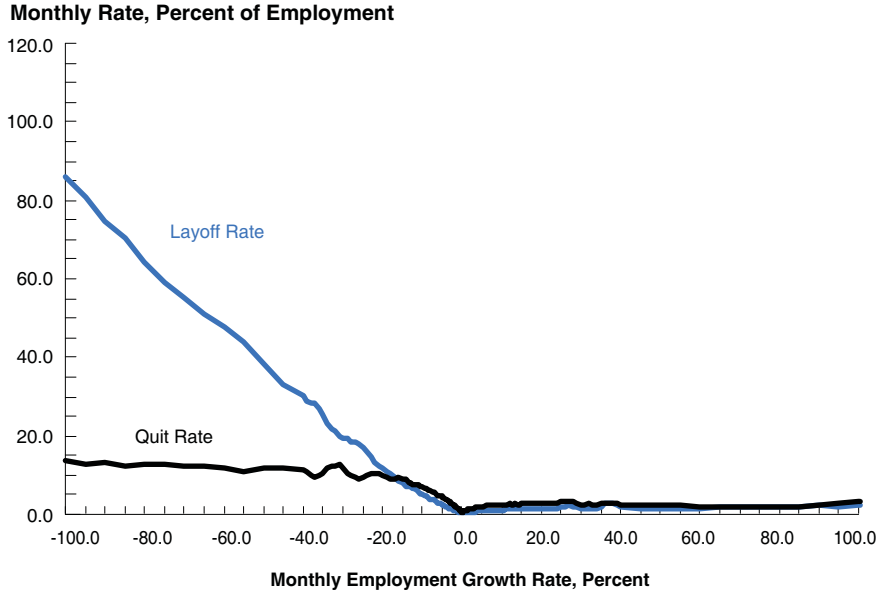
Hiring vs. Business-Level Growth



Source: Estimates from my study with Steven Davis and John Haltiwanger, which uses establishment micro-data from JOLTS pooled over 2001-2006. The dashed line represents a 45-degree line emanating from the origin.

FIGURE 4

Separations (by Type) vs. Business-Level Growth



Source: Estimates from my study with Steven Davis and John Haltiwanger, which uses establishment micro-data from JOLTS pooled over 2001-2006.

show that the changes for businesses with high growth or large contractions are substantial. Moving from an expansion period to a recession period reduces the share of employment at businesses with high growth (greater than 10 percent of employment) from 18.7 percent to 14.1 percent. This reduction corresponds to changes that affect roughly 6.2 million workers.

Figure 5 also shows that the shift in the distribution is *asymmetric*: The shift skews the distribution of employment away from a small range of expanding businesses and toward a broad range of contracting businesses. Figure 5 shows that when moving from expansion to recession, the fraction of employment at high-growth businesses falls 4.6 percent, while the fraction of employment at businesses with a large contraction rises 6.3 percent.

Finally, it turns out that the worker flow rates depicted in Figures 3 and 4 barely change over time, as my research with Steven Davis and John Haltiwanger shows.[4] Therefore, the movements in the national-level worker flows observed in Figure 1 occur primarily through the shifts in the growth rate distribution depicted in Figure 5.

IMPLICATIONS FOR CYCLICAL EMPLOYMENT CHANGES

The fact that the growth rate distribution tends to have an asymmetric shift when moving into a recession is an important reason some recessions are driven by relatively high job loss, while others are driven by relatively weak hiring. The example in Table 2 shows how an asymmetric shift toward contracting businesses can produce a modest drop in the national-level hiring rate but a considerable increase in the national-level separation rate.

Suppose the economy from the previous example falls into recession, causing the growth rate distribution to shift to the left. Assume that the shift is asymmetric, just as it is in Figure 5.

In the example in Table 2, the fraction of employment at declining businesses rises by 10 percentage points, while the fraction of employment at growing businesses falls by 5 percentage points. The difference is made up by a 5-percentage-point fall in the fraction of employment at stable businesses. We assume that the business-level hiring and separation rates are the same as before, consistent with what we find in the data. Recall that the previous shares of employment at contracting, stable, and expanding businesses produced a hiring rate of 4.55 percent, a quit rate of 1.825 percent, and a layoff rate of 2.275 percent at the national level. With the new employment shares, national-level hiring and separation rates are now:

National-Level Hiring Rate =
(0.35)(2.0)+(0. 40)(1.0)+(0.25)(12.0)
= 4.10 percent

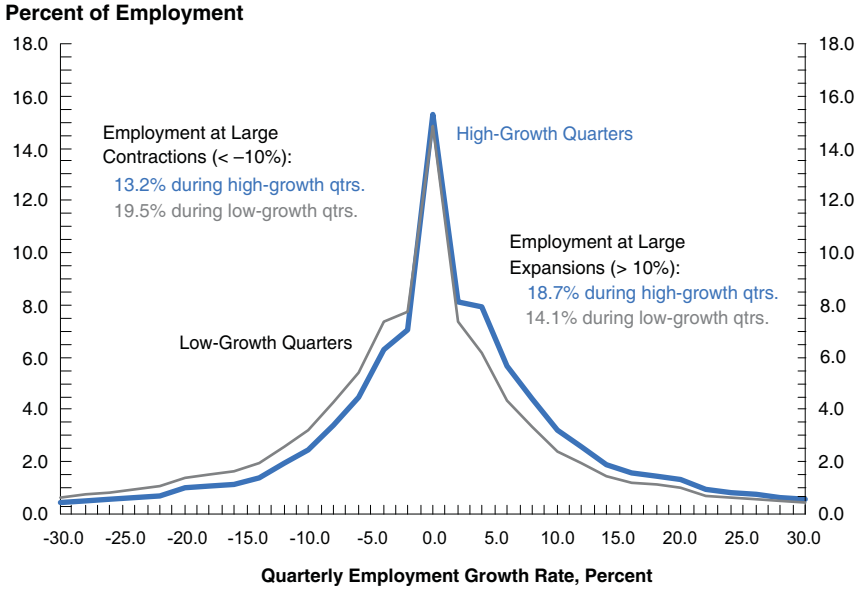
National-Level Quit Rate =
(0.35)(4.0)+(0.40)(0.5)+(0.25)(2.0)
= 2.10 percent

National-Level Layoff Rate =
(0.35)(7.0)+(0.40)(0.5)+(0.25)(1.0)
= 2.90 percent

As the economy moves from expansion to recession, the hiring rate falls from 4.55 to 4.10 percent and the separation rate rises from 4.10 to 5.00 percent. As a result, the national-level employment growth rate moves from +0.45 to -0.90 percent. The labor market is now contracting rather

FIGURE 5

The Distribution of Business-Level Employment Growth



Source: Estimates from my study with Steven Davis, John Haltiwanger, and Ian Rucker, which uses quarterly establishment-level growth rates from BED micro-data from 2001-2006.

[4] In the data, the exception is the quit rate relationship in Figure 4, which shifts down during recessions.

TABLE 2

	Contracting Businesses	Stable Businesses	Expanding Businesses
Old Share of Employment (Expansion)	25.0	45.0	30.0
New Share of Employment (Recession)	35.0	40.0	25.0

sharply. Moreover, the change is driven more by the rise in the separation rate (+0.90 percent), particularly the layoff rate (+0.63 percent), than by the fall in the hiring rate (-0.45 percent).[5] Thus, our example produces the same result we find in the data: Severe recessions have relatively high layoff rates, more so than low hiring rates, at the national level.

Besides the asymmetric shift, the other reason our example is able to generate large layoffs during a deep recession is that it assumes that the hiring and layoff rates exhibit the "hockey-stick" relationships we observe in Figures 3 and 4. Since the layoff rate rises sharply with the size of a business's contraction, larger leftward shifts in the growth rate distribution, that is, larger increases in the share of businesses experiencing a large contraction, will drive the national-level layoff rate even higher. Figure 6 illustrates this phenomenon with a hypothetical interaction of the business-level layoff rate with movements in the growth rate distribution. The further the growth rate distribution shifts to the left, the greater is the share of employment at businesses with very high layoff rates. This causes the national-level layoff rate to increase sharply. Since the shift in the growth rate distribution is asymmetric, the rise in the layoff rate is greater than the decline in the hiring rate. In contrast, a mild recession has a relatively small shift to the left, meaning that there is only a small increase in the share of businesses with very high layoff rates, and consequently, the asymmetry plays less of a role. In this case a rise in the national-level layoff rate may be similar to, or even smaller than, the decline in the hiring rate.

Intuitively, a mild recession means that there is a relatively large share of businesses cutting their workforces modestly. Figure 4 shows that such businesses generally do so with an equal mix of quits and layoffs. Since the contraction is small, a business can use regular attrition to shrink its employment and will have to lay off only a few additional workers, on average. At the same time, however, these businesses are not hiring, so those workers that do lose their jobs find it difficult to find new work and remain unemployed for some time. A deep recession involves an increase in the share of businesses undergoing large contractions. Figure 4 shows that, in these cases, attrition is not enough to get businesses to their new desired employment levels, so they must let sizable fractions of their workforces go, adding to the unemployment rolls through these layoffs.

The recessions of the 1970s and 1980s had sharp, deep declines in employment. While we do not have data on business-level growth distributions that go back that far, our exercise and the large spikes in job destruction and UI claims observed during these periods (Figure 2) suggest that these periods likely involved large leftward shifts of the distribution.[6] The rise in unemployment during these periods was driven by the large number of workers who lost their jobs as a result of these layoffs. The 1990-91 recession and the 2001 recession had relatively modest declines in employment, suggesting that these periods involved much smaller shifts in the growth rate distribution. As our exercise would imply, these periods saw only modest rises in the layoff rate. In relative terms, there was a decline in hiring that was just as important during these periods. Without a large spike in layoffs, the unemployment rate did not rise as much as it did in the 1970s and 1980s. Both recessions, however, were followed by "jobless recoveries," during which hiring remained depressed for an extended period. During this time, it was difficult for those who did lose their jobs to find new work, and consequently, the unemployment rate

[5] The quit rate rises in this example, contradicting its behavior in Figure 1, because, for simplicity, I have assumed away the fact that the quit relationship in Figure 4 is the only one of the three that changes (by shifting down) during a recession. This does not affect the main point of the example, though.

[6] The two studies by Steven Davis and John Haltiwanger find similar spikes in job destruction during these periods.

remained elevated for some time.

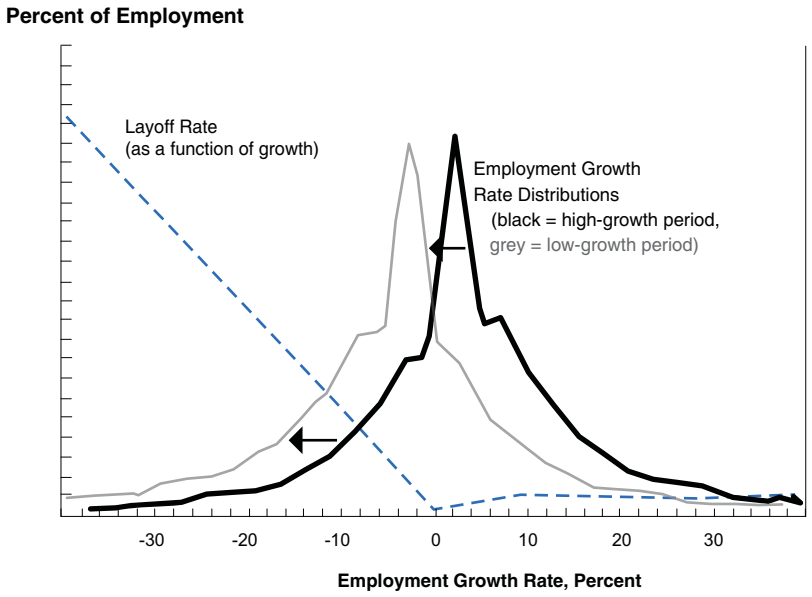
By historical standards, the current recession is very deep, and the pace of layoffs is comparable to that seen in the 1970s and 1980s. Consequently, it likely represents a large leftward shift of the growth rate distribution. Through the end of 2009, a high layoff rate led to a sharp increase in the unemployment rate, but as Figure 1 shows, there has also been a sharp drop in hiring.

The exercise in this article, though, speaks only to the severity of a recession, not to its *length*, which is generally determined by the nature of the macroeconomic shocks to the economy that cause a recession. Historically, deep recessions have been relatively brief (i.e., have a "V-shaped" recovery), implying that the growth rate distribution shifts to the left for a short period of time and then quickly begins shifting back toward the right, while the more shallow recessions have extended periods of job loss (i.e., have an "L-shaped" recovery), implying that the distribution shifts to the left and remains there for a while.

As of this writing, the current recession could have either a V-shaped or L-shaped recovery. Under the first scenario, the growth rate distribution would shift sharply to the left but then revert relatively quickly, creating a large but brief spike in layoffs and a subsequent sharp, but similarly brief, rise in the unemployment rate. Under the second and more troubling scenario, the growth rate distribution would shift to the left and remain there for some time. Layoff rates would remain high and hiring would remain depressed, leading to very high unemployment rates that persist for some time.

FIGURE 6

An Illustration of the Interaction Between Growth Distribution and Employer Flow Functions



Note: Figure is a hypothetical illustration of the interaction between the business-level employment growth rate distribution (Figure 5) and the layoff rate (Figure 4). The shift in the distribution is exaggerated for illustrative purposes.

CONCLUSION

A weak labor market is the outcome of two different types of employment adjustment: weaker hiring and greater job loss. This article has shown that the severity of a recession determines whether high job loss or weak hiring will be the more important source of declining employment and rising unemployment through asymmetric shifts in the distribution of business-level employment growth. These shifts interact with kinked "hockey stick" relationships between hiring, layoffs, and business-level growth to generate this result. Therefore, an important part of understanding the behavior of employment and the primary causes of unemployment during an economic downturn is understanding how the employment behavior of individual businesses changes over the business cycle.

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ESTIMATING THE ELASTICITY OF LABOR SUPPLY: HOME PRODUCTION, DEMOGRAPHICS, AND HOUSEHOLD CHARACTERISTICS

This paper revisits the argument, posed by Rupert, Rogerson, and Wright (2000), that estimates of the intertemporal elasticity of labor supply that do not account for home production are biased downward. The author uses the American Time Use Survey, a richer and more comprehensive data source than those used previously, to replicate their analysis, but he also explores how other factors interact with household and market work hours to affect the elasticity of labor supply. An exact replication of their analysis yields an elasticity of about 0.4, somewhat larger than previously estimated. Once the author accounts for demographics and household characteristics, particularly the number of children in the household, the estimate is essentially zero. This is true even when accommodating extensive-margin labor adjustments. Households' biological inability to smooth childbearing over the life cycle and the resulting income effect on market work hours drive this result.

Working Paper 10-3, "Revisiting the Role of Home Production in Life-Cycle Labor Supply," R. Jason Faberman, Federal Reserve Bank of Philadelphia

EXPLAINING OUTPUT VARIABILITY ACROSS COUNTRIES

Inference about common international stochastic trends and interest rates is gained using a small open-economy model, data from seven developed countries, and Bayesian methods. Shocks to these common factors explain up to 17 percent of the variability of output in several economies. Country-specific preference and premium disturbances account for the bulk of the volatility observed in the data. There is substantial heterogeneity in the estimated structural parameters as well as stochastic processes for the countries in the sample. This diversity translates into a rich array of impulse responses across countries. According to the model, the recent low international interest rates might have initially deepened the decline of GDP in several developed economies.

Working Paper 10-4, "Common Factors in Small Open Economies: Inference and Consequences," Pablo Guerron-Quintana, Federal Reserve Bank of Philadelphia

MONITORING MACROECONOMIC ACTIVITY IN REAL TIME

The authors sketch a framework for monitoring macroeconomic activity in real time and push it in new directions. In particular, they focus not only on real activity, which has received the

most attention to date, but also on inflation and its interaction with real activity. As for the recent recession, the authors find that (1) it likely ended around July 2009; (2) its most extreme aspects concern a real activity decline that was unusually long but less unusually deep, and an inflation decline that was unusually deep but brief; and (3) its real activity and inflation interactions were strongly positive, consistent with an adverse demand shock.

Working Paper 10-5, "Real-Time Macroeconomic Monitoring: Real Activity, Inflation, and Interactions," S. Borağan Aruoba, University of Maryland, and Visiting Scholar, Federal Reserve Bank of Philadelphia, and Francis X. Diebold, University of Pennsylvania, and Visiting Scholar, Federal Reserve Bank of Philadelphia

EXPECTATIONS AND MACROECONOMIC FLUCTUATIONS

Using survey-based measures of future U.S. economic activity from the Livingston Survey and the Survey of Professional Forecasters, the authors study how changes in expectations, and their interaction with monetary policy, contribute to fluctuations in macroeconomic aggregates. They find that changes in expected future economic activity are a quantitatively important driver of economic fluctuations: a perception that good times are ahead typically leads to a significant rise in current measures of economic activity and inflation. The authors also find that the short-term interest rate rises in response to expectations of good times as monetary policy tightens. Their results provide quantitative evidence on the importance of expectations-driven business cycles and on the role that monetary policy plays in shaping them.

Working Paper 10-6, "Expectations and Economic Fluctuations: An Analysis Using Survey Data," Sylvain Leduc, Federal Reserve Bank of San Francisco, and Keith Sill, Federal Reserve Bank of Philadelphia

PROVIDING INCENTIVES TO DETER FRAUD

Social and private insurance schemes rely on legal action to deter fraud and tax evasion. This observation guides the authors to introduce a random state verification technology in a dynamic economy with private information. With some probability, an agent's skill level becomes known to the planner, who prescribes a punishment if the agent is caught misreporting. The authors show how deferring consumption can ease the provision of incentives. As a result, the marginal benefit may be below the marginal cost of investment in the constrained-efficient allocation, suggesting a subsidy on savings. They characterize conditions such that the intertemporal wedge is negative in finite horizon economies. In an infinite horizon economy, the authors find that the constrained-efficient allocation converges to a high level of consumption, full insurance, and no labor distortions for *any* probability of state verification.

Working Paper 10-7, "Fraud Deterrence in Dynamic Mirrleesian Economies," Roc Armenter, Federal Reserve Bank of Philadelphia, and Thomas M. Mertens, New York University

TRANSFERRING RISK THROUGH LOAN SALE AND SECURITIZATION

Depository institutions may use information advantages along dimensions not observed or considered by outside parties to "cream-skim," meaning to transfer risk to naïve, uninformed, or unconcerned investors through the sale or securitization process. This paper examines whether "cream-skimming" behavior was common practice in the subprime mortgage securitization market prior to its collapse in 2007. Using Home Mortgage Disclosure Act data merged with data on subprime loan delinquency by ZIP code, the authors examine the bank decision to sell (securitize) subprime mortgages originated in 2005 and 2006. They find that the likelihood of sale increases with risk along dimensions observable to banks but not likely observed or considered by investors. Thus, in the context of the subprime lending boom, the evidence supports the cream-skimming view.

Working Paper 10-8, "'Cream-Skimming' in Subprime Mortgage Securitizations: Which Subprime Mortgage Loans Were Sold by Depository Institutions Prior to the Crisis of 2007?" Paul Calem, Federal Reserve Board of Governors; Christopher Henderson, Federal Reserve Bank of Philadelphia; and Jonathan Liles, Freddie Mac

AN ALTERNATIVE APPROACH TO MEASURING BANK COMPETITION

Measuring banking competition using the HHI, Lerner index, or H-statistic can give conflicting results. Borrowing from frontier analysis, the authors provide an alternative approach and apply it to Spain over 1992-2005. Controlling for differences in asset composition, productivity, scale economies, risk, and business cycle

influences, they find no differences in competition between commercial and savings banks nor between large and small institutions, but the authors conclude that competition weakened after 2000. This appears related to strong loan demand where real loan-deposit rate spreads rose and fees were stable for activities where scale economies should have been realized.

Working Paper 10-9, "A Revenue-Based Frontier Measure of Banking Competition," Santiago Carbó, University of Granada, Spain; David Humphrey, Florida State University, and Visiting Scholar, Federal Reserve Bank of Philadelphia; and Francisco Rodriguez, University of Granada, Spain

CHANGE IN ICEBERG COSTS AND THE RISE IN U.S MANUFACTURING EXPORTS

The authors study the rise in U.S. manufacturing exports from 1987 to 2002 through the lens of a monopolistically competitive model with heterogeneous producers and sunk costs of exporting. Using the model, they infer that iceberg costs fell nearly 27 percent in this period. Given this change in iceberg costs, the authors use the model to calculate the predicted increase in trade. Contrary to the findings in Yi (2003), they find that the exports should have grown an additional 70 percent (78.7 vs. 46.4). The model overpredicts export growth partly because it misses the shift in manufacturing to relatively small establishments that did not invest in becoming exporters. Contrary to the theory, employment was largely reallocated from very large establishments, those with more than 2,500 employees, toward very small manufacturing establishments, those with fewer than 100 employees. The authors also find that very little of the contraction in U.S. manufacturing employment can be attributed to trade.

Working Paper 10-10, "Do Falling Iceberg Costs Explain Recent U.S. Export Growth?" George Alessandria, Federal Reserve Bank of Philadelphia, and Horag Choi, University of Auckland

OPTIMAL CAPITAL INCOME TAXATION

This paper quantitatively investigates the optimal capital income taxation in the general equilibrium overlapping generations model, which incorporates characteristics of housing and the U.S. preferential tax treatment for owner-occupied housing. Housing tax policy is found to have a substantial effect on how capital income should be taxed. Given the U.S. preferential tax treatment for owner-occupied housing, the optimal capital income tax rate is close to zero, contrary to the high optimal capital income tax rate implied by models without housing. A lower capital income tax rate implies a narrowed tax wedge between housing and non-housing capital, which indirectly nullifies the subsidies (taxes) for homeowners (renters) and corrects the over-investment to housing.

Working Paper 10-11, "Optimal Capital Income Taxation with Housing," Makoto Nakajima, Federal Reserve Bank of Philadelphia

A NEW APPROACH TO MODELING LONG-TERM DEBT

In this paper, the authors present a new approach to incorporating long-term debt into equilibrium models of unsecured debt and default. They make three sets of contributions. First, the authors advance the theory of sovereign debt begun in Eaton and Gersovitz (1981) by proving the existence of an equilibrium price function with the property that the interest rate on debt is increasing in the amount borrowed. Second, using Argentina as a test case, they show that unlike a one-period debt model, their model of long-term debt is capable of accounting for the average external debt-to-output ratio, average spread on external debt, and the standard deviation of spreads for the 1993-2001 period, without any deterioration in the model's ability to account for Argentina's other cyclical facts. Third, the authors propose a new and very accurate method for solving the model.

Working Paper 10-12, "Maturity, Indebtedness, and Default Risk," Satyajit Chatterjee, Federal Reserve Bank of Philadelphia, and Burcu Eyigungor, Koç University

MORTGAGE DEFAULT: ASSESSING THE ROLE OF NEGATIVE EQUITY AND ILLIQUIDITY

This paper assesses the relative importance of two key drivers of mortgage default: negative equity and illiquidity. To do so, the authors combine loan-level mortgage data with detailed credit bureau information about the borrower's broader balance sheet. This gives them a direct way to measure illiquid borrowers: those with high credit card utilization rates. The authors find that both negative equity and illiquidity are significantly associated with mortgage default, with comparably sized marginal effects. Moreover, these two

factors interact with each other: The effect of illiquidity on default generally increases with high combined loan-to-value ratios (CLTV), though it is significant even for low CLTV. County-level unemployment shocks are also associated with higher default risk (though less so than high utilization) and strongly interact with CLTV. In addition, having a second mortgage implies significantly higher default risk, particularly for borrowers who have a first-mortgage LTV approaching 100 percent.

*Working Paper 10-13, "What 'Triggers' Mortgage Default?" **Ronel Elul**, Federal Reserve Bank of Philadelphia; Nicholas S. Souleles, University of Pennsylvania; Souphala Chomsisengphet, Office of the Comptroller of the Currency; Dennis Glennon, Office of the Comptroller of the Currency; and Robert Hunt, Federal Reserve Bank of Philadelphia*

ACCOUNTING FOR TIME-VARYING VOLATILITY IN U.S. AGGREGATE DATA: STOCHASTIC VOLATILITY VS. CHANGES IN MONETARY POLICY

This paper compares the role of stochastic volatility versus changes in monetary policy rules in accounting for the time-varying volatility of U.S. aggregate data. Of special interest to the authors is understanding the sources of the great moderation of business cycle fluctuations that the U.S. economy experienced between 1984 and 2007. To explore this issue, the authors build a medium-scale dynamic stochastic general equilibrium (DSGE) model with both stochastic volatility and parameter drifting in the Taylor rule and they estimate it non-linearly using U.S. data and Bayesian methods. Methodologically, the authors show how to confront such a rich model with the data by exploiting the structure of the high-order approximation to the decision rules that characterize the equilibrium of the economy. Their main empirical findings are: 1) even after controlling for stochastic volatility (and there is a fair amount of it), there is overwhelming evidence of changes in monetary policy during the analyzed period; 2) however, these changes in monetary policy mattered little for the great moderation; 3) most of the great performance of the U.S. economy during the 1990s was a result of good shocks; and 4) the response of monetary policy to inflation under Burns, Miller, and Greenspan was similar, while it was much higher under Volcker.

Working Paper 10-14, "Fortune or Virtue: Time-Variant Volatilities Versus Parameter Drifting," Jesus Fernandez-Villaverde, University of Pennsylvania; Pablo Guerron-Quintana, Federal Reserve Bank of Philadelphia; and Juan F. Rubio-Ramirez, Duke University and Federal Reserve Bank of Atlanta

ESTIMATING A DSGE MODEL TO EXAMINE RECENT U.S. MONETARY HISTORY

The authors report the results of the estimation of a rich dynamic stochastic general equilibrium model of the U.S. economy with both stochastic volatility and parameter drifting in the Taylor rule. They use the results of this estimation to examine the recent monetary history of the U.S. and to interpret, through this lens, the sources of the rise and fall of the great American inflation from the late 1960s to the early 1980s and of the great moderation of business cycle fluctuations between 1984 and 2007.

Working Paper 10-15, "Reading the Recent Monetary History of the U.S., 1959-2007," Jesus Fernandez-Villaverde, University of Pennsylvania; Pablo Guerron-Quintana, Federal Reserve Bank of Philadelphia; and Juan F. Rubio-Ramirez, Duke University and Federal Reserve Bank of Atlanta