Ups and Downs:

How Wages Change Over the Business Cycle

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The cyclical behavior of real wages — wages adjusted for inflation — has changed over time. Before World War II, real wages in the U.S. were countercyclical: They rose during recessions and fell during expansions. Since the war, however, wages have become procyclical, falling during recessions and rising during expansions. One standard explanation is that economic shocks shifted from the demand side of the economy prewar to the supply side postwar. In this article, Kevin Huang offers evidence of an alternative explanation: the increased role that intermediate goods play in the production process in the postwar era.

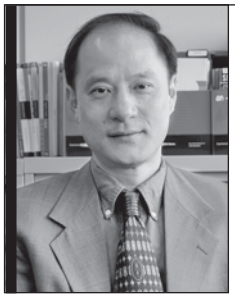
Modern economies experience recurrent fluctuations in business activity. As output and employment fall in recessions and busts and rise in recoveries and booms, other variables of economic significance also go through lows and highs.

One such variable is real wages. Generally speaking, real wages are simply wages adjusted for changes in inflation.[1] For a working family, real wages provide a source of real income, but this income must be earned by giving up valuable leisure time. For a business entity that must hire workers to carry out its operations, real wages constitute part of the firm's real production costs. The way in which real wages fluctuate over business cycles has important implications for both households and firms.

The cyclical behavior of real wages has changed over time. In the prewar period (1919 to 1939), real wages in the United States were countercyclical: That is, real wages went up during recessions and fell during expansions. Since World War II, real wages have become procyclical: They fall during recessions and rise during expansions.

What might have caused this change in the cyclical behavior of real wages? One explanation attributes the change to a shift from disturbances (which economists call shocks) on the demand side of the economy during the prewar period to disturbances on the supply side in the postwar era.

Generally speaking, shocks are unanticipated changes in variables, such as extreme environmental conditions (severe weather, hurricanes, earthquakes, etc.), unanticipated changes in monetary and fiscal policy, and events that alter the world price of energy. Typical examples of demand shocks include unexpected changes in the demand for money, unexpected changes in the money supply[2] or interest rates (monetary policy shocks), unexpected changes in government spending (fiscal policy shocks), financial crises, exchange rate disturbances, and sudden changes in households' tastes or preferences. Examples of supply shocks include sudden disruptions in oil supply, discoveries of oil reserves, and technological innovations.



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[1] In reality, there is more than one measure of inflation. In this article, our use of the term real wages refers to wages adjusted for a cost-of-living index such as the consumer price index (CPI). The CPI measures the cost of labor in terms of a basket of goods consumed by a worker. An alternative notion of real wages is wages adjusted for the wholesale price index or the producer price index (PPI). The PPI measures the cost of labor in terms of the units of goods produced by a worker. The two ideas are often used interchangeably. To tell the story here, I will follow this tradition of not distinguishing between these two measurements of real wages.

[2] The money supply is the quantity of money available in the economy with which to purchase goods and services.

Many economists have argued that demand shocks were more important in the prewar period, especially during the Great Depression, an episode in which unexpected changes in the money supply and financial crises (such as bank failures) played a dominant role. Supply shocks, on the other hand, are more important in the postwar period, especially after the 1970s, when several large oil-price shocks hit the economy.

But trying to explain the change in the cyclical behavior of real wages by pointing to changes in shocks hitting the economy is not appealing because it does not capture all of the empirical facts. To provide a convincing account of this switch in real-wage cyclicality, we must look at another change in the U.S. economy between the prewar and postwar periods, namely, the increased role of intermediate goods in the production process. For example, in the postwar period, the production of final consumption goods — such as home appliances, consumer electronics, and, more recently, computers — requires more intermediate processing, involving greater shares of more processed intermediate inputs, such as pressed steel, plastic, glass, microchips, and processors, and smaller shares of labor and capital.[3]

As I will discuss, it is likely that the switch in real-wage cyclicality arose from the increased share of intermediate goods in production.

REAL WAGES: FROM COUNTERCYCLICAL TO PROCYCLICAL

Real-wage cyclicality is gauged by the statistical correlation between real wages and output. This correlation measures how these two variables co-vary over time. Correlations must lie between -1 and 1: the closer the correlation is to -1, the more the two variables move in opposite directions. The closer the correlation is to 1, the more the two variables move in the same direction.

Economists Susanto Basu and Alan Taylor have computed the correlation between real wages and real output for the prewar and postwar periods (Figure 1).[4] Their results show that, in the prewar era, the correlation between real wages and output was significantly negative (-0.444), suggesting that real wages moved strongly against real output in this period. Postwar, the correlation between real wages and output is significantly positive (0.381) between 1945 and 1971, and it rises further (to 0.503) between 1972 and 1992. Thus, real wages co-move closely with output after World War II. In a 1996 article, Christopher Hanes provides evidence of this change in the behavior of real wages.

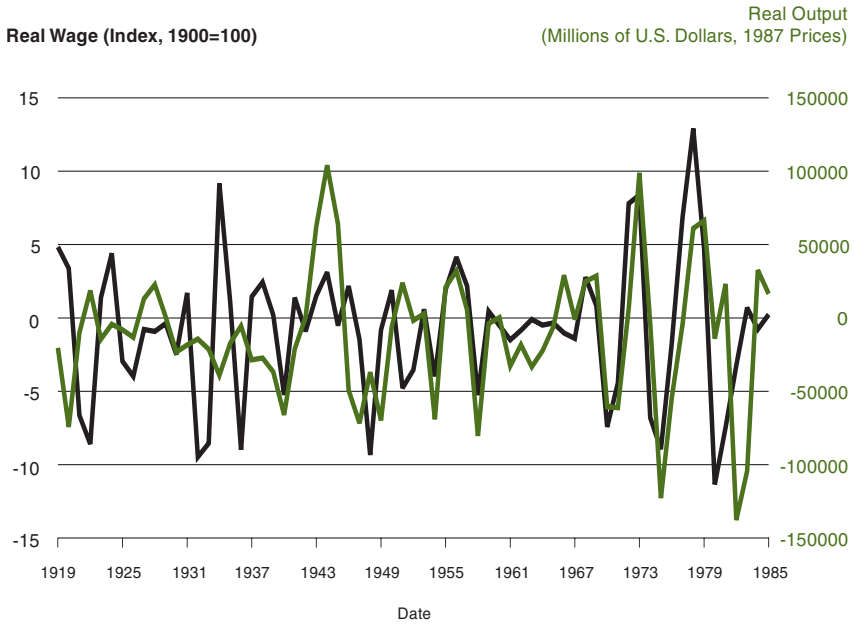
Another insightful account is provided by Ben Bernanke and James Powell, who examine the cyclical property of real wages for the periods 1923 to 1939 and 1954 to 1982. They

[3] In a production economy, goods produced in one sector or industry may be used as intermediate inputs by the same or different sectors or industries for producing goods that may, in turn, be used as intermediate inputs by the same or different sectors or industries, etc., before a final consumption good is produced. Such an input-supplier/output-demander relationship among sectors or industries is usually referred to as an input-output structure. The Input-Output Table of the Bureau of Economic Analysis (BEA) summarizes the U.S. economy's input-output structure. As Robert J. Gordon pictures it, "The gigantic matrix represents the real world, full of heterogeneous firms enmeshed in a web of intricate supplier-demander relationships."

[4] Basu and Taylor used a statistical technique to remove the long-term trends from the data in order to focus on how the data behaved over business cycles.

FIGURE 1

Real Wage and Real Output in the United States (Deviations from Trend)



Source: Basu and Taylor (1999a)

find a marked difference in the cyclical behavior of real wages from the prewar to the postwar period. Bernanke and Powell's study is important for another reason. One could argue that the mix of goods that households consume also changed from the prewar period to the postwar period, and the observed switch in the cyclical behavior of real wages could have simply reflected this change. Studies using aggregate data — that is, data for the economy as a whole — cannot directly address this issue. Instead, Bernanke and Powell employ industry-level data that control for the shift in the mix of goods. Yet their finding is broadly consistent with the evidence presented in Basu and Taylor's paper, which is based on aggregate data.[5]

In sum, the historical evidence suggests a general pattern in the evolution of the cyclical behavior of real wages from countercyclical during the prewar period to procyclical in the postwar era. In particular, the correlation between real wages and real output has switched from significantly negative prewar to significantly positive postwar.

SHIFT FROM DEMAND SHOCKS TO SUPPLY SHOCKS: NOT A CONVINCING STORY

Economic theory is essentially a story about supply and demand. Business-cycle theory seeks to understand how unexpected changes in supply or demand generate cyclical fluctuations of economic variables. As we've noted, one explanation for the switch in real-wage cyclicality is based on this shift from demand shocks to supply shocks.

According to a well-known economic theory, the classic Keynesian theory, demand shocks push prices and output in the same direction, but they do not immediately affect wages very much, because wages are usually set in advance.[6] Consequently, real wages, that is, wages adjusted for inflation, move in the opposite direction from output: Real wages rise when output falls, since as output falls so do prices, while wages are sticky, and vice versa. According to another well-known economic theory, the real business-cycle theory, how much workers get paid depends on their productivity, and supply shocks generally mean that labor productivity — output per worker — and output move in the same direction.[7] As a result, real wages and output move together.

That real wages can respond countercyclically to demand shocks but procyclically to supply shocks might lead one to conjecture that it is indeed the shift from prewar demand shocks to postwar supply shocks that explains the shift in real-wage cyclicality. In particular, the oil-price spikes that occurred in the 1970s are often viewed as the main factor that led to procyclical real wages during the postwar period.

However, this hypothesis is not convincing for at least two reasons. First, while empirical studies suggest that oil-price shocks might have been an important force contributing to postwar business cycles in the U.S., a

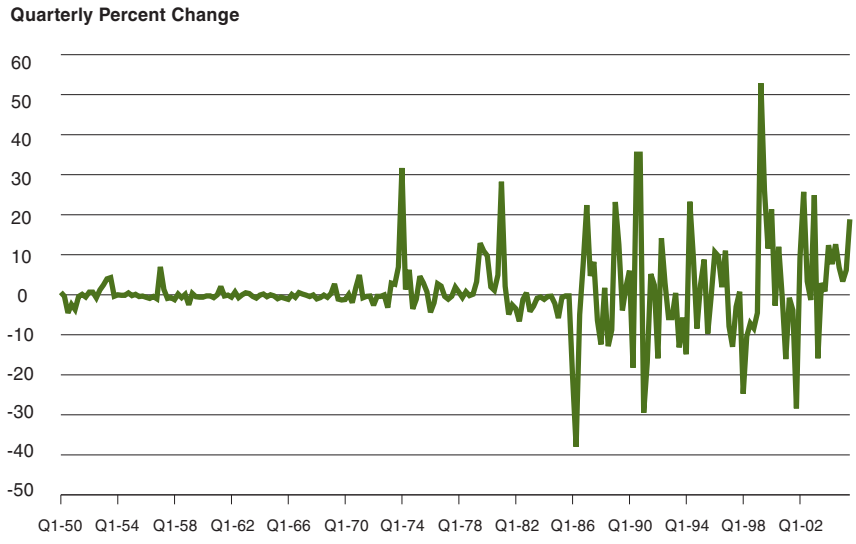
[5] Other studies, such as the ones by Mark Bils; Gary Solon, Robert Barsky, and Jonathan Parker; and Katharine Abraham and John Haltiwanger, provide corroborating evidence in support of such a switch in the postwar era. Evidence based on aggregate data is also provided in the article by Finn Kydland and the one by Wouter J. den Haan and Steven W. Sumner.

[6] Keynesian theory emphasizes the role of demand shocks and wage contracts, that is, agreements between unions and firms on the level of wages firms will pay union workers over a certain period.

[7] Real business-cycle theory emphasizes the role of supply shocks in the economy.

FIGURE 2

Oil Price Shocks in the Postwar Period



Source: Haver Analytics (PPI for crude petroleum - not seasonally adjusted)

study by Kevin Hoover and Stephen Perez and another by Charles Fleischman note that the price of crude oil remained relatively stable until 1973 (Figure 2). Yet, the correlation between real wages and output had already changed from a significant negative value of -0.44 in the prewar period to a significant positive value of 0.38 from 1945 to 1971, an era before the onset of the major oil-price shocks in the 1970s.[8] Indeed, as Christopher Hanes shows, real wages remain procyclical even if the period from December 1973 through June 1980 is excluded from the postwar period. This suggests that forces other than oil-price shocks must have triggered the switch.

Second, in contrast to the prediction of the Keynesian theory, real wages have responded differently to demand shocks in the prewar period than in the postwar period. In particular, the tightening of monetary policy triggered a rise in real wages in the prewar period, especially during the Great Depression, but a fall in real wages and output in the postwar period. For the prewar period, two studies by Barry Eichengreen and Jeffrey Sachs and another by Bernanke and Kevin Carey find that real wages were countercyclical and that monetary policy shocks were a central driving force of this result. On the basis of their finding, Bernanke and Carey dismiss explanations of the relationship between output and real wages during the period 1929 to 1936 that do not involve monetary policy shocks. Michael Bordo, Christopher Erceg, and Charles Evans also present evidence showing that monetary policy tightening led to an increase in real wages during the downturn of 1929 to 1933 in the U.S. and that monetary policy shocks accounted for between 50 and 70 percent of the decline in real GNP at the Depression's trough in the first quarter of 1933.

For the postwar period, a study by Lawrence Christiano, Martin Eichenbaum, and Charles Evans and another by Edward Gamber and Frederick Joutz find that monetary policy shocks, and demand shocks in general, tend to generate procyclical real wages. Marvin Barth and Valerie Ramey also find evidence of procyclical real wages following contractionary monetary policy actions in the postwar U.S. economy. This reversed pattern in the cyclicality of real wages driven solely by monetary policy shocks is inconsistent with a story that relies on a shift from demand shocks to supply shocks.

Even in the absence of supply shocks, we have seen a switch from countercyclical to procyclical real wages.

Thus, even in the absence of supply shocks, we have seen a switch from countercyclical to procyclical real wages. A convincing theory about this switch in real-wage cyclicality needs to hold up, even when demand shocks are the sole driving force of business-cycle booms and busts. Now, let's turn to a theory that emphasizes the role of a change in the U.S. economic structure over the course of the 20th century.

INTERMEDIATE GOODS: INCREASING IMPORTANCE IN PRODUCTION

The key part of this alternative theory involves another major change in the U.S. economy from the prewar to the postwar period: a shift in the mix of the types of inputs used in production. As we know, production of final consumption goods usually requires several types of inputs: labor, capital, and intermediate goods. The historical change is that, in the postwar period, intermediate goods are used more in the production of final goods. In the prewar era, goods that households consumed were relatively less processed — typical prewar goods include simple farm and fishery products and basic consumer durables like hand tools, oil burners and heating apparatus, and coal stoves and ranges — and their production required mostly primary inputs (labor, capital, land, and coal). In the postwar period, goods that households consume are much more complex — typical postwar goods include more processed farm and fishery products and increasingly more sophisticated consumer durables such as gas and electric appliances, home electronics, and intricately made cars and computers — and the production of such goods requires greater shares of manufactured intermediate inputs, which themselves are typically more advanced goods.[9]

Several existing studies illustrate the changes in the production of final consumption goods and in the input-output structure from the prewar to the postwar period. John Kendrick's classic work documents value added (by labor and capital) and gross output (which is the sum of value added and all intermediate inputs used in

[8] James D. Hamilton argues that oil shocks led to some of the pre-1970 recessions in the U.S., but the cyclical effects of these shocks, as he shows, became much stronger during the 1970s.

[9] Recall that intermediate goods are goods (and services) that are purchased from other businesses and that are used up within the production period. Although my discussion focuses on the role of increasing technological sophistication, the fact that the use of intermediate inputs has been rising over time might also reflect increased specialization of production, since, all else constant, the greater the degree of vertical integration, the lower is the proportion of intermediate goods purchased in total output.

production) for several key sectors in the prewar period. Using this information, Zheng Liu, Louis Phaneuf, and I show that the share of intermediate inputs rose significantly in the postwar period.[10]

Two historical studies by Christopher Hanes provide evidence that the input-output structure has become more sophisticated in the postwar period. His general finding is that typical prewar goods were made of relatively unfinished goods, while typical postwar goods involve more intermediate processing before they enter the marketplace. Hanes reports that the share of crude material inputs (such as farm, fishery, and mineral products) in final output in the United States fell significantly from the beginning of the 20th century to the end of the 1960s. He also reports that from the turn of the 20th century to 1986, the share of consumption expenditure on food (excluding restaurant meals) decreased significantly, while the share of consumer durables, a category that includes many complex goods such as automobiles, increased steadily over the same period. The corroborating evidence in the two studies by Basu and Taylor lends further credence to the observation that intermediate goods make up an increasingly larger share of total U.S. output in the postwar period.

Other studies provide evidence of the increased use of intermediate goods in production during the postwar period. The work by Dale Jorgenson, Frank Gollop, and Barbara Fraumeni shows that from 1947 to 1979, intermediate goods account for a large share of the revenue from total manufacturing output in the U.S. and they account for an even higher share of manufacturing costs.[11]

To summarize, existing studies lead us to conclude that there has been a significant increase in the use of intermediate inputs in the U.S. economy from prewar to postwar.

INTERMEDIATE INPUTS AND THE SWITCH IN REAL-WAGE CYCLICALITY

The story of the switch in the cyclicality of real wages is built on the following reasoning. Real wages determine the amount of consumption goods that a worker's wages can buy. The cheaper the good, the more of it can be purchased with wages. How cheap the good is depends on how much it costs to produce. The cost is usually composed of three parts: cost of capital, cost of intermediate inputs, and wages.

Capital, such as plant and equipment, can last for a relatively long time before depreciating completely. The value of capital depends on what the capital is used for during its lifetime. In a capitalistic world, this value is determined in the asset market, which usually responds quickly to changes in current and expected economic conditions. As a result, the cost of capital that a firm incurs in order to carry out its production plans varies a lot over business-cycle booms and busts.

In contrast, since making a sophisticated intermediate good typically requires some advance planning, a firm that needs to use an intermediate good often must lock into a contract that specifies a purchase price long before the good is delivered. The supplier of the intermediate good often needs to lock into contracts with its own suppliers of other intermediate goods required for producing the first good. The business world is full of such sophisticated input-output relationships. For instance, the production of a computer requires many types of intermediate inputs, such as a monitor, a motherboard, a hard drive, and an operating system. Producing a monitor involves other intermediate inputs, such as plastic, glass, and electronic components, and making a motherboard requires microchips, processors, and so forth. Such a business-to-business supply-chain network is a popular business model in many other sectors, such as the automobile industry.

As Robert Gordon describes, the intricate supplier-demander relationships among many firms at many different stages of processing imply that a contractual price between two firms can also matter to other firms involved in the production process since they may be those other firms' direct or indirect suppliers or demanders. As a result, the two firms may be reluctant to change their contractual price even if it is about time to renegotiate their contract unless they know those other firms will do so as well. Since it is difficult for all firms in this gigantic web of complex supplier-demander rela-

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[10] Our study shows that the share of intermediate goods in U.S. production was 0.4 prewar and 0.7 postwar.

[11] Susanto Basu's estimate of the cost share is about 0.80. The revenue and cost shares of intermediate inputs calculated by Huang, Liu, and Phaneuf for the postwar period, based on data in the BEA's 1997 Benchmark Input-Output Tables, are about 0.7.

tionships to synchronize the timing of their contract renegotiations, as demonstrated by many empirical studies surveyed in John B. Taylor's article, the price of an intermediate good can stay sticky much longer than the length of a single contract and typically does not immediately respond to changes in economic conditions.[12]

Firms often sign wage contracts with workers as well, and according to Taylor's survey, the length of wage contracts for labor, on average, is about the same as the length of price contracts for intermediate goods (about one year). Yet, the renegotiation of a wage contract is a relatively simple matter that usually involves only the employee and the employer. Thus, the wage of a worker typically stays sticky just as long as the length of a single contract and often responds somewhat to changing economic conditions.

Generally speaking, the cost of capital is most responsive to changes in economic conditions, next are wages, and the contractual costs of intermediate inputs are least responsive.

With this in mind, we are ready to tell the story. During recoveries and booms, when the level of output rises and firms demand more capital, labor, and intermediate inputs, the cost of capital rises quickly. However, because of contractual obligations, wages rise slowly, and the contractual cost of intermediate inputs does not change much. If the share of intermediate inputs in production is small, a firm's production costs would rise more than its workers' wages because the firm is paying more for capital and using more of it in production. The firm would pass on the increase in its production costs in the form of a higher price for its product.[13] In consequence, because workers pay more for the firm's final good, their real wages fall. The situation is quite different if the share of intermediate inputs in production is large. With a large share of intermediate inputs, a firm's production costs would rise less than its workers' wages because the contractual cost of the intermediate inputs is unchanged. As a result, because workers pay less for the firm's final good, their real wages rise.

The analysis for periods of recessions and busts is symmetric. When intermediate goods make up a small share of the production process, real wages tend to move in the opposite direction from output (real wages are countercyclical). When intermediate goods constitute a large share of the production process, real wages tend to move in the same direction as output (real wages are procyclical).

Liu, Phaneuf, and I demonstrate how the cyclical behavior of real wages can change when the share of intermediate inputs rises. We show that as the share of intermediate inputs in production grows from its prewar value (0.4) to its postwar value (0.7), the correlation between real wages and output switches from a significantly negative number (-0.498), close to its prewar value, to a significantly positive number (0.464), close to its postwar value.[14]

The Link Holds at Other Levels. The link between the cyclical behavior of real wages and the share of intermediate goods holds not just for the U.S. economy as a whole; it also holds at the sector or industry level. As noted by Christiano, Eichenbaum, and Evans, in the postwar U.S. economy, real wages are more procyclical in the manufacturing sector than they are in the economy as a whole. Incidentally, in the postwar era, the ratio of total sales to GDP is greater in the manufacturing sector than in the economy as a whole, indicating that the manufacturing sector uses a greater share of intermediate inputs in production than other sectors (see the table).[15] The findings about the importance of intermediate goods presented in this article lead to a natural conjecture that the differing shares of intermediate goods across sectors/industries may account for the observed differences in the behavior of real wages at the sectoral and industrial levels in the postwar U.S. economy.

Although the analysis in this article is drawn from the U.S. experience, the general insight laid out here linking real-wage cyclicality to the use of intermediate goods may have implications for other economies. For example, the analysis suggests that real wages can be more procyclical in more developed countries than in less developed ones, since production in the more developed economies generally uses greater shares of intermediate goods. Thus, the implications for

[12] This is not to be confused with the notion that the spot price (the price for a good that is paid for now and for which delivery is made now) of certain components of intermediate inputs — such as oil — is quite sensitive to business cycles. What I have emphasized here is that pricing of products that use such inputs — including oil — is often based on contractual costs rather than the spot price.

[13] The argument here ignores cyclical movements in profit margins and assumes that price and cost move in proportion.

[14] To focus on how the data behaved over the business cycles, these authors applied the same statistical technique that Basu and Taylor used to remove the long-term trends from the data and computed the correlations based on the de-trended data.

[15] The U.S. input-output table has gone through a number of redefinitions by the U.S. Bureau of Economic Analysis. I made the necessary regroupings to make the classifications of sectors and industries presented in the table consistent across the three selected years. The shares reported in the table are shares in revenue. To get shares in cost, one needs to adjust for profit margins in the corresponding sectors.

households and firms can also differ across countries in different stages of development.

CONCLUSION

Over the past century, the U.S. economy has seen a significant change in the cyclicality of real wages and in the share of intermediate goods used in the production process. This article explains the link between the two: It's likely that the switch in real-wage cyclicality from countercyclical in the prewar period to procyclical in the postwar era can be attributed to the increased use of more processed intermediate goods in production. This shift in the cyclicality of real wages, the increased use of intermediate goods, and, more important, the link investigated here have implications for households and firms.

TABLE

Share of Intermediate Inputs in the U.S by Sector

	1987	1997	2003
Construction	0.5297	0.5705	0.4938
Manufacturing	0.5923	0.6765	0.6478
Trade	0.2998	0.3614	0.2826
Transportation, Communication, and Utilities	0.4563	0.4773	0.4849
Financial Services	0.3214	0.3018	0.3356
Nonfinancial Services	0.4329	0.3640	0.3970

Source: BEA Input-Output Table. The shares reported in the table are shares in revenue.

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Using Collateral to Secure Loans

BY YARON LEITNER

Many businesses post collateral as security for loans. Collateral protects the lender if the borrower defaults. However, not all borrowers put up collateral when taking out loans. There's even some evidence that loans with collateral attached may be riskier for lenders. Why is collateral used sometimes, but not others? And why does collateral potentially involve more risk? In this article, Yaron Leitner considers these questions. He looks at some of the explanations for using collateral, focusing on its benefits and drawbacks.

Collateral is a contractual device used by borrowers and lenders around the world. Collateral has also been around for a long time. In one famous example, a pound of Antonio's flesh collateralized Shylock's loan to Bassanio in Shakespeare's "Merchant of Venice." Generally, the term collateral refers to assets pledged by a borrower to secure a loan. The lender can seize these assets if the borrower does not make the agreed-upon payments on the loan, so the lender has some protection if the borrower defaults. Therefore, the use of collateral can make it easier for firms to obtain loans to finance their investments.

Understanding collateral is important because it is a characteristic feature of bank loans, which help to channel resources to their best use.[1] While early research focused mainly on how collateral affects the borrower's behavior, recent research has also incorporated lenders' behavior, for example, how collateral affects lenders' incentives to take care in evaluating a business's prospects. Economists have also examined the relationship between collateral and risk, empirically verifying bankers' common wisdom that collateralized loans are riskier for the bank than noncollateralized loans. To a significant extent, recent theoretical work on collateral has been driven by economists' desire to provide explanations for the use of collateral that are consistent with this empirical finding among others.

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COLLATERAL AND BORROWERS' INCENTIVES

We start by focusing on the way collateral affects a borrower's incentives to ensure the business's success. Consider a loan contract where an individual borrows some money to start a new business. The success of the business often depends on actions the borrower takes after the loan is signed, for example, the way he allocates money among different activities, and the effort he expends in choosing low-cost/high-value alternatives. Ideally, the loan contract would specify all of these actions. However, in many cases, this is impossible because some of these actions may not be observable to a third party or even to the lender; for example, it may be difficult for the bank to argue in court that a borrower did not exert enough effort in choosing the best alternatives.[2]

If the borrower and lender had the same objectives, the fact that the borrower's actions are not observable to others would not be a problem.

[1] According to the Federal Reserve's Surveys of Terms of Business Lending, more than 50 percent of the value of all commercial and industrial loans made by domestic banks in the U.S. is currently secured by collateral (based on the surveys for February 2005, May 2005, and August 2005).

[2] The finance and economics literature refers to this hidden action problem as *moral hazard*. This term, which was coined in the insurance industry, captures the idea that an individual who has insurance is less likely to take actions to avoid problems. For example, if you have comprehensive car insurance with no deductibles, you may be less careful about locking your car or parking it in a safe spot. More broadly, the term moral hazard refers to any contracting problem where the actions of one party cannot be observed by others.

The borrower would take the actions that are best for him, and these actions would also be best for the lender. However, in practice, the borrower and lender often have different objectives. The lender wants to make sure that the loan is paid in full; the borrower cares about the profits left after paying the loan. The borrower may also care about some perks that benefit him, but not the business as a whole; for example, the borrower may enjoy expensive business meals, a private jet, and so forth.

Consider the following as an example of a conflict of interests between borrowers and lenders: A business can either succeed or fail. If it fails, the loan cannot be repaid, and both the borrower and lender get nothing. If the business succeeds, the loan is paid in full, and the borrower is left with the rest of the profits. Now suppose that the borrower can take an action that has the following effect: If the business is a success, the action increases profits; however, the action reduces the chances that the business will succeed.[3] The borrower may be happy to take such an action because it increases the money left for him — remember, he gets paid only if the business succeeds.[4] The lender, however, is unhappy because he is less likely to get his money back.

Anticipating the conflict of interests above, the lender may demand a higher interest rate on the loan, and in some cases, he may not lend at all. Of course, the borrower can promise to take some agreed-upon actions according to the lender's wishes, but when these actions cannot be verified in court, such a promise is just cheap talk.

Collateral May Induce the Borrower to Exert Effort… Suppose the borrower posts his house or some of his business assets as collateral to secure the loan. This may induce him to put more effort into ensuring the business succeeds because if the business fails, the borrower loses his collateral. In other words, collateral can give the borrower the incentive to work harder. When the borrower works harder, the business is more likely to succeed, and the borrower is less likely to default. But then the lender may be more willing to lend his money and at a lower interest rate.

…But Using Collateral Is Costly. The benefit above comes at a cost. A business might fail even if the borrower exerts a lot of effort; the borrower may have bad luck. In this case, the borrower loses the collateral, which may be worth more to him than it is to the lender. For example, if the borrower has posted his house as collateral, being able to continue living there is important to the borrower but not the lender. Or if the borrower has posted his business assets, they may be worth more to him, since he knows how to use those assets to produce goods, and the lender does not. The lender may choose to sell the collateral to someone else, but since the lender has an incentive to sell as quickly as possible, he may obtain less than what the collateral would normally sell for. In addition, businesses in a given industry often fail together. But when many lenders try to sell at the same time, the market gets flooded and the price they can obtain decreases. Overall, economists call this loss in asset value a *deadweight loss* because the lender does not gain as much as the borrower loses. Another deadweight loss involves transferring control of the collateralized assets, which often involves legal and other administrative costs. Therefore, there is a tradeoff: Collateral reduces the cost of borrowing because it gives the borrower incentives to work hard, but it also increases the cost of borrowing because the collateral may be worth more to the borrower than to the lender and because transferring control imposes costs.

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A Long-Term Relationship with a Bank Can Reduce the Need for Collateral. In their paper, Arnoud Boot and Anjan Thakor suggest that long-term relationships between a borrower and a lender can reduce the need for collateral. When the loan contract is a one-time transaction for the bank and borrower, there are two ways to induce the borrower to exert effort.

The first is to require collateral, as discussed above. The second is to lower the interest rate on the loan. A lower interest rate leaves more profits for the borrower and therefore induces him to exert effort to make the business succeed. However, if the interest rate needed to induce the borrower to

[3] An example of such an action is a business expansion. If the business succeeds, there are more profits. But because the firm spends resources on the expansion, it has less to spend cultivating its old customers.

[4] Of course, many businessmen and -women are motivated by ethical concerns and their reputations. For the most part, we ignore these motivations to highlight the role of collateral.

exert effort is too low, the loan may not be profitable to the lender; he may be able to get a higher interest rate by lending to other firms or individuals. The result is that the lender may need to require collateral, and as we have seen, this comes at a cost.

When the borrower and lender have a long-term relationship, the bank has another way to induce the borrower to exert effort. The bank can promise the borrower better terms on new loans in the future, once the business shows some signs of success.[5] Better terms mean less collateral and a lower interest rate. The borrower has an incentive to work hard even though he pledges less collateral because working hard increases the chances that the business will succeed and the terms on future loans will improve. In the future, under the new loan terms, the borrower has an incentive to work hard because of the low interest rate; therefore, collateral is no longer needed to induce effort.

But how can the lender afford to reduce the interest rate on future loans? In a competitive loan market, all lenders break even; they make enough money just to cover their costs. Thus, a lender that offers a lower interest rate and requires less collateral than anyone else would lose money. The lender can make up for this loss by charging a higher interest rate in the initial periods. In other words, at the beginning of the relationship with a borrower, before the business shows signs of success, the lender must demand an interest rate that is higher than a break-even rate; later on, he requires a lower interest rate. In this way, the bank makes a lot of profits at the start of the relationship, and this compensates the bank for the loss of profits later in the relationship. Overall, the bank breaks even, and the cost of collateral is reduced because, at the start of the relationship, the promise of better loan terms reduces the need for collateral, and when the relationship progresses, collateral is not needed.

Boot and Thakor's model predicts that borrowers with a longer banking relationship are less likely to pledge collateral. This prediction is consistent with what Allen Berger and Gregory Udell found in their 1995 paper. Using data on collateral requirements on lines of credit issued to small businesses, Berger and Udell found that firms that had long-term relationships with a lender were less likely to pledge collateral.[6] An additional 10 years of bank-borrower relationship lowered the probability of collateral's being pledged from 53 percent to 37 percent. Boot and Thakor's model also predicts that the interest rate on the loan will decline as the relationship progresses; however, results regarding this prediction are mixed.[7]

> When a borrower posts collateral, the bank becomes less conservative in approving his loan.

COLLATERAL AND RISK

We have seen that collateral provides incentives for the borrower to avoid default. Collateral also reduces the loss to the lender if a borrower defaults on a loan: If the loan is not paid, the lender can seize the collateral. One might conclude that secured loans are safer for the lender than unsecured loans. The data, however, show the opposite.

In their 1990 paper, Berger and Udell found that net chargeoffs (the amount of a loan the bank cannot collect) are likely to be higher when a loan is secured. They also found that borrowers who post collateral are more likely to perform poorly; for example, they are more likely to be late on their payments. These two findings suggest that secured loans are riskier for the bank; this is consistent with conventional wisdom in the banking industry.[8]

A possible explanation is that banks require more collateral when they perceive a loan to be riskier. Banks collect information about borrowers, for example, the borrower's income and performance with past loans. Banks can use this information to distinguish between borrowers who are more risky (that is, borrowers more likely to default) and borrowers who are less risky (those less likely to default), and they require more collateral from the riskier borrowers. Even though seizing collateral when a borrower defaults reduces the bank's loss, this is not enough to compensate

[5] Such a promise might be believable because there is an explicit contract or maybe because the bank, which deals with many firms, cares about its reputation for keeping its promises.

[6] The data came from the 1988-89 Survey of Small Business Finance, conducted by the Federal Reserve Board and the Small Business Administration.

[7] See Philip Strahan's chapter for a survey of results from small-business loans around the world. For the most part, the finding that collateral requirements fall with the length of the relationship is replicated in a number of studies. The effect of relationships on loan rates varies widely across studies.

[8] Ideally, the analysis would use data on individual loans. For example, the researcher would follow every loan to see if it was collateralized, if the borrower paid on time, and what the net chargeoff was. Since such data do not exist outside bank loan files, Berger and Udell used data on chargeoffs and loans past due at the bank level. They found that a bank with a larger share of collateralized loans has a larger number of chargeoffs and loans past due.

the bank for the fact that the loan was riskier to begin with.[9]

Berger and Udell provide evidence consistent with the explanation above.[10] Loosely speaking, they show in their 1990 paper that a collateralized loan typically has a higher interest rate. To correct for the fact that higher interest rates can reflect different points in the business cycle, they subtract the interest rate on a Treasury security with the same duration to calculate the markup on the bank loan and show that the collateralized loan typically has a larger markup.[11] Since Treasury securities are believed to be default free, the markup is a measure of how risky the loan is. If we assume that a bank charges a higher markup when it perceives that a loan is riskier, Berger and Udell's result suggests that a bank requires more collateral when it perceives a loan is riskier.[12]

Note that, in theory, the bank could eliminate the risk of default by requiring more collateral. In practice, however, the bank faces risk even if the whole value of the loan is secured by collateral. First, the value of the collateral may decrease over the life of the loan. Second, the "automatic stay" clause in the U.S. bankruptcy code often creates a significant delay between the time the borrower defaults on the loan and the time the lender can seize the collateral. Even though the value of the collateral is usually preserved, the fact that the payment is delayed imposes a cost on the lender.[13] According to Andrea Eisfeldt and Adriano Rampini, the difficulty in repossessing collateral explains why some firms may prefer to lease their assets, rather than to borrow money to purchase assets.[14]

COLLATERAL AND LENDERS' INCENTIVES

Boot and Thakor's model focused on how collateral affects the borrower's incentives to exert effort in ensuring that the loan is paid.[15] Roman Inderst and Holger Müller shift focus by dealing with the lender's incentives. The problem in their model is that lenders may choose not to finance some projects even though it is socially desirable to undertake them. Inderst and Müller show that using collateral can improve the lender's incentives to finance these projects.

Socially, it is desirable to undertake a project when consumers are willing to pay more than what the resources cost, that is, when the project creates value that can be shared between owners and lenders. When this happens, economists say that the project has a positive net present value (NPV).[16] In Inderst and Müller's model, banks tend to be too conservative. They refuse loans to projects that have a positive but relatively low NPV.

In the model, a firm applies for a loan from a local bank. The local bank faces competition from other lenders, but it has an information advantage. For firms located nearby, it can distinguish between projects that have positive NPVs and projects that have negative NPVs.[17] To other lenders, all projects look essentially the same, so they must charge a higher interest rate than the local lender to compensate for losses from the possibility of financing the negative NPV projects.[18]

How can the local bank use its information advantage? It can charge a high interest rate, but there is a limit. If the bank charges an interest rate that is too high, the firm would simply go to the other lenders. This places a

[9] Note that the fact that chargeoffs are higher for riskier loans does not mean that a bank that makes these loans loses money. Not all borrowers default. The bank can charge a higher interest rate when it perceives a loan to be riskier. While the bank loses money on riskier borrowers who default on their loans, it makes money on those who pay in full.

[10] The data came from the Federal Reserve's Survey of Terms of Bank Lending, which contains information on individual characteristics of domestic loans.

[11] When payments are made before final maturity, the duration of a security is less than its maturity. The duration of a security is shorter when a larger share of the total payments are made earlier.

[12] A high interest rate on a loan can also reflect a premium for additional collateral-related monitoring costs or for the cost of evaluating the loan as discussed in the next section. Yet, it is reasonable to believe that a higher interest rate reflects more risk.

[13] For more details, read Chapter 10 in Gregory Udell's book.

[14] Eisfeldt and Rampini focus on the following tradeoff: Leasing allows the firm to borrow more because it is easier for the lender to repossess the asset. However, leasing is costly because the borrower (the lessee) has fewer incentives to take appropriate care of the asset.

[15] Examples of other papers that focus on collateral and borrower's incentives are those by Yuk-Shee Chan and Anjan Thakor and by Arnoud Boot, Anjan Thakor, and Gregory Udell.

[16] One of the difficulties in saying whether a project creates value is that cash flows are received at different times; for example, a dollar you receive this year is worth more than a dollar you receive in five years because you can invest it and start earning interest earlier. In addition, cash flows can be uncertain; for example, they can be high or low. The net present value takes into account the timing and riskiness of all cash flows; it indicates the value of the project (today) net of the initial investment and net of all future investments.

[17] The local bank may have an information advantage because it is easier to monitor and collect information about a firm located nearby. More generally, the "local" bank might refer to a bank with which the borrower has had prior dealings.

[18] The local bank has access to "hard" information (for example, the firm's books) as well as "soft" information (for example, information about the borrower's managerial quality). The other lenders have access only to hard information; thus, they may not have a complete picture of the firm. Rebel Cole, Lawrence Goldberg, and Lawrence White provide evidence that in approving small-business loans, large banks tend to employ hard information, whereas small banks are more likely to rely on soft information.

ceiling on the local bank's return from making the loan, and the lender may choose not to finance the project even though it has a positive NPV.

To see why, consider the following example: Suppose that because of competition from other banks the local lender must leave the borrower with at least $15 million of revenues. Now suppose the local lender estimates that the project will cost $110 million and the expected revenues will be $120 million. Since the revenues are more than the cost, the project has a positive NPV of $10 million.[19] Now suppose that because the borrower has no cash, the local lender must provide all of the investment outlay. Since the borrower obtains $15 million, the lender is left with an expected revenue of $105 million, an amount that is less than the initial investment. The local lender will reject the loan because if he does not, he loses $5 million.[20]

Collateral Can Improve Lenders' Incentives... To see how collateral can improve the bank's lending policy, it is helpful to think first about the bank's lending policy when collateral is not used. To do so we make the example a little more realistic by recognizing the fact that the project can either succeed or fail. If the project succeeds, it yields $200 million; if it fails, it yields only $40 million.

To determine whether the project is profitable, the lender needs to estimate the probability that the project will succeed. For example, if the probability of success is half, the expected revenue is $120 million (½ x 200 + ½ x 40). If the probability is higher, the expected revenue is higher. For example, if the probability is 80 percent, the expected revenue is $168 million (0.8 x 200 + 0.2 x 40). We saw earlier that in the first case (revenue of $120 million), the lender will reject the loan. In the second case, the lender will approve the loan because he will be left with expected revenue of $153 million ($168 million minus $15 million), which is more than the initial cost. More generally, the bank will approve the loan only if it thinks that the probability of success exceeds some cutoff level.

Now suppose that the borrower posts collateral. The bank seizes the collateral only if the project fails. Thus, if the project is very likely to succeed, collateral has a very small effect on the bank's payoff. However, if the project has a lower probability of success, the bank's expected profits increase significantly when the borrower posts collateral. In other words, collateral increases the bank's payoff mainly from projects whose probability of success is relatively low. Thus, when borrowers post collateral, the cut-off (success) probability for approving a loan becomes lower.[21]

Consistent with the empirical findings in the previous section, the model associates collateral with more risk. Intuitively, when a borrower posts collateral, the bank becomes less conservative in approving his loan; therefore, the borrower is more likely to default. The model also predicts that borrowers who are more risky to begin with will post more collateral and pay a higher loan rate (that is, a higher markup over the interest on Treasury bills) than borrowers who are less risky. Here the intuition is simple: When the bank faces a risky borrower, it takes more measures to protect itself.

...But Too Much Collateral May Have a Negative Effect. In Inderst and Müller's model collateral is good for society because it allows more projects that have a positive NPV to be financed. Although the bank is less selective in approving projects (so there is more default), the bank finances only projects that have a positive NPV.

In some cases, however, collateralized lending can actually be bad for society. Indeed, if the borrower posts a lot of collateral, the lender might be tempted to finance a project even if he knows the project has a negative NPV. The lender may gain from such a loan because he obtains the collateral whenever the loan goes bad. However, society as a whole (in particular, the borrower) loses because of the deadweight cost associated with collateral and because resources are spent on projects with a negative NPV.[22] In their working paper, Philip Bond, David Musto, and Bilge Yilmaz use the term *predatory lending* to refer to a situation in which a lender knowingly makes a loan that is harmful to the borrower.[23]

But if the borrower is worse off, why would he agree to such a loan?

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[19] To make the example simple, I ignore the fact that revenues are not received at the same time as the investment is made. I also ignore the fact that revenues are risky.

[20] After the local lender rejects a loan, other lenders, who know that the loan was rejected by the local lender, will reject the loan too. The reason is that other lenders know there is a chance that the loan was rejected because the project was found to be unprofitable.

[21] When the borrower posts collateral, the bank will require a lower interest rate; otherwise, the borrower will go to other lenders. Thus, under the loan contract with collateral, the bank obtains more if the project fails but less if the project succeeds. In other words, collateral shifts the bank's payoff from the good states (where the project succeeds) to the bad states (where the project fails). Requiring a higher interest rate would not improve the bank's lending policy because a higher interest rate, which is paid only if the project succeeds, improves the bank's payoff mainly from projects that would have been approved anyway.

[22] This may suggest that, in some cases, society as a whole can benefit by limiting the maximum amount of collateral that can be posted in loan contracts or by including bankruptcy exemptions and provisions that limit banks' ability to repossess collateral.

[23] The Bond, Musto, and Yilmaz model focuses on one aspect of predatory lending. In practice, there may be other important aspects not explored in this model.

One possible explanation is that the borrower misunderstood the loan contract. Bond, Musto, and Yilmaz offer another explanation. They show that predatory lending may occur even if every borrower fully understands the loan contract.

For this to happen the lender must be better informed than the borrower; only the lender knows that the borrower will be made worse off. The bank (the lender) can assess the likelihood that the borrower will be able to repay the loan better than the borrower, a plausible assumption since the bank has made many similar loans in the past and has followed many borrowers. The borrower in turn may overestimate his ability to repay the loan because of lack of experience or maybe because of overconfidence.

Of course, a borrower would never apply for a loan if he knew that the bank always exploited him. In Bond and coauthors' model, some borrowers overestimate their likelihood of repayment, and some borrowers underestimate. Only the bank knows whether a potential borrower is overly optimistic; nonetheless, the bank offers the same contract to everyone. Thus, the borrower cannot deduce the bank's information and predatory lending can occur.[24]

Collateral May Also Reduce Incentives to Evaluate Loans. Michael Manove, Jorge Padilla, and Marco Pagano explore another situation in which the use of collateral may lead to a bad outcome. As in the previous paper, the bank is better informed than the borrower, but now the bank needs to incur some cost to obtain its information. In particular, by exerting some effort (for example, conducting an investigation), the bank can learn whether the project is likely to be profitable.

When the cost of evaluating the project is lower than the cost of investing in a project with a negative NPV, society benefits if the bank evaluates each loan before approving it. However, since no one can verify how much effort the bank expended, the bank may be "lazy," in Manove, Padilla, and Pagano's terminology. In particular, if the bank is protected by collateral, its incentive to exert effort in evaluating loans is reduced because it can recoup the value of the loan by seizing the collateral. If, on the other hand, the bank is not protected by collateral, the bank evaluates the loan more carefully because the bank does not obtain much if a firm's project fails.[25]

As in the model of Inderst and Müller, the use of collateral makes the bank more lenient in approving loans; thus, collateral is associated with more default. In Inderst and Müller's model, being more lenient is good because the bank approves more loans that have positive NPVs. In contrast, in Manove, Padilla, and Pagano's model, being more lenient is bad because the bank approves some negative NPV projects that would not be approved had the bank conducted a careful evaluation. Moreover, their model does not predict that those who post collateral are borrowers of low quality. In their model, firms have information about their own costs, and firms with low costs use collateral to communicate their information to the bank. (To learn more, see *Collateral Can Help the Bank Distinguish Between Borrowers*.)

COLLATERAL AND FIRMS' INVESTMENT DECISIONS

Until now, we have not been specific about the type of collateral used. Actually, there are two types: outside collateral and inside collateral. Outside collateral refers to the case where the borrowing firm pledges assets not owned by the firm. For example, the firm's owner might post his house as collateral for a business loan. Inside collateral refers to the case where the borrowing firm pledges assets it owns, such as machines and inventories. Although some of the ideas discussed earlier may apply to inside collateral, the models previously discussed are most convincing as explanations of outside collateral.

The discussion in the next section refers to inside collateral. When a borrower posts collateral for a loan, such a loan is called secured debt. Implicitly, a firm's debt is secured by its assets because if the firm goes bankrupt, the proceeds are used to pay the firm's lenders.[26] Therefore, most explanations of debt secured by inside collateral depend on the firm's having more than one lender. Secured debt gives some lenders priority over others for some specific set of assets.

Collateral Can Overcome Underinvestment. In their article, René Stulz and Herb Johnson suggest that issuing secured debt may allow a firm to take advantage of investment opportunities with a positive NPV that it otherwise could not. Taking advantage of such investment opportunities is desirable because it increases the firm's value; it increases the pie to be shared among the firm's shareholders and the firms' debt holders (its lenders).

The logic is as follows: Suppose the firm is considering borrowing to

[24] Economists refer to this scenario, in which the bank offers the same contract to all potential borrowers, as a *pooling equilibrium*.

[25] In Manove, Padilla, and Pagano's model, collateral reduces the bank's incentives to evaluate a project *before* a loan is approved. Raghuram Rajan and Andrew Winton explore how collateral affects the bank's incentives to monitor a firm *after* the loan is approved. They show that collateral may actually increase banks' incentive to monitor.

[26] To be precise, some claimants, including lawyers and the IRS, must be paid before lenders receive anything.

Collateral Can Help the Bank Distinguish Between Borrowers

Michael Manove, Jorge Padilla, and Marco Pagano's model illustrates what economists call the screening role of collateral. In their model, collateral helps the bank distinguish between firms that are likely to have positive net present value (NPV) projects and firms that are likely to have negative NPV projects.

Suppose there are two types of firms: firms with high operating costs and firms with low operating costs. When a firm applies for a loan, it knows its operating cost, so it has an idea of whether its project is likely to be successful and have a positive NPV. But since there are other factors affecting the project's success, the firm cannot know for sure. The bank can find out whether the firm has high costs or low costs as well as other information about the firm's project, but only after some investigation. Before the bank investigates, all firms look identical to the bank.

To recoup the cost of evaluation the bank must charge some fee. To make sure it puts the appropriate amount of effort into evaluating the loan, the bank charges only those firms whose loans are approved. Otherwise, the bank can make money by charging a fee without doing an evaluation and then rejecting all applicants.[a] In turn, firms whose loans are approved end up subsidizing the firms whose loans are not approved. But since the low-cost firms are the ones whose loans are more likely to be approved, they know they are the ones subsidizing the high-cost firms.

To avoid this, low-cost firms may try to distinguish themselves from high-cost ones by offering to post collateral. An economist would say that the low-cost firm is using collateral to *signal* its information to the bank. Posting collateral is costly to the firm because the firm loses it if its project fails. However, since the firm's costs are low, it knows the project is very likely to succeed and the risk of losing collateral is not large.

However, low-cost firms can signal their information using collateral only if high-cost firms find it unprofitable to mimic low-cost firms by posting collateral, too. This is the case if the high- and low-cost firms differ enough. For a high-cost firm, the cost of putting up collateral is much higher than for a low-cost firm because the firm knows it is more likely to default. The result is that low-cost firms post collateral and high-cost firms do not.

The bank can then distinguish between the two firms. If a firm is willing to post collateral, the bank concludes that the firm has low costs and approves the firm's project without an evaluation; in this case, a careful evaluation is not likely to change the bank's decision. If a firm is not willing to post collateral, the bank concludes the firm has high costs and evaluates the project; in this case, the bank's evaluation may indicate that the firm's project has a positive NPV, even though the firm has high costs.[b]

[a] In the real world a bank that acted this way would develop a bad reputation and lose loan applicants. The reader should interpret the story in the model as a stark version of the real-world problem that if all applicants are charged a fee upfront, the bank will have an incentive to exert too little effort in monitoring.

[b] Economists refer to this scenario, where one firm distinguishes itself from another firm, as a *separating equilibrium*. Note that if separation works, the firm can avoid investigation by posting less collateral than in the case where all firms behave the same. Since the bank concludes that a firm that posts collateral has low cost, further investigation is not likely to change the bank's decision.

Helmut Bester first introduced the idea that a borrower who thinks his project is likely to succeed prefers to pledge more collateral than a borrower was thinks his project is likely to fail. One of the problems with this type of model is that the "inherently good" borrowers (for example, those with low cost) are the ones who post more collateral. This seems inconsistent with the empirical evidence and with the common wisdom in the banking industry.

finance a new investment project that has a positive NPV and is very low risk. Further, suppose the firm already has relatively risky debt in place. In other words, if the firm does not undertake the new project, there is a significant likelihood it will default on its existing debt because its past investments may do poorly. If, instead, the firm undertakes the new project, the firm is less likely to default on its existing debt because it can use the cash flow from the new project to pay existing debt holders. But what if the cash flows from the new project are just enough to pay the new debt but not enough to pay both the new and the existing debt? In this case, the firm goes bankrupt, and the cash flows from the new project are shared between the existing debt holders and the new debt holders; thus, the new debt holders get paid less than what was promised to them. If, how-

ever, the firm did not have the risky debt in place, it could pay its new debt holders in full. Accordingly, any new unsecured debt holders would supply funds only at a very high interest rate, perhaps so high that the investment would be unprofitable for the firm.

Now suppose the new debt is secured by the new assets purchased with the borrowed funds. Then if the firm's initial project fares poorly and the firm goes bankrupt, the new assets posted as collateral are transferred to the new debt holders rather than shared among all creditors, new and old. Since the new debt holders obtain more when the firm goes bankrupt, they are willing to provide funds at better terms (a lower interest rate). This, in turn, increases stockholders' profits from making the new investment.[27]

CONCLUSION

Even though collateral has been around for a very long time, research into economic factors underlying the use of collateral has been particularly active in the past few years. Economists have deepened their understanding of the reasons some firms post collateral (and others don't) and of society's costs and benefits from collateralized lending.

Using collateral protects the lender if the borrower defaults. Collateral may also induce the borrower to exert more effort to ensure the loan is repaid. This is good because borrowers with good (positive NPV) investment opportunities can obtain credit more easily.

However, the use of collateral comes at some cost. Transferring control may be costly, and the lender may not value the collateral as much as the borrower does. In addition, a lender protected by collateral may exert too little effort in evaluating projects; he may even be induced to engage in predatory lending. This is bad from society's standpoint because firms obtain loans for projects that are likely to waste resources. A long-term relationship between a borrower and a lender can reduce the need for collateral and save on some of these costs.

[27] While Stulz and Johnson emphasize priority issues, Udell's book on asset-based finance emphasizes the informational value of monitoring inside collateral (inventory and accounts receivable). A recent working paper by Loretta Mester, Leonard Nakamura, and Micheline Renault lends empirical support to Udell's perspective.

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Is Technology Raising Demand for Skills, or Are Skills Raising Demand for Technology?

BY ETHAN LEWIS

A common view is that recent technological advances, such as the introduction of computers, have rendered obsolete some occupations that require less skill and have increased businesses' desire to hire skilled workers. However, some economists have challenged this view: What if the rising skills of U.S. workers are inducing businesses to adopt — and maybe even develop — new technologies that require workers who are more skilled? In this article, Ethan Lewis assesses this alternative view. To do so, he examines the evidence that increasing skills are driving technological change.

Since the late 1990s, incomes of the highest earning Americans have risen faster than the income of other Americans, a trend that has not gone unnoticed by the press.[1] The recent rise follows a decade of relative stability in income distribution, but it resumes a pattern of growing inequality that began in earnest in the 1970s. Until recently, a standard explanation for rising inequality was that a steady flow of technological advances, such as the increasing power and falling price of computers, has raised the desire of businesses to hire skilled workers and has made obsolete some occupations that require less skill. Economists call this phenomenon "skill-biased technological change" because new technologies are "biased" toward raising the productivity (and, hence, wages) of the most skilled workers. The primary direct evidence for this explanation is that the use of advanced technologies is more common among more-skilled, highly paid workers and in plants and industries with more-skilled workers.[2]

Some economists, however, have challenged this standard view, arguing the reverse: Rising skills of U.S. workers — as evidenced by the rising proportion of people who complete college — are driving businesses to adopt and possibly even to *develop* new technologies that require more-skilled workers. Paul Beaudry and David Green argue that the decision to use new technology is not automatic but depends critically on the availability of skilled labor and capital. Daron Acemoglu goes further, arguing that as the proportion of workers who are skilled rises, inventors will direct more effort toward technological advances that skilled workers can use.[3] The distinction is subtle. Technology is still involved in rising inequality, but it is the increase in the proportion of workers who are skilled, rather than technology per se, that is the cause of rising inequality.

This article assesses the alternative views that recent technological advances may have driven up inequality or that rising skills may be driving technological advances. It begins by examining the recent changes in the income distribution. How exactly has the distribution been changing, and why might technological forces

[1] Both the *Wall Street Journal* and the *New York Times* have recently published series on rising inequality. See, for example, the article by David Johnston and the one by David Wessel.

[2] Wage and skill are closely related. In a perfectly competitive labor market, a worker's wage exactly reflects how productive the worker is, which, in turn, depends on her skill level. In practice, that is not always true (wages might also reflect a worker's bargaining power, for example), but highly paid workers do tend to have higher values of observable characteristics that are valued in the labor market, such as education and work experience. Skill-biased technological change, it is argued, has raised the value, or "price," of skills in the market and, hence, the wages of skilled workers compared to those of less skilled workers.

[3] Keith Sill's article describes Acemoglu's theory of directed technical change in more detail.

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be responsible? Is there any direct evidence that new technologies favor skilled workers? Is the association large enough to explain rising inequality? Are rising skills driving technological change?

RECENT CHANGES IN THE WAGE STRUCTURE

The basic facts about rising inequality were presented in an article by Keith Sill, but they bear repeating here. The most basic fact is that the gap between the wages of the most highly paid workers and others has been rising in recent decades in the U.S., especially in the 1980s and in the late 1990s (Figure 1). The figure shows an index of hourly wages (adjusted for changes in the cost of living) in different parts of the wage distribution from 1979 to 2003. For our purposes here, I exclude women; only men's wages have been used in the calculations. (Inequality growth is smaller if women are included: Women's wages are rising over this period compared to men's. For more on this, see *Women's Wages and Increasing Inequality*.) The 90th percentile line represents the wage for high-skill men: Only 10 percent of men earn more than this wage. The 10th percentile line represents the wage for low-skill men: only 10 percent of workers earn less than this wage. The median, or 50th percentile, represents the middle of the distribution. The top line in Figure 1 shows the gap between the 90th percentile and median wages, a measure of inequality. The figure reveals that the growth in inequality has been driven not only by the rising wages of high earners but also by the falling wages of low and median earners.

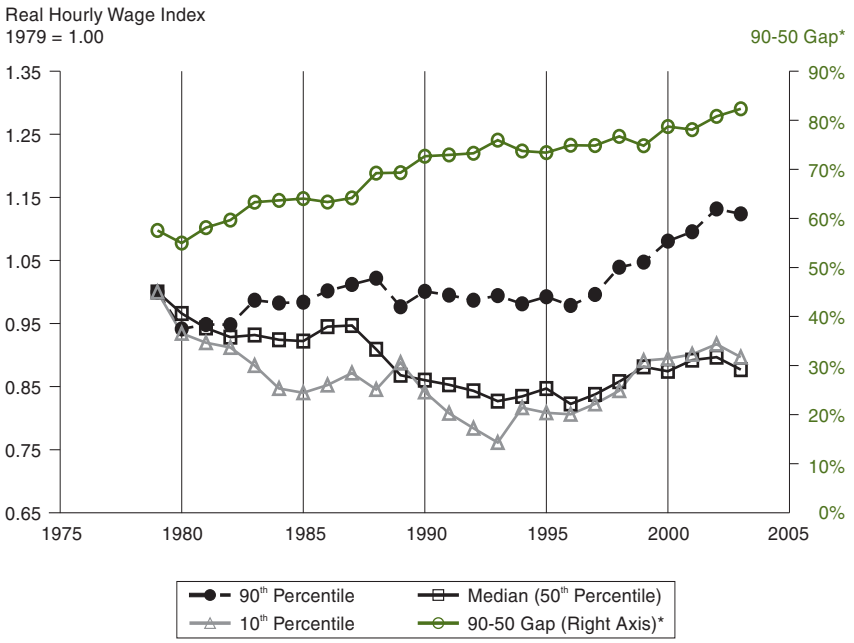
At least some of the increase in wage inequality, and some argue most of it, seems to be due to rising "return" to skill, that is, an increasing wage premium paid to workers with more skills.[4] One place this shows up is in the rising gap between the wages of more and less educated workers. Figure 2 shows wage indexes at different education levels, again for male workers only. These indexes are adjusted for changes in the cost of living, and in this case, they are also adjusted to represent workers who have similar amounts of work experience (15 years). The upper line shows that the return to a college degree — the percentage difference in earnings between a college degree and a high school diploma — has risen dramatically in the past few decades: from 30 percent to 50 percent. Earnings gaps between the other levels of education have also risen, as seen in the spreading out of lines in the lower part of Figure 2. Adjusted for inflation, the earnings of less educated workers, especially high-school dropouts, have fallen.

At the same time that the relative wages of more educated workers have been rising, the proportion of

[4] Interestingly, wage inequality has increased even among workers with very similar characteristics (for example, the same education, work experience, and occupation), which suggests not all of the increase in inequality should be attributed to an increased skill premium. However, Chinhui Juhn, Kevin Murphy, and Brooks Pierce argue that increases in inequality among similar workers could reflect increasing returns to skills that are not easily measured.

FIGURE 1

Real Hourly Wages (Males), 1979-2003



Data Source: Current Population Survey merged outgoing rotation groups, 1979-2003. Calculations include working males age 16-65 old enough to be out of school. Wages are adjusted for changes in the cost of living.

* 90-50 gap is the percentage difference between the hourly wage of the median male worker and the hourly wage of the male worker earning the 90th percentile wage.

workers who complete more education — the supply of skilled workers — has also been rising (Figure 3). The figure reports the fraction of workers with different levels of education. The fraction of workers who are high-school dropouts trends down, while the fraction with at least some college education trends up. If demand for different types of workers remains the same, a simple model of supply and demand would suggest that as the educational level of the work force rises, the gap between the wages of more and less educated workers should narrow. That the gap actually widened suggests that the availability of skilled workers may not have kept up with the pace at which businesses wanted to hire them, causing wages for skilled workers to rise. Another way to say this is that demand for skilled workers rose faster than supply.

There are competing explanations for the simultaneous rise in the supply of skilled workers and their relative wages. A standard view is that skill-biased technological change is responsible. This view originates from the observation that rising inequality coincides with the spread of computers: The PC was introduced in 1981, for example, and the late 1990s "tech boom" was a period of rapid investment in and diffusion of new information technologies (for example, the Internet and e-mail). This view posits that skilled workers are needed to operate and maintain computer technology, so demand for skilled labor rose after its introduction.

But the timing of the spread of computers is a weak argument for its effect on the returns to skill. The rise in inequality in the 1980s was largely due to a decline in the wages of less-skilled workers. As many researchers have pointed out, this may have been caused by other contemporaneous forces, including an influx of less-skilled immigrants, declining union participation, and increasing trade with the developing world.[5] Other forces that may have increased inequality and skill premiums in the 1980s include an increase in the proportion of women working (see *Women's Wages and Increasing Inequality*) and the substantial erosion in the real value of the minimum wage (Figure 4). A careful analysis by David Lee shows that the decline in the minimum wage may have been largely responsible for the increase in inequality during the 1980s.[6]

Still, economists disagree about the degree of influence of these other forces on inequality. Proponents of skill-biased technological change have pointed out that alternative forces like the minimum wage have little to say about why the wages of skilled workers would rise.[7] Also, the late 1990s

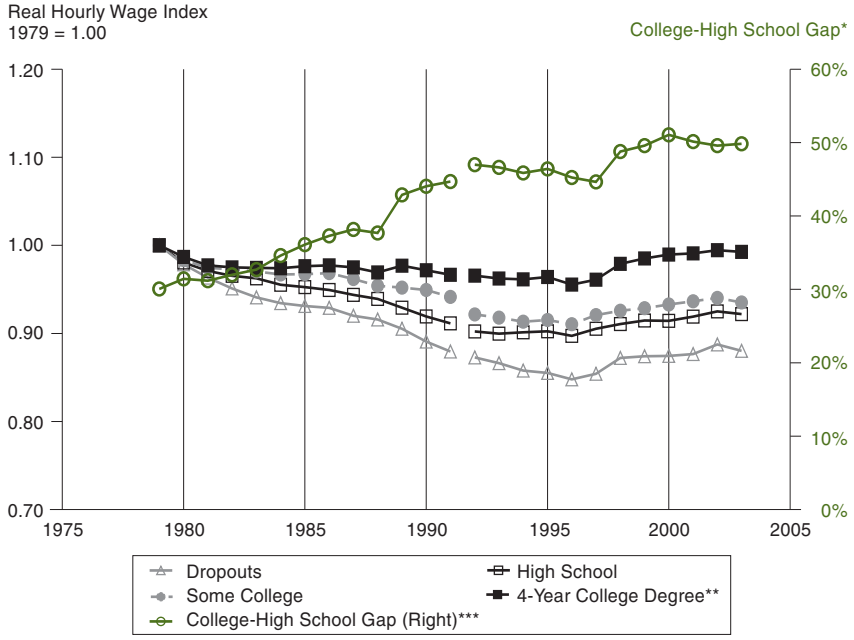
[5] For more on these factors, see Sill's article.

[6] Lee supports this view by showing that inequality rose in poorer states where many workers were earning the federal minimum wage and rose hardly at all in richer states where few earned the minimum wage.

[7] See the article by David Autor, Lawrence Katz, and Melissa Kearney.

FIGURE 2

Experience-Adjusted* Average Hourly Wage by Education Level (Males, 1979-2003)



Data Source: Current Population Survey, merged outgoing rotation groups.

*Wages are adjusted to reflect the mean for males with 15 years of work experience and for changes in the cost of living.

** Exactly 4-year degree. The series is broken between 1991 and 1992 because of a change in how the education question was asked beginning in 1992.

*** Percentage difference between the average male worker with 15 years of experience with exactly a 4-year college education and one with exactly a high-school diploma.

Women's Wages and Increasing Inequality

Most researchers who study the recent increases in wage inequality exclude women from their analysis. This is an important omission. If women are included in the calculations, recent increases in inequality are substantially smaller. This is shown in Figure 1a, which is identical to Figure 1 in the text except that both men and women are included in the calculations. Compared to Figure 1, the 90-50 wage gap measure of inequality increased by only half as much over the last 25 years and has changed little since the mid-1990s.

The reason inequality growth is smaller when women are included is that women's wages compared to men's rose rapidly over the same 25-year period. Figure 1b shows that women's mean hourly wages rose from only 67 percent to nearly 85 percent of male mean wages in the past 25 years. One force that may have made women's wages increase is women's increasing participation in the work force. Figure 1b also shows that during this same period, the proportion of women who work rose from 60 to 70 percent.[a] Another force is the rising skills of women. Women have increased their presence in professional occupations, especially since the late 1960s, a change research has linked to women's increased ability to delay child-bearing after the birth-control pill became widely available.[b] Changing social norms may have also played a role in raising women's ability to advance in professional careers.

Because researchers want to ignore these compositional changes in the work force when studying skill-biased technological change, they have typically excluded women from the analysis. Put another way, proponents of skill-biased technical change argue the wage paid to a skilled worker is higher today than a similarly skilled worker in the past; they argue that including women would risk clouding the analysis because it would mix the rising "price" of skill with an increase in the proportion of workers who are skilled (owing to women's increased presence in highly skilled occupations).[c]

While this is a widely held view, other research that examines women's wages more closely tends to reject the idea that changes in women's and men's wage distributions can be treated separately. For example, Nicole Fortin and Thomas Lemieux

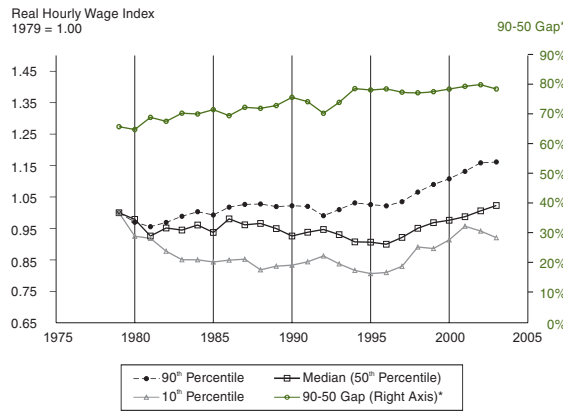
[a] Beyond this most recent period, since World War II there has been a dramatic increase in how much women — especially married women — work. Aubhik Khan's *Business Review* article describes some of the possible causes of this.

[b] See the article by Claudia Goldin and Lawrence Katz.

[c] A more subtle issue that worries economists is that women are "self-selected": that is, not all women work, and those who do may have very different earnings capacity from those who do not. If the amount of selection has changed over time — and the fact that the proportion of women who work has increased suggests that it has — it would confound measures of inequality growth. In fact, Casey Mulligan and Yona Rubinstein argue that women's wages have increased entirely because highly skilled women used to not work, and now they do. This "problem" can be overstated. The proportion of men working is also not 100 percent (in 2003, 83 percent of men age 16-65 worked) and has also been changing over time (it has been falling). However, most economists believe selection problems are smaller for men than they are for women.

FIGURE 1a

Real Hourly Wages Including Women

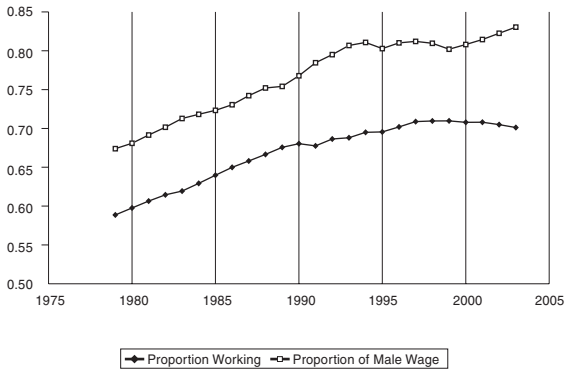


Data Source: CPS, merged outgoing rotation groups, 1979-2003. Calculations include working men and women age 16-65 old enough to be out of school. Wages are adjusted for changes in the cost of living.

* 90-50 gap is the percentage difference between the hourly wage of the median worker and the hourly wage of the worker earning the 90th percentile wage.

FIGURE 1b

Women: Proportion Working and Hourly Wage as a Proportion of Men's



Data Source: Current Population Survey, merged outgoing rotation groups, 1979-2003.

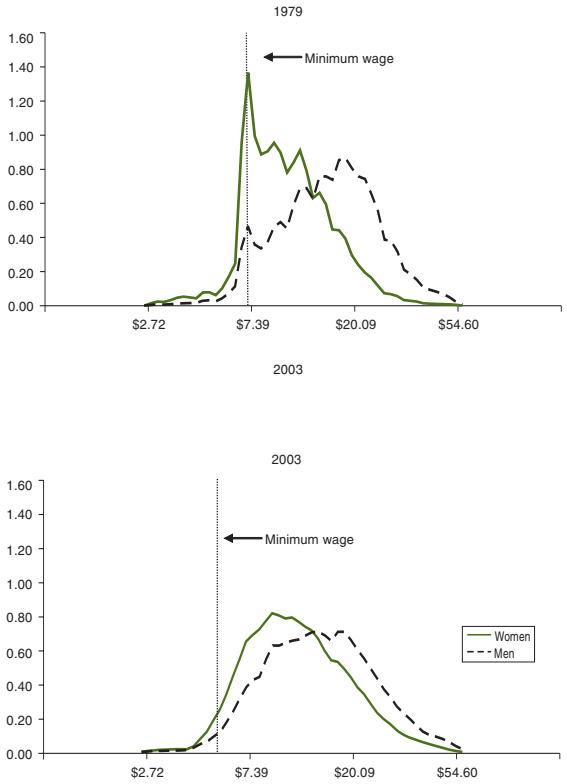
Women's Wages and Increasing Inequality (continued)

find that as women have entered into high-wage jobs, they have displaced some men, leading both male inequality and women's wages to rise at the same time. A version of their analysis is shown in Figure 1c, which gives the distribution of men's and women's wages in 1979 and 2003 (on a natural log scale). In 1979, many women were concentrated in jobs earning near the minimum wage, while men were disproportionately high earners. By 2003 men's and women's wage distributions converged and became more symmetric, as women rose to the part of the wage distribution where men formerly dominated, and men fell to the part of the wage distribution where women formerly dominated. Fortin and Lemieux argue that the increased competition from women in high-wage jobs may have increased male wage inequality, a circumstance that is missed by focusing on changes in male wages alone.[d]

However, recent research by Marigee Bacolod and Bernardo Blum argues skill-biased technological change might also partly explain the increase in women's wages. They show that women are concentrated in occupations that require "cognitive" skills (for example, doctors) whose wages have risen (arguably because of skill-biased technological change), while more men than women are in occupations that require "motor" skills (for example, mechanics) whose wages have been falling. They find that the changes in the prices of different skills account for at least 80 percent of the observed increase in women's wages compared to men's, which may mean that skill-biased technological change has helped raise women's wages compared to men's.[e]

FIGURE 1c

Distribution of Men's and Women's Real Hourly Wages (natural log scale)



Data Source: Current Population Surveys. Wages are in 2000 dollars.

[d] The figure also nicely shows the role that the fall in the minimum wage may have played in increasing inequality. In 1979, when minimum wages were high, the figure shows that wages are compressed in a spike near the minimum wage. After the real value of the minimum wage fell in the 1980s (see Figure 4 in the text), this spike in the wage distribution disappears.

[e] On the other hand, the fall in the price of motor skills might reflect other forces such as de-unionization and a fall in the real value of the minimum wage, rather than technological change.

appear to be different from the 1980s: The increase in inequality in the late 1990s was driven largely by the rapid increase in the wages of skilled workers.

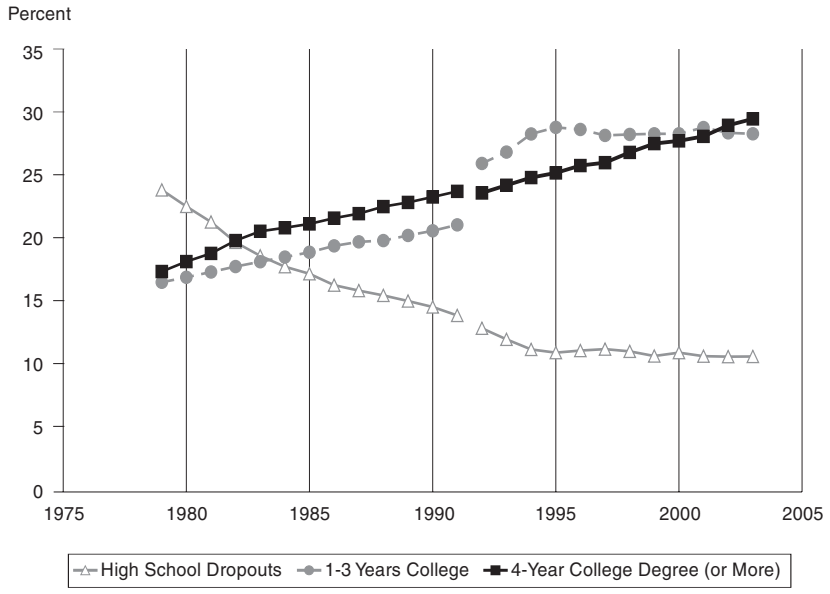
To bolster their case, proponents of skill-biased technological change have attempted to find more direct evidence of the link between technology and wages using data on individual workers, industries, and plants.

EVIDENCE FROM WORKERS, INDUSTRIES, AND PLANTS

Workers. Alan Krueger was one of the first to attempt to show directly that computers may make workers, especially skilled workers, more productive. Using data on individual workers' wages and on-the-job computer use, he showed that workers who used a computer at work earned wages that were 15 to 20 percent higher than those who did not. This earnings premium remained when controlling for characteristics of workers, such as age, education, and occupation. In addition, Krueger found that the premium was especially large for more educated workers, suggesting that the technology favored more-skilled workers. On the basis of this finding, Krueger argued that the increased use of computers over time has led to an increase in in-

FIGURE 3

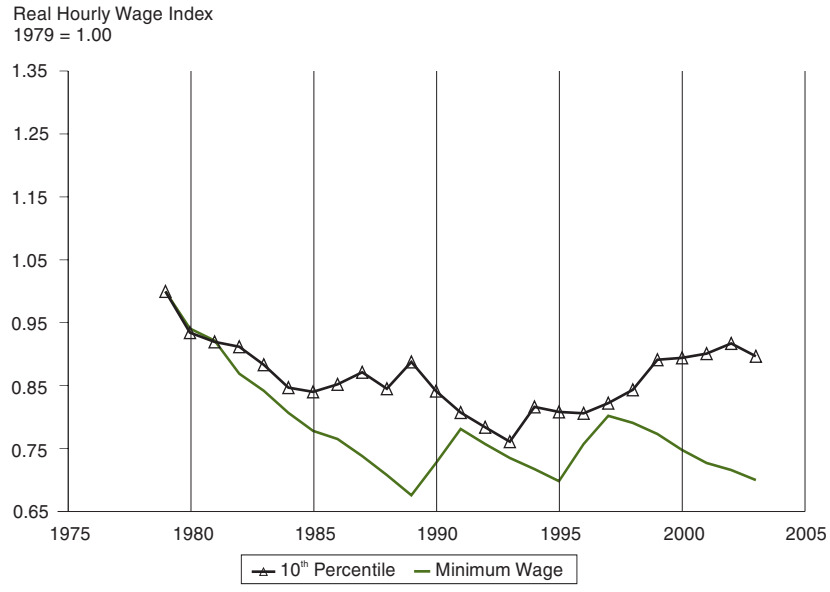
Rising Skills: Percent of Workers by Education



Data Source: Current Population Survey, merged outgoing rotation groups. The series is broken between 1991 and 1992 because of a change in how the education question was asked beginning in 1992.

FIGURE 4

Wages of Less-Skilled Males and the Federal Minimum Wage



Data Source: Current Population Survey, merged outgoing rotation groups, 1979-2003. See previous figures for further notes.

equality. He showed that, based on his estimates, as much as half of the rise in the college/high-school wage gap (see Figure 2) might be explained by computerization of the workplace.

In contrast to Krueger, Robert Valletta showed growing computer use at work is not likely to be responsible for growing inequality. Taking at face value the wage premium on computer use, his approach asks how much lower inequality would have been if different groups of workers (defined by work experience, education, gender, and race, among other things) had not increased their computer use between 1984 and 2003. During these 19 years Valetta estimates that on-the-job computer use rose substantially, from 25 percent to 57 percent of workers. Surprisingly, though, he finds that this led to virtually no increase in inequality. The basic idea behind this result is that the increase in computer use has been widespread, not limited to the most highly paid workers. As a result, although rising computer use may have made workers more productive and raised the general level of wages, it is unlikely to have increased the spread between high and low wages.

John DiNardo and Steffen Pischke provide further reason for skepticism about evidence based on association between computer use and skills. Using data on German workers, they showed that observationally similar workers who use a pencil at work earn a wage "premium" similar to that of those who use a computer at work. Since the use of a pencil does not require special skills, they conclude that one must be cautious about interpreting any wage premium on computer use. High-paying jobs may be more likely to involve a computer, they argue, but it is not necessarily the computer that makes the job high paying.

Industries. David Autor, Frank Levy, and Richard Murnane contribute to this debate by specifying the

mechanism by which computers affect the wage structure, and they provide empirical support for their view. They argue that computers replace routine cognitive tasks, that is, those tasks that involve thinking but that can be easily codified into a set of instructions for a computer. Recordkeeping is an example of a cognitive routine task. Creative writing is a nonroutine cognitive task: Computers cannot substitute for humans in this task. Autor and his co-authors also distinguish manual tasks from cognitive tasks and argue that computers replace only routine cognitive tasks (though factory automation, discussed below, may replace some routine manual tasks as well). As the price of computers falls, workers who perform routine cognitive tasks will likely be replaced by computers (or take a cut in wages), while skilled workers will be more productive because they can spend more time on nonroutine tasks.

To evaluate this view, the authors examined the relationship between the tasks performed in different occupations and increases in computer use over a long period. They use Labor Department surveys to measure how much routine cognitive, nonroutine cognitive, routine manual, and nonroutine manual tasks were required in each occupation. They found that the more an industry increased its use of computers between 1984 and 1997, the more it decreased its employment of workers in routine cognitive occupations and increased employment of workers in nonroutine cognitive occupations in recent decades. In the 1960s, before the widespread introduction of computers, the authors find little shift in occupation mix in the same industries. Though the evidence is supportive of their view, the authors are careful to acknowledge that the association between occupation shifts and computer use does not necessarily imply that the shift was caused by computerization.

Plants. Computers are not the only technology that may have contributed to rising inequality. Over the past few decades, manufacturing plants have become more automated as technologies such as robotics have become increasingly powerful and prevalent. Some research has focused on the impact of factory automation.

Mark Doms, Timothy Dunne, and Kenneth Troske obtained detailed data on the use of a variety of new automation technologies at a sample of manufacturing plants, as well as the characteristics of the workers at those same plants. They found that more-automated plants paid higher wages and had a higher proportion of workers who were college graduates, engineers, and nonproduction workers. However, they also found that the same plants had more skilled workers long before the technologies were introduced. Like DiNardo and Pischke's result for pencils, this finding suggests that automation was not necessarily the cause of the increased employment of skilled workers, even if it is associated with it.

GEOGRAPHIC DIFFERENCES IN TECHNOLOGY USE

Another way to explain the relationship between technology and income inequality is to treat different parts of the U.S. as different "markets." This approach takes advantage of the fact that there are wide differences in technology use and the availability of skilled workers in different regions of the U.S. To assess the causal relationship between technology and skills, I examined, in a previous article, how the relative availability of skilled and unskilled workers in a plant's local geographic market (metropolitan area) affected automation.[8] Aiding this approach is the fact that some differences in skill mix across local markets occur for idiosyncratic reasons that probably have little to do with technology. For example, some markets have a lot of less-skilled workers because they contain enclaves of less-skilled immigrants, whose numbers have increased rapidly in recent decades. Los Angeles, for example, has twice as many high-school dropouts per capita as other cities, largely because it is a major destination for Mexican immigrants, many of whom arrive in the U.S. without a high school diploma.

On the other end, some markets have a lot of highly educated workers because they were lucky enough to receive federal funds to build land-grant universities in the 19th century. These idiosyncratic differences provide natural "experiments" to evaluate the causal relationship between skills and technology.

In this earlier work, I found that in places with abundant unskilled labor, plants are less automated, and in places where skilled labor is abundant, plants are more automated. In addition, increases over time in the availability of skilled labor lead plants to increase their use of automation. This suggests that plants adopted these technologies to fill shortages of unskilled labor. Put another way, the use of technology responds to the amount of skilled labor available to operate it.

Looking across geographic markets also reveals a similar relationship for computers. In another article, I used another "natural experiment" — the aftermath of the Mariel boatlift, the 1980 exodus of Cubans that dramatically increased the availability of unskilled labor in Miami — to evaluate the impact of skills on technology.[9] I found that businesses in Miami were much slower to adopt computers at

[8] See my 2005 *Business Review* article.

[9] See my 2004 working paper.

work after the boatlift than businesses in other, similar cities.

In another recent paper, Mark Doms and I examined businesses' adoption of personal computers in the 1990s. We found that the adoption of PCs by otherwise similar businesses depended on the availability of college-educated labor in the local market. For example, Figure 5 presents a version of a scatter plot from this paper. It plots the number of personal computers per employee in the average business, adjusted for the businesses' industry and employment, in different metropolitan areas against the share of the workers in that area who are college educated.[10] The college share is measured in 1980, before businesses used PCs, while computer use is measured in 2000, by which time PCs were the dominant computing technology (used by 50 percent of workers). The figure shows that high-skill cities, such as San Francisco, use personal computers intensively, while cities with fewer college-educated workers, such as Scranton, use computers less intensively. Philadelphia is near the middle of this skills-technology relationship. Once again, the data in the figure have been adjusted for industry and size. For example, the figure adjusts for factors such as San Francisco's large "tech" sector and New York's large financial sector (both are computer-intensive sectors). Another way to say this is that very similar businesses, for example, law firms of a certain size, appear to vary their use of personal computers depending on the local availability of college-educated labor.[11]

In one sense, these results support the notion of skill-biased technological change, since they imply that as technology gets cheaper, firms replace unskilled workers with cheaper technology and hire more skilled workers. But these results also provide a more complex view of the increased use of skilled labor and the adoption of new technologies. It is not only the availability of new technology that induces plants to hire skilled workers but also the availability of skilled workers that induces plants to adopt new technology. In this alternative view, recent technological change may result partly from the rising skills of U.S. workers (see Figure 3) rather than being a fully independent force affecting the labor market.

CONCLUSION

Wage inequality has risen over the past few decades. Many economists believe that this is related to steady advances in and the diffusion of information and automation technologies, which may favor the employment of skilled workers. Though this explanation is appealing because technology has rapidly become more prevalent and is more often used by skilled workers, recent research finds that it is not consistent with many of the facts.[12] Other

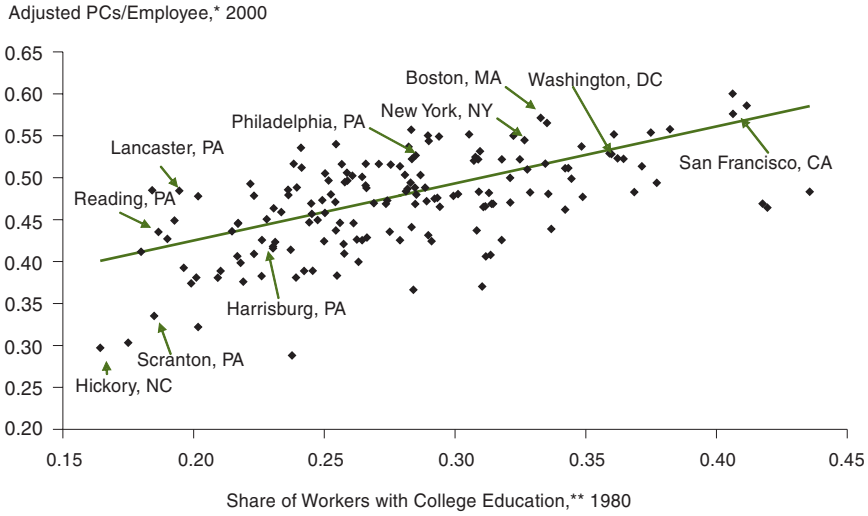
[10] The data for this figure come from two sources. College share comes from author's tabulations from the 1980 Census of Population, while personal computers per worker is tabulated from the "Harte-Hanks" data set, a proprietary establishment-level survey of technology use. Personal computers per employee figures are adjusted to control for the industry and size of the establishment. (Interestingly, this adjustment makes little difference!) College share includes all those with a four-year college degree plus one-half of those with one to three years of college education.

[11] In a similar result, Nicole Nestoriak found that plants in areas with an abundance of highly paid workers invested more in computing technology.

[12] See the article by David Card and John DiNardo.

FIGURE 5

Personal Computers/Employee vs. College Education by Metropolitan Area



*Data Source: Harte-Hanks, 2000-2002. Figures report number of personal computers per worker at the average business, adjusted for industry and establishment size (employment).

**Data Source: Census of Population, 1980. Figures report share of workers with at least a 4-year college degree + 1/2 of the share of workers with 1-3 years of college education.

forces, such as falling minimum wages, appear to have played a role in rising inequality. Researchers have also had difficulty establishing definitively that new technologies actually *cause* the number of jobs for skilled workers to increase. Some evidence even suggests the reverse: The spread of new technologies responds to the rising skills of the work force, rather than being an independent force affecting the demand for skills.

Economists are likely to continue to debate this issue. The latest increase in inequality, in the late 1990s, occurred during the period of rapid investment in information technology. This episode will be sure to inspire further research.

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Changes in the Use of Electronic Means of Payment: 1995-2004

BY LORETTA J. MESTER

This article updates the tables published in the Third Quarter 2003 *Business Review*. These tables, which were first published as part of an article in the March/April 2000 *Business Review*, presented data from the Federal Reserve's Survey of Consumer Finances. Loretta Mester, author of the original article, has compiled information from the recently released 2004 survey to keep our readers up to date.

In "The Changing Nature of the Payments System: Should New Players Mean New Rules?" (*Business Review*, Federal Reserve Bank of Philadelphia, March/April 2000), I presented some data from the 1995 Federal Reserve Survey of Consumer Finances on the use of electronic banking. This survey of more than 4,000 households, which is designed to be representative of all households in the U.S., is redone every three years. The following exhibits update the statistics indicating how the usages of various means of electronic payment have changed between 1995 and 2004.

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As seen in Exhibit 1, usage of electronic forms of payment, including ATMs, debit cards, automatic bill paying, and smart cards, has risen from about 78 percent of households in 1995 to about 90 percent of households in 2004. Debit card use, which doubled between 1995 and 1998, continued to increase rapidly and now stands at nearly 60 percent of all households. Increases were seen in all categories by age, income, and education. Use of direct deposit and automatic bill paying showed somewhat smaller increases, with the percentage of households now using automatic bill paying over double what it was in 1995. Nearly 75 percent of households have an ATM card. The question on smart cards was dropped from the survey in 2004; usage remained low in 2001, with less than 3 percent of households having a smart card they could use for purchases. There was a small increase in the percentage of households that use some type of computer software to manage their money: from 18 percent in 2001 (the first year this question was asked) to about 19 percent in 2004. Respondents under 60 years old, those with higher income, and those with college degrees are more likely to use a computer for money management.

As seen in Exhibit 2, households that do business with at least one financial institution have continued to shift from paper-based methods of conducting this business to automated methods. A sizable fraction of households, over 75 percent, still report that one of the main ways they deal with at least one of their financial institutions is in person; this percentage held steady between 2001 and 2004 but is down from 1995. Overall use of electronic means of doing business – either ATM, phone, fax, direct deposit and payment, other electronic transfer, and/or computer – continued to increase between 2001 and 2004, but not as sharply as the sizable rise seen between 1995 and 1998. In 2004, 89 percent of households used an electronic method as one of their main ways of conducting business, and differences by income and education have become less pronounced. There remains, however, a large difference in the popularity of ATMs across age groups: over 79 percent of those under 30 years old use ATMs as one of their main ways of conducting business, while less than 40 percent of those over 60 years old use them. Still, the usage by those over 60 has more than doubled since 1995.

The largest increase was seen in the percentage of households that use a computer, the Internet, or an online service to do business. In 2004, over

33 percent of households used these methods, up from less than 4 percent in 1995. Youth, high income, and a college degree continue to be associated with a higher incidence of computer banking, but the computer remains a less popular means of doing business with financial institutions compared with other methods.

EXHIBIT 1, PART 1

Percent of U.S. Households That Use Each Instrument: 1995, 1998, 2001, and 2004[a]

	ATM[b]				Debit Card				Smart Card[b]		
	1995	1998	2001	2004	1995	1998	2001	2004	1995	1998	2001
All Households	62.5%	67.4%	69.8%	74.4%	17.6%	33.8%	47.0%	59.3%	1.2%	1.9%	2.9%
By Age:											
Under 30 years old	72.3%	75.6%	78.1%	83.0%	24.4%	45.0%	60.6%	74.4%	1.8%	2.6%	2.6%
Between 30 and 60 years old	68.6%	76.1%	76.8%	82.3%	19.7%	38.6%	53.4%	67.6%	1.5%	2.3%	3.3%
Over 60 years old	44.2%	41.9%	48.9%	51.6%	9.6%	16.0%	24.6%	32.5%	0.3%	0.5%	2.1%
By Income:[c]											
Low income	38.5%	45.9%	46.8%	53.0%	7.0%	19.7%	29.2%	41.2%	0.7%	1.5%	1.9%
Moderate income	61.5%	64.4%	67.4%	73.4%	16.0%	31.6%	46.3%	57.4%	0.6%	3.1%	3.0%
Middle income	70.9%	72.0%	75.2%	78.3%	20.5%	36.6%	50.0%	64.3%	1.3%	2.0%	2.4%
Upper income	77.2%	82.3%	83.7%	86.5%	25.1%	43.8%	57.8%	69.3%	1.8%	1.7%	3.7%
By Education:											
No college degree	54.7%	60.1%	63.7%	67.4%	14.3%	29.2%	42.3%	54.9%	0.8%	1.8%	2.4%
College degree	80.4%	82.1%	81.6%	86.4%	25.2%	43.1%	56.2%	67.0%	2.1%	2.0%	3.8%

[a] The percentages reported are based on the population-weighted figures using the revised Kennickell-Woodburn consistent weights for each year. (For further discussion see the Survey of Consumer Finances codebooks at www.federalreserve.gov/pubs/oss/oss2/scfindex.html.) This exhibit reports percentages for all households.

[b] The questions on ATMs and smart cards asked whether any member of the household had an ATM card or a smart card, not whether the member used it. The other questions asked about usage. The question on smart cards was dropped from the 2004 survey.

[c] Low income is defined as less than 50 percent of the median household income; moderate income is 50 to 80 percent of the median; middle income is 80 to 120 percent of the median; and upper income is greater than 120 percent of the median. Each survey refers to income in the previous year. Median income was $32,264 in 1994; $37,005 in 1997; $41,990 in 2000; and $43,318 in 2003.

Source: 1995, 1998, 2001, and 2004 Survey of Consumer Finances data as of March 31, 2006, Federal Reserve System, and author's calculations.

EXHIBIT 1, PART 2

Percent of U.S. Households That Use Each Instrument: 1995, 1998, 2001, and 2004[a]

	Direct Deposit				Automatic Bill Paying				Software[b]		Any of the Methods: ATM, Debit Card, Smart Card, Direct Deposit, Automatic Bill Paying, or Software			
	1995	1998	2001	2004	1995	1998	2001	2004	2001	2004	1995	1998	2001	2004
All Households	46.7%	60.5%	67.3%	71.2%	21.8%	36.0%	40.3%	47.4%	18.0%	19.3%	77.7%	85.5%	88.4%	90.4%
By Age:														
Under 30 years old	31.0%	45.2%	48.8%	54.0%	17.7%	30.5%	32.1%	36.5%	17.0%	20.4%	76.3%	80.2%	83.0%	87.3%
Between 30 and 60 years old	42.8%	58.0%	64.8%	68.2%	24.4%	38.6%	44.1%	50.3%	22.0%	21.9%	78.7%	87.5%	89.3%	90.3%
Over 60 years old	63.3%	74.8%	83.2%	87.0%	18.2%	33.0%	35.9%	46.5%	9.0%	12.8%	76.1%	83.7%	89.2%	91.9%
By Income:[c]														
Low income	32.5%	44.3%	51.9%	54.8%	9.7%	17.1%	18.2%	24.6%	6.1%	6.8%	56.7%	69.3%	73.6%	77.4%
Moderate income	42.9%	58.8%	63.1%	64.0%	17.5%	30.5%	35.1%	40.5%	10.7%	11.1%	78.4%	87.2%	88.5%	88.6%
Middle income	48.3%	66.1%	65.7%	73.2%	23.4%	42.8%	45.1%	52.8%	16.3%	17.8%	85.1%	89.4%	92.3%	95.1%
Upper income	58.3%	70.4%	80.2%	83.6%	32.1%	49.3%	55.2%	62.4%	29.9%	31.4%	89.6%	94.9%	96.5%	97.1%
By Education:														
No college degree	40.3%	54.4%	61.8%	64.3%	18.1%	30.2%	33.7%	39.5%	10.9%	12.4%	71.4%	80.7%	84.7%	86.2%
College degree	61.0%	72.6%	78.0%	83.2%	30.1%	47.7%	53.2%	61.1%	31.8%	31.3%	91.8%	95.1%	95.6%	97.5%

[a] The percentages reported are based on the population-weighted figures using the revised Kennickell-Woodburn consistent weights for each year. (For further discussion see the Survey of Consumer Finances codebooks at www.federalreserve.gov/pubs/oss/oss2/scfindex.html.) This exhibit reports percentages for all households.

[b] The question on software asked whether the respondent or spouse/partner uses any type of computer software to help in managing their money.

[c] Low income is defined as less than 50 percent of the median household income; moderate income is 50 to 80 percent of the median; middle income is 80 to 120 percent of the median; and upper income is greater than 120 percent of the median. Each survey refers to income in the previous year. Median income was $32,264 in 1994; $37,005 in 1997; $41,990 in 2000; and $43,318 in 2003.

Source: 1995, 1998, 2001, and 2004 Survey of Consumer Finances data as of March 31, 2006, Federal Reserve System, and author's calculations.

EXHIBIT 2, PART 1

Percent of U.S. Households with at Least One Financial Institution Using Each Method Among the Main Ways of Conducting Business with at Least One of Their Financial Institutions[a]

	In Person				Mail				ATM			
	1995	1998	2001	2004	1995	1998	2001	2004	1995	1998	2001	2004
All Households	85.5%	79.5%	77.2%	77.3%	56.5%	54.1%	50.4%	50.2%	33.8%	52.6%	56.7%	64.4%
By Age:												
Under 30 years old	77.0%	73.7%	71.5%	72.9%	58.2%	51.9%	50.5%	44.2%	53.0%	68.8%	72.6%	79.3%
Between 30 and 60 years old	86.8%	81.8%	78.6%	77.3%	62.1%	60.4%	56.6%	56.3%	37.7%	61.5%	65.0%	72.0%
Over 60 years old	86.7%	77.2%	76.8%	79.5%	44.0%	39.9%	36.0%	39.1%	16.2%	22.3%	29.8%	39.8%
By Income:[b]												
Low income	81.2%	70.3%	68.2%	71.2%	32.8%	33.4%	24.7%	28.9%	19.6%	34.7%	35.6%	46.6%
Moderate income	85.9%	80.4%	76.9%	75.0%	48.5%	46.9%	42.0%	42.6%	29.6%	47.8%	50.5%	62.3%
Middle income	85.7%	81.4%	78.6%	77.7%	56.9%	56.4%	58.4%	56.0%	37.7%	54.1%	60.7%	65.7%
Upper income	87.7%	84.1%	81.8%	81.4%	74.3%	69.1%	64.9%	62.4%	42.3%	65.2%	69.6%	74.4%
By Education:												
No college degree	85.8%	79.2%	75.1%	76.9%	49.4%	48.2%	43.5%	44.1%	27.4%	45.1%	50.1%	59.1%
College degree	84.8%	80.2%	81.1%	78.0%	71.2%	65.2%	63.0%	60.1%	46.7%	66.7%	68.8%	72.9%

[a] The percentages reported are based on the population-weighted figures using the revised Kennickell-Woodburn consistent weights for each year. (For further discussion see the Survey of Consumer Finances codebooks at www.federalreserve.gov/pubs/oss/oss2/scfindex.html.) Referring to each financial institution with which the household does business, the survey asked: "How do you mainly do business with this institution?" Respondents could list multiple methods, with the main method listed first. This exhibit reports for all households with at least one financial institution all the methods a respondent listed for each of the household's financial institutions. Note, the percentages do not add up to 100 percent across columns, since households could list more than one method and more than one financial institution. Previous versions of this chart reported for 1998 and 2001 on the main ways respondents did business with their depository financial institutions (i.e., commercial banks, trust companies, thrifts, and credit unions) rather than with any of their financial institutions.

[b] Low income is defined as less than 50 percent of the median household income; moderate income is 50 to 80 percent of the median; middle income is 80 to 120 percent of the median; and upper income is greater than 120 percent of the median. Each survey refers to income in the previous year. Median income was $32,264 in 1994; $37,005 in 1997; $41,990 in 2000; and $43,318 in 2003.

Source: 1995, 1998, 2001, and 2004 Survey of Consumer Finances data as of March 31, 2006, Federal Reserve System, and author's calculations.

EXHIBIT 2, PART 2

Percent of U.S. Households with at Least One Financial Institution Using Each Method Among the Main Ways of Conducting Business with at Least One of Their Financial Institutions[a]

	Phone				Computer				Electronic[b]			
	1995	1998	2001	2004	1995	1998	2001	2004	1995	1998	2001	2004
All Households	25.7%	49.7%	48.9%	48.8%	3.7%	6.2%	19.6%	33.6%	56.2%	81.7%	87.0%	89.2%
By Age:												
Under 30 years old	20.8%	45.4%	45.9%	43.2%	5.2%	8.3%	22.9%	42.2%	66.7%	81.0%	85.2%	89.2%
Between 30 and 60 years old	28.1%	54.3%	52.4%	51.4%	4.5%	7.6%	24.2%	39.8%	59.9%	85.1%	89.4%	90.9%
Over 60 years old	23.0%	40.6%	42.4%	45.7%	1.2%	1.6%	7.3%	15.4%	43.4%	73.9%	82.4%	85.4%
By Income:[c]												
Low income	13.5%	28.8%	29.2%	30.0%	1.3%	1.5%	4.8%	14.0%	35.3%	65.4%	73.8%	78.7%
Moderate income	18.6%	42.5%	42.8%	44.8%	1.8%	2.7%	11.2%	22.5%	48.5%	80.1%	84.2%	84.8%
Middle income	22.6%	51.7%	51.7%	50.7%	4.0%	4.3%	17.8%	32.4%	59.2%	85.2%	89.7%	92.1%
Upper income	37.9%	64.9%	61.4%	60.0%	5.9%	11.5%	32.5%	49.4%	70.8%	91.0%	94.5%	95.6%
By Education:												
No college degree	19.7%	41.9%	41.7%	43.4%	2.8%	2.7%	11.3%	23.9%	47.8%	76.5%	83.2%	85.7%
College degree	38.1%	64.3%	61.9%	57.7%	5.6%	12.8%	34.8%	49.3%	73.5%	91.4%	94.0%	94.9%

[a] The percentages reported are based on the population-weighted figures using the revised Kennickell-Woodburn consistent weights for each year. (For further discussion see the Survey of Consumer Finances codebooks at www.federalreserve.gov/pubs/oss/oss2/scfindex.html.) Referring to each financial institution with which the household does business, the survey asked: "How do you mainly do business with this institution?" Respondents could list multiple methods, with the main method listed first. This exhibit reports for all households with at least one financial institution all the methods a respondent listed for each of the household's financial institutions. Note, the percentages do not add up to 100 percent across columns, since households could list more than one method and more than one financial institution. Previous versions of this chart reported for 1998 and 2001 on the main ways respondents did business with their depository financial institutions (i.e., commercial banks, trust companies, thrifts, and credit unions) rather than with any of their financial institutions.

[b] In 1995, electronic refers to ATM, phone, payroll deduction and direct deposit, electronic transfer, or computer. In 1998, 2001, and 2004, electronic refers to ATM, phone (via voice or touchtone), direct deposit, direct withdrawal/payment, other electronic transfer, computer/Internet/online service, or fax machine.

[c] Low income is defined as less than 50 percent of the median household income; moderate income is 50 to 80 percent of the median; middle income is 80 to 120 percent of the median; and upper income is greater than 120 percent of the median. Each survey refers to income in the previous year. Median income was $32,264 in 1994; $37,005 in 1997; $41,990 in 2000; and $43,318 in 2003.

Source: 1995, 1998, 2001, and 2004 Survey of Consumer Finances data as of March 31, 2006, Federal Reserve System, and author's calculations.

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THE EQUITY PREMIUM AND RETURN ON ASSETS

Recent empirical work documents a decline in the U.S. equity premium and a decline in the standard deviation of real output growth. The author investigates the link between aggregate risk and the asset returns in a dynamic production-based asset-pricing model. When calibrated to match asset return moments, the model implies that the post-1984 reduction in TFP shock volatility of 60 percent gives rise to a 40 percent decline in the equity premium. Lower macroeconomic risk post-1984 can account for a substantial fraction of the decline in the equity premium.

Working Paper 06-1, "Macroeconomic Volatility and the Equity Premium," Keith Sill, Federal Reserve Bank of Philadelphia

EXPLORING THE DYNAMICS OF PREDATORY LENDING

Regulators express growing concern over "predatory lending," which the authors take to mean lending that reduces the expected utility of borrowers. They present a rational model of consumer credit in which such lending is possible and identify the circumstances in which it arises with and without competition. Predatory lending is associated with imperfect competition, highly collateralized loans, and poorly informed borrowers. Under most circumstances competition among lenders eliminates predatory lending.

Working Paper 06-2, "Predatory Lending in a Rational World," Philip Bond, The Wharton School, University of Pennsylvania, and Visiting Scholar, Federal Reserve Bank of Philadelphia; David K. Musto, The Wharton School, University of Pennsylvania; and Bilge Yilmaz, The Wharton School, University of Pennsylvania

DEVELOPING EMPIRICALLY VIABLE MODELS

The time series fit of dynamic stochastic general equilibrium (DSGE) models often suffers from restrictions on the long-run dynamics that are at odds with the data. Relaxing these restrictions can close the gap between DSGE models and vector autoregressions. This paper modifies a simple stochastic growth model by incorporating permanent labor supply shocks that can generate a unit root in hours worked. Using Bayesian methods the authors estimate two versions of the DSGE model: the standard specification in which hours worked are stationary and the modified version with permanent labor supply shocks. They find that the data support the latter specification.

Working Paper 06-3, "Non-Stationary Hours in a DSGE Model," Yongsung Chang, Seoul National University; Taeyoung Doh, University of Pennsylvania; and Frank Schorfheide, University of Pennsylvania, CEPR, and Visiting Scholar, Federal Reserve Bank of Philadelphia

POLICY ANALYSIS AND POTENTIALLY MISSPECIFIED MODELS

This paper proposes a novel method for conducting policy analysis with potentially misspecified dynamic stochastic general equilibrium (DSGE) models and applies it to a New Keynesian DSGE model along the lines of Christiano, Eichenbaum, and Evans (JPE 2005) and Smets and Wouters (JEEA 2003). The authors first quantify the degree of model

misspecification and then illustrate its implications for the performance of different interest-rate feedback rules. The authors find that many of the prescriptions derived from the DSGE model are robust to model misspecification.

Working Paper 06-4, "Monetary Policy Analysis with Potentially Misspecified Models," Marco Del Negro, Federal Reserve Bank of Atlanta, and Frank Schorfheide, University of Pennsylvania, and Visiting Scholar, Federal Reserve Bank of Philadelphia

REVIEWING ESTIMATION AND EVALUATION TECHNIQUES IN DSGE MODELS

This paper reviews Bayesian methods that have been developed in recent years to estimate and evaluate dynamic stochastic general equilibrium (DSGE) models. The authors consider the estimation of linearized DSGE models, the evaluation of models based on Bayesian model checking, posterior odds comparisons, and comparisons to vector autoregressions, as well as the nonlinear estimation based on a second-order accurate model solution. These methods are applied to data generated from correctly specified and misspecified linearized DSGE models, and a DSGE model that was solved with a second-order perturbation method.

Working Paper 06-5, "Bayesian Analysis of DSGE Models," Sungbae An, University of Pennsylvania, and Frank Schorfheide, University of Pennsylvania, and Visiting Scholar, Federal Reserve Bank of Philadelphia

THE RELATIONSHIP BETWEEN INCENTIVES TO INVENT AND INCENTIVES TO PATENT

This paper develops a simple duopoly model in which investments in R&D and patents are inputs in the production of firm rents. Patents are necessary to appropriate the returns to the firm's own R&D, but patents also create potential claims against the rents of rival firms. Analysis of the model reveals a general necessary condition for the existence of a positive correlation between the firm's R&D intensity and the number of patents it obtains. When that condition is violated, changes in exogenous parameters that induce an increase in firms' patenting can also induce a decline in R&D intensity. Such a negative relationship is more likely when (1) there is sufficient overlap in firms' technologies so that each firm's inventions are likely to infringe the patents of another firm, (2) firms are sufficiently R&D intensive, and (3) patents are cheap relative to both the cost of R&D and the value of final output.

Working Paper 06-6, "When Do More Patents Reduce R&D?," Robert Hunt, Federal Reserve Bank of Philadelphia

REVISING ESTIMATES OF THE CPI FOR TENANT RENTS

Until the end of 1977, the U.S. consumer price index for rents tended to omit rent increases when units had a change of tenants or were vacant, biasing inflation estimates downward. Beginning in 1978, the Bureau of Labor Statistics (BLS) implemented a series of methodological changes that reduced this nonresponse bias, but substantial bias remained until 1985. The authors set up a model of nonresponse bias, parameterize it, and test it using a BLS microdata set for rents. From 1940 to 1985, the official BLS CPI-W price index for tenant rents rose 3.6 percent annually; the authors argue that it should have risen 5.0 percent annually. Rents in 1940 should be only half as much as their official relative price; this has important consequences for historical measures of rent-house-price ratios and for the growth of real consumption.

Working Paper 06-7, "The CPI for Rents: A Case of Understated Inflation," Theodore M. Crone and Leonard Nakamura, Federal Reserve Bank of Philadelphia, and Richard Voith, Econsult Corporation

DEVELOPING A SIMPLE STATE-DEPENDENT PRICING MODEL

The authors develop an analytically tractable Phillips curve based on state-dependent pricing. They differ from the existing literature by considering a local approximation around a zero inflation steady state and introducing idiosyncratic shocks. The resulting Phillips curve is a simple variation of the conventional time-dependent Calvo formulation but with some important differences. First, the model is able to match the micro evidence on both the magnitude and timing of price adjustments. Second, holding constant the frequency of price adjustment, the authors' state-dependent model exhibits greater flexibility in the aggregate price level than does the time-dependent model. On the other hand, with real rigidities present, this state-dependent pricing framework can exhibit considerable nominal stickiness, of the same order of magnitude suggested by a conventional time-dependent model.

Working Paper 06-8, "A Phillips Curve with an Ss Foundation," Mark Gertler, New York University and NBER, and John Leahy, New York University, NBER, and Visiting Scholar, Federal Reserve Bank of Philadelphia