Debt Overhang:
Why Recovery from a Financial Crisis Can Be Slow*

BY SATYAJIT CHATTERJEE

A particularly troublesome feature of the most recent recession has been the painfully slow growth in employment during the recovery. For employment growth to accelerate, economists believe that firms need to invest in new productive capacity. This view is typically couched in terms of the need to reallocate jobs away from crisis-depressed sectors into other sectors. But doing so requires an expansion in productive capacity in those other sectors. Tepid employment growth is a sign that this investment in new productive capacity has not been forthcoming. One reason for the reluctance to undertake productive investment following a financial crisis is *debt overhang*, a situation in which the existence of prior debt acts as a disincentive to new investment. There are other explanations that, to varying degrees, account for the current reluctance of U.S. corporations to invest. In this article, Satyajit Chatterjee focuses on the debt overhang problem.

In their widely read book, Carmen Reinhart and Kenneth Rogoff have marshaled an impressive amount of data on global financial crises going back eight centuries. One lesson from their work is that economic recovery from bad financial crises tends to be slow. On average, it takes an economy somewhere around seven years following a crisis to get economic activity back to its normal trend path. In some cases, the return to trend can take much longer — close to two decades!

This historical experience resonates with our current situation. A particularly troublesome feature of the recent recession has been the painfully slow growth in employment during the recovery. In order for employment growth to accelerate, economists believe that firms need to invest in new productive capacity. This view is typically couched in terms of the need to absorb workers formerly employed in the sectors that were most adversely affected by the financial crisis — namely, the construction and financial sectors — into other sectors of the economy. The reallocation of jobs away from crisis-depressed sectors requires an expansion in productive capacity in other sectors. Tepid employment growth is a sign that this investment in new productive capacity has not been forthcoming.

But it is not for a lack of resources. Figure 1 displays the profits of the nonfinancial corporate sector and shows that profits rose strongly during this recovery. And if we examine the disposition of investible funds, we discover that the nonfinancial corporate sector has dramatically reduced its investment in productive capacity relative to the resources available for investment.

This is evident in Figure 2, which shows capital outlays of the nonfinancial corporate sector as a percentage of funds that the nonfinancial corporate sector already possesses (without recourse to any new borrowings or equity issues — so-called "internal funds") and can use for this purpose. This percentage fell precipitously during the recession and has since remained depressed. These facts indicate that the U.S. nonfinancial corporate sector possesses investible resources but has chosen not to deploy these resources in productive investments during the re-

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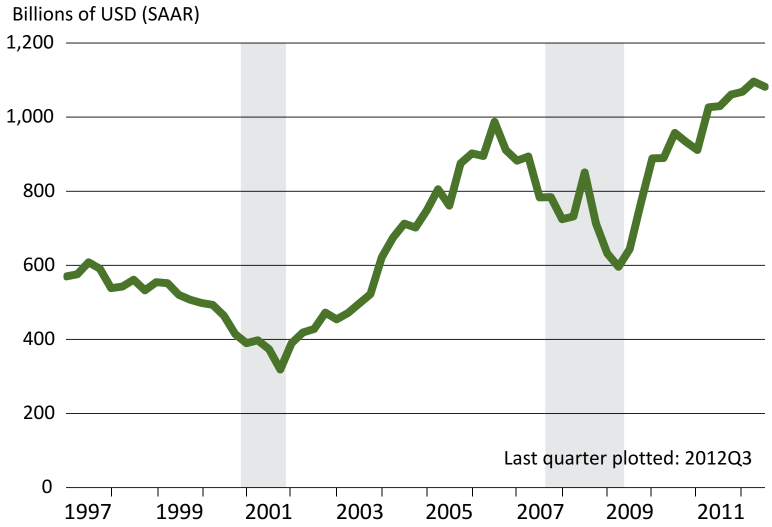
* The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

FIGURE 1

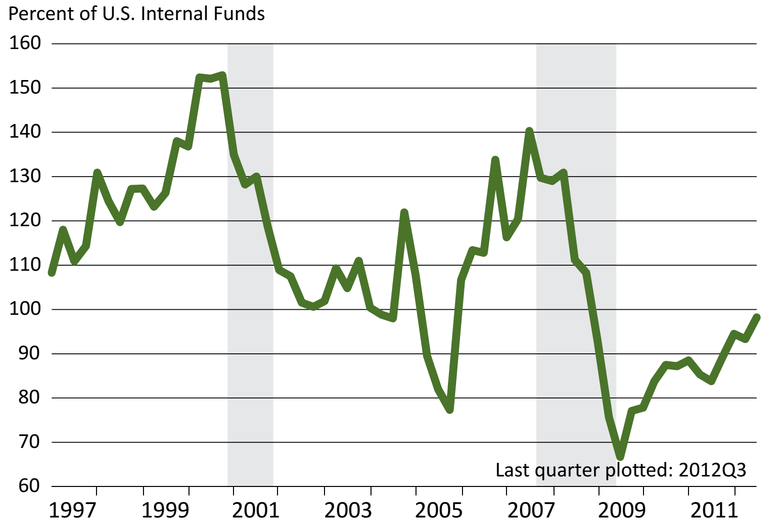
Domestic Nonfinancial Corporate Profits Before Tax with IVA and CC Adjustments



Sources: BEA, Haver

FIGURE 2

Nonfinancial Corporations: Capital Outlays/U.S. Internal Funds (SA)



Sources: FRB Flow of Funds, Haver

covery. Since our current slow recovery is partly attributable to the reluctance of businesses to invest in productive assets, we need to understand why financial crises have this effect on investment.[1]

Economists believe that one reason for the reluctance to undertake productive investment following a financial crisis is *debt overhang.* Debt overhang is a situation in which the existence of prior debt acts as a disincentive to new investment. When a firm has outstanding debt on which the likelihood of default is significant, any investment that improves the firm's future profit potential also increases the value of outstanding debt. All else remaining the same, an increase in the value of outstanding debt reduces the value of equity in the firm; that is, it results in a wealth transfer from equity owners to existing creditors. Since equity owners are the ones who make investment decisions, the transfer acts like a tax on the return on new investment. This "tax" results in a drop in the rate of investment in business capital, which, in turn, slows down the recovery.

There are other possible explanations for the reluctance of U.S. companies to invest. One oft-cited reason is "increased uncertainty about the future." When investment decisions are costly to reverse, there is value in waiting and learning more about future conditions before committing funds to a project. Thus, increased uncertainty about the future may cause companies to delay investment. Aside from the increased uncertainty that inevitably accompanies a deep recession, commentators have pointed to uncertainty about the future path of U.S. fiscal (tax and expenditure) policy as well as uncertainty about the impact on businesses' health-care costs resulting from the recently enacted Affordable Care Act as factors holding back investment and hiring. Another explanation may be that the growth rate of (multifactor) productivity has fallen back to its historical norm from the above-average pace experienced during the decade preceding the onset of the financial crisis, causing the rate of investment growth to decline in tandem. Finally, it is thought that retiring baby boomers may be holding back business investment by depressing equity values as they sell stocks to fund their retirement. More fundamentally, a more slowly growing labor force requires less growth in capital equipment to productively equip new workers joining the labor force, so there is less growth in investment. Of course, all of these explanations, to varying degrees, account for the current reluctance of U.S. corporations to invest. In this article I focus on the debt overhang problem.[2]

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[1] One might think that the reluctance to add new productive capacity results from current capacity utilization rates being low. If existing capacity is not being fully utilized, why expand capacity? True, but it raises the question of why utilization rates are low. If corporations as a whole were investing more, capacity utilization rates would go up right away. One must consider the possibility that low capacity utilization is a symptom of some deeper malady that is affecting investment – not the malady itself.

FINANCIAL CRISIS AND THE GENESIS OF DEBT OVERHANG

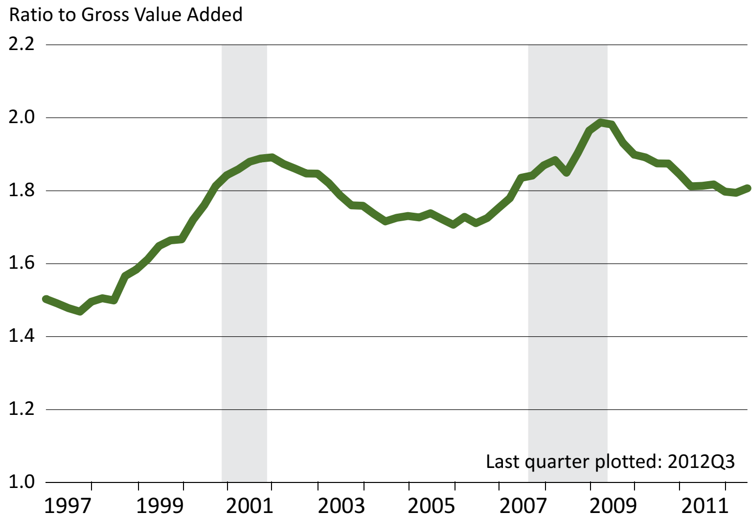
The genesis of the debt overhang problem lies in the recent financial crisis. The crisis caused the U.S. banking sector to deleverage. In doing so, banks cut off credit to the nonfinancial sector — the now infamous "credit crunch." Because credit is a fundamental ingredient in the smooth operation of asset markets, the crunch adversely affected the value of all types of tangible business capital. The steep drops in the value of assets owned by the nonfinancial corporate sector also lowered the sector's net worth and raised the frequency of business failures.[3] Both factors made corporate debt appear more risky to investors.

It is worth observing that "excessive borrowing" by the nonfinancial corporate sector during the boom years is *not* part of this narrative. Figure 3 shows the liabilities of the nonfinancial corporate sector scaled by the gross value added in the sector.[4] During much of the boom period, the liabilities of the sector shrank relative to its GDP. Nevertheless, it is true that whatever debt there was became much more risky following the onset of the financial crisis in the fall of 2008. Figure 4 shows the difference in yields on medium-term industrial bonds and U.S. Treasuries. The difference is the additional return required by investors to absorb the default risk present in industrial bonds but absent in Treasury bonds. As one can see, the compensation for default risk (the so-called *risk spread*) rose dramatically as the crisis unfolded and remains elevated today.

Although risk spreads can go up

FIGURE 3

Nonfinancial Corporations: Liabilities as a Share of Gross Value Added



Sources: BEA, FRB Flow of Funds, Haver

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[2] Following the onset of the financial crisis, a number of researchers and many commentators have pointed to debt overhang as a reason for the drop in investment and its slow recovery. The article by Thomas Philippon and the commentary by Filippo Occhino, for instance, discuss the debt overhang problem as it pertains to the current crisis. Occhino and Andrea Pescatori's article discusses the role of debt overhang in constraining investment during business downturns more generally. The article by Karen Croxson, Susan Lund, and Charles Roxburgh stresses the global extent of the debt overhang problem and looks broadly at both private-sector and public-sector debt.

[3] The net worth of the nonfinancial corporate sector is simply the difference between the value of its assets and its liabilities. The mechanism through which a drop in net worth amplifies a credit crunch is discussed in more detail in my 2010 *Business Review* article.

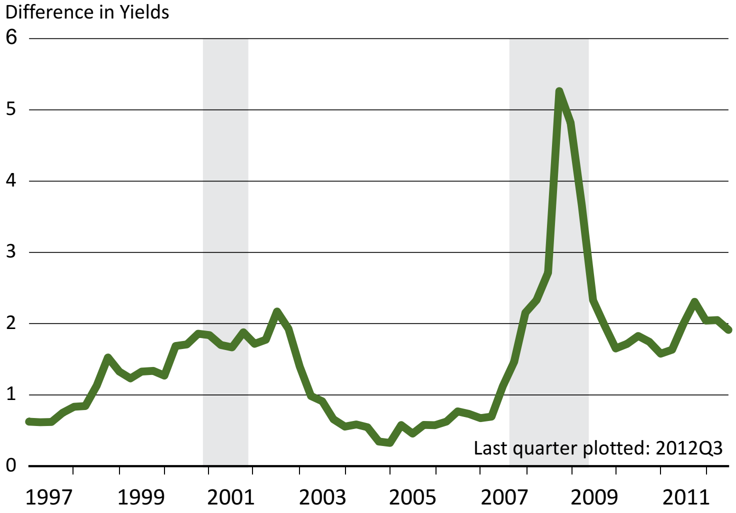
[4] Scaling by sector GDP takes account of the fact that borrowing is a natural complement of economic activity and tends to go up with it. Thus, to determine if the sector indulged in "excessive" borrowing, it is important to look at its liabilities relative to a measure of economic activity.

for many reasons, the evidence is suggestive of a crisis-induced increase in default risk as well as loss rates given default. Figure 5 displays the number of business bankruptcy filings. Filings were on an upward trend even before the crisis, but they have accelerated since the third quarter of 2008. Although filings have come down, they remained elevated relative to the boom years until recently. Figure 6 displays the ratio of credit market debt of the nonfinancial corporate sector and the value of tangible assets in this sector. As shown, the ratio rose from around 42 percent at the start of 2007 to more than 56 percent at the height of the crisis. The ratio is currently above 50 percent. A higher value of debt relative to tangible assets is a concern for creditors because tangible assets are what creditors mostly recover if a company fails. A loan-to-value ratio of 50 percent is an indication to creditors that they should now expect higher loss rates (given default) compared with the pre-crisis years.[5]

Finally, there is direct evidence of a greater likelihood of default or an increase in expected loss rates given default. This evidence comes from credit default swap (CDS) spreads on bonds issued by highly reputable U.S. corporations.[6] A CDS written on a specific corporate bond is an agreement in which the seller of the CDS promises to compensate the buyer for

FIGURE 4

Corporate Bond Spreads

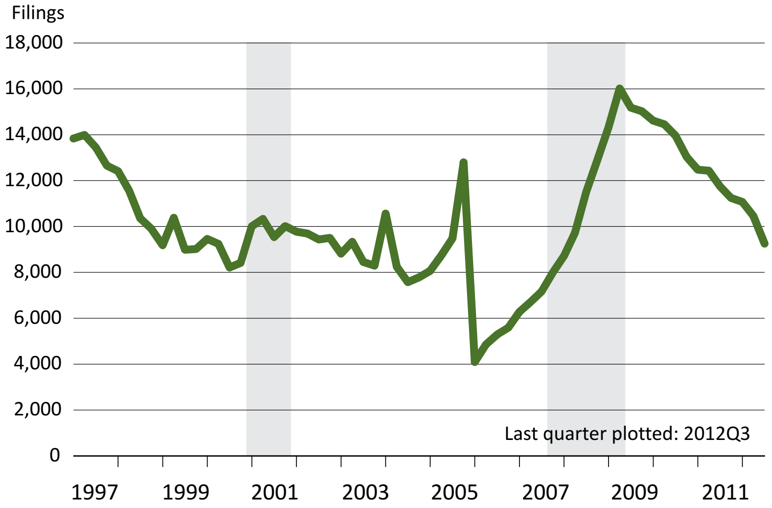


Note: Current Treasuries 5-10 years subtracted from corporate industrial bond 5-10 years, yield to maturity

Sources: Bank of America, Merrill Lynch, Haver

FIGURE 5

Business Bankruptcy Filings



Sources: Administrative Office of the U.S. Courts, Haver any losses incurred due to default on the named bond. In return, the buyer pays the seller an insurance premium each period. This insurance premium is measured as a percent of the face value of the bond and is referred to as the CDS spread. A high spread means that default on the bond is more likely, that the loss incurred in the event of default is higher, or both. As Figure 7 shows, the CDS spread was around 50 basis points (a basis point is 1/100 of a percent) prior to the crisis, then rose dramatically during the crisis, and is still almost twice as high compared with the pre-crisis period.

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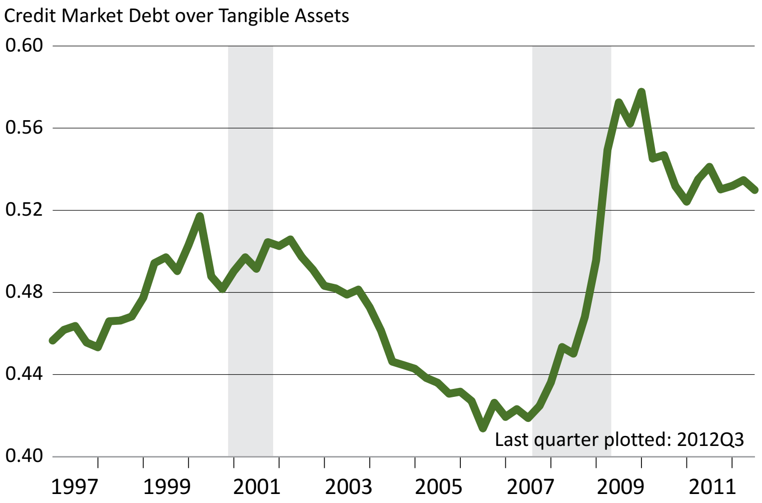
[5] On the face of it, a loan-to-value ratio of 50 percent suggests that creditors will not take any losses in case of bankruptcy. However, the value of the firm's tangible assets is much lower in bankruptcy than its reported value when the firm is a going concern. Indeed, it is not uncommon for creditors to dispose of recovered assets at huge discounts. These so-called "fire sales" occur because it is costly for creditors to hold on to recovered assets.

[6] The index is based mostly on the corporate debt of nonfinancial firms. The few financial firms that are included in this index are firms whose debt maintained a top credit rating through the crisis.

The bottom line is that corporate sector debt began to look substantially more risky to investors following the financial crisis, mostly because the crisis depressed asset values.

FIGURE 6

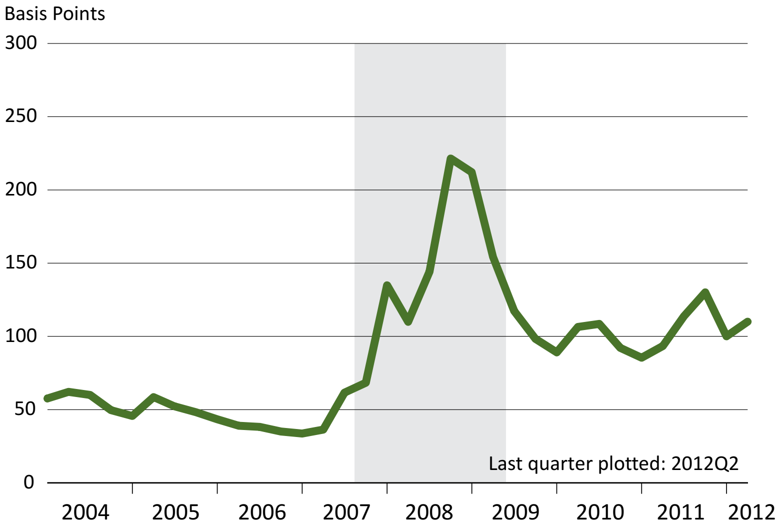
Nonfinancial Corporations: Credit Market Debt/Tangible Assets



Sources: FRB Flow of Funds, Haver

FIGURE 7

CDS Spreads for Investment Grade Bonds



Sources: Markit CDX.NA.IG, Bloomberg

DEBT OVERHANG: WHAT IT MEANS AND WHY IT'S BAD NEWS

In his 1995 article, Owen Lamont gives an example of what debt overhang means and why it is bad for investment. Suppose that a firm has $100 in debt, due next year, but will have assets worth only $80. Thus, the firm will not have enough resources to meet its debt obligations next year and will default for sure. Now suppose that a business opportunity presents itself to this firm in the form of a project that will cost $5 today and yield $15 next year. If existing creditors are first in line for the payout of the firm, no outside investors will be willing to supply $5 to the firm because the benefit will go to the original creditors, who will have their payoff go up to $95. Lamont calls the $20 gap between assets and liabilities the *debt overhang*. If the net payoff from the new investment cannot cover this gap, the project will never be financed by an outside investor. Debt overhang raises the bar for new investments: Only very profitable investments will be worth undertaking. In this example, the return on the $5 dollar investment would have to be at least $25 to make the investment worthwhile to the outside investor. The return would enable the firm to repay what is owed to the original creditor and still make a positive return on the investment.

It is easy to generalize this example to the case where default is probable but not certain. First, assume that if no new investment is undertaken, the value of assets in the next period can be either $80 or $110 with equal probability. Thus, there is a 50 percent chance that the firm will be bankrupt and the creditors will get $80, and there is a 50 percent chance that the firm will not be bankrupt, in which case we may assume that the creditors will receive $100.[7] The market value of the firm's debt is then (½) × $80 + (½) × $100 = $90.[8] Correspondingly, the market value of the firm's equity (i.e., the value of the firm to its owners) is (½) × $0 + (½) × $10 = $5 (which follows from the fact that when the firm is bankrupt, the owners lose everything, and when it is not bankrupt, the owners retain the difference between the value of the assets and the value of the liabilities). Now, assume the new investment is undertaken. Then, the value of the firm's assets in the next period will be either $95 (which is the sum of $80 plus $15, the latter being the return from the new investment) or $125 (which is the sum of $110 and $15). Notice that even with the new investment, there is a 50 percent probability that the firm will go bankrupt, but instead of receiving $80, the creditors will get $95 in the event of default. Therefore, the market value of existing debt will rise to (½) × $95 + (½) × $100 = $97.50. Correspondingly, the market value of equity will rise to (½) × $0 + (½) $25 = $12.50. The important point to note here is that although the total value of the firm rises by $15 (the payoff from the new investment), half of the overall increase in value goes to current creditors and half to owners. The implicit expected percentage of the "tax" imposed by current creditors on the return on new investment to equity holders is 50 percent, which is simply the probability of bankruptcy.

It is worth pointing out that the debt overhang problem can be eliminated if the returns to new investment can be dedicated solely to new investors.

The fact that the return to owners from undertaking a new investment is adjusted downward by the probability of default on existing debt is what financial economists call the "debt overhang" problem.[9] Simply put, in the event of default, the returns to any new investment will first accrue to the creditors rather than to the equity holders, and this fact lowers the return to equity holders from funding new investment projects. All else remaining the same, the overhang can be expected to reduce investment by leveraged corporations. Said differently, the debt overhang raises the required rate of return for new investment to be undertaken.

Empirical estimates of the effects of debt overhang for individual corporations appear to be quite large. According to the study by Christopher Hennessey, Amnon Levy, and Toni Whited, a 1 percent increase in leverage for a corporation with median leverage leads to a 1 percent decline in investment for that corporation. While it is not easy to translate this estimate into an estimate of the reduction in aggregate business fixed investment due to the debt overhang problem, it suggests that the effect is potentially significant. In the aggregate, the leverage of the nonfinancial corporate sector (measured as the ratio of its liabilities to its net worth) is around 13 percent higher now than before the crisis, suggesting that business investment may now be 13 percent lower as a result of debt overhang. Over a four-year period (the third quarter of 2008 to the third quarter of 2012), this would amount to annual growth in business investment that is about 2 percent slower than what it would have been had the crisis not intervened.[10]

It is worth pointing out that the debt overhang problem can be eliminated if the returns to new investment can be dedicated solely to new investors. This is not possible if new investors are given equity shares in the firm because, by law, equity holders cannot be paid off unless all creditors are paid off first. In other words, creditors have a *senior claim* on the income and assets of the firm vis-à-vis equity holders. On the other hand, if the new investment is debt financed (i.e., the firm issues debt rather than equity to its new investors), the debt overhang problem boils down to whether *new* creditors have a senior claim to the income and assets of the firm vis-à-vis existing creditors. If they do, the debt overhang problem again disappears.[11] In practice, creditors typically insist that their claims be senior to the claims of any future creditor of the firm so that the debt overhang problem remains even if the new investment is debt financed.[12]

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[7] In this eventuality, the firm can borrow $100 again from the same or a different set of creditors and pay off the loan that has come due. The process of using new loans to pay off maturing debt is called "rolling over" the debt.

[8] For simplicity, I have assumed that the interest rate on safe financial investments (say, a one-year Treasury bond) is zero. If the interest rate were positive, say, 1 percent, the market value of the firm's debt would be $90 ÷ 1.01.

[9] See, for instance, the articles by Christopher Hennessey and Stewart Myers.

[10] Normally, a lower level of business fixed investment can be expected to be partially offset by an increase in some other component of aggregate demand (such as higher consumer spending on durables), and the overall effect on real GDP would be smaller than that implied by a 13 percent decrease in business fixed investment alone. But when there is slack in resource utilization (as evidenced by the current high unemployment and low capacity utilization rates), there may not be any offset.

The bottom line is that if a firm has debt outstanding on which there is a positive probability of default (risky debt), the presence of that debt lowers the returns to equity owners from new investment. This is because in the event of default, all of this new investment is lost. In this situation, investors would be unwilling to invest in new projects unless these projects are very profitable. Consequently, the rate of growth of business investment is adversely affected by the presence of risky debt.

DEBT OVERHANG AND THE INCREASED VALUE OF LIQUIDITY

So far, I have considered the incentives of outside investors (equity holders or new creditors) to invest in a new project. However, as we have seen, the nonfinancial corporate sector is not starved for funds. For debt overhang to be an explanation for lackluster investment, we also need to consider the firm's incentives to invest its *own* funds in the new project.

I will do this by going back to the example where the future value of the firm's assets is uncertain (and can be either $80 or $110). Imagine now that the $5 is actually the firm's own money, obtained as profits from current operations. What should the firm do with it? The top row of Table 1 shows what the firm can get if it invests its $5 in the new project today. With a 50 percent probability, the firm will go bankrupt and all of the return from the project will be lost, and with a 50 percent probability, the firm will survive and the project will return $15. On average, the new project will fetch an additional $7.50 tomorrow. This amounts to an expected rate of return of (7.50 − 5)/5 × 100 = 50 percent. This might look like an attractive return, except that when default is a possibility, there might be another strategy that will fetch the owners an even more attractive return.

Suppose that the firm's owners can keep the $5 in the firm as cash and, in the next period, decide if they want to pursue the new investment after learning about the value of their existing assets. The returns from this strategy are displayed in the bottom row of Table 1. If the value of the assets turns out to be $80 (which happens with a 50 percent probability), they have $85 on hand. Since they owe $100, they are bankrupt. At this point, suppose they are able to take $1 out of the $5 as profits and hand the firm over to the creditors.[13] So, with a 50 percent probability, the owners

TABLE 1

Investment Strategy	Payoff in Bankruptcy (50 percent chance)	Payoff Outside of Bankruptcy (50 percent chance)	Average Payoff	Average Return (Average Payoff − 5)/5 * 100
Invest $5 Now	$0	$15.00	$7.50	50 percent
Hold $5 in Cash & Invest Tomorrow If Not Bankrupt	$1.00	$15.00	$8.00	60 percent

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[11] For instance, in the example, suppose that all of the new investment is financed by new debt. Since the new investment costs $5, the firm will owe $105 next period. The probability of default is still 50 percent, since it will occur only if the value of assets turns out to be $95. But if the $5 claim of the new investors is senior to the $100 claim of existing creditors, new creditors can be paid off even in bankruptcy because the value of the firm's assets ($95) is sufficient to cover the $5 claim of new creditors. Given this, new creditors would view the loan as a safe investment and would presumably go ahead and finance the investment project. In contrast, if the claim of new creditors is junior to the claims of existing creditors, they get nothing in the event of default because the $100 claim of existing creditors will exhaust all of the firm's assets.

[12] It would take us too far afield to fully explain the reasons why existing creditors insist on the seniority of their claims vis-à-vis future creditors. The article by Burcu Eyigungor sheds light on this issue.

[13] Bankruptcy law makes it illegal for corporations to distribute any dividends in a state of insolvency. Thus, the example is not to be taken literally. Rather, it is intended to capture the fact that owners do have opportunities to legally take money out of the firm when bankruptcy is probable but not certain. The assumption that only a portion of total cash holdings can be taken out in this manner acknowledges the limitations that exist on this type of equity extraction.

get back $1. If the value turns out to be $110, they have $115 on hand, and their assets are worth more than their liabilities. At this point, they can ask their creditors to roll over the $100 debt and invest the $5 in the new investment project and earn $15 in the following period. So, with a 50 percent probability, the owners get back $15. The expected payoff from just hanging on to the $5 as cash today is then (½) × $1 + (½) × $15 = $8 and the expected return is (8 − 5)/5 × 100 = 60 percent. Since 60 percent beats 50 percent, the firm's owners are likely to be tempted to just keep their profits as cash in the firm and decide what to do with it in the next period.

The bottom line is that cash has the benefit of liquidity: It gives equity owners the option to take some of their money out if bankruptcy becomes more probable. Thus, when there is a relatively high probability of bankruptcy, equity owners have an incentive to delay making real investments and accumulate cash with the intention of taking that cash out as dividends at some point in the future. This seems consistent with the evidence. As shown in Figure 8, the ratio of financial assets to gross value added in the nonfinancial corporate sector has risen during this recovery.

DEBT OVERHANG AND SELF-FULFILLING PESSIMISM

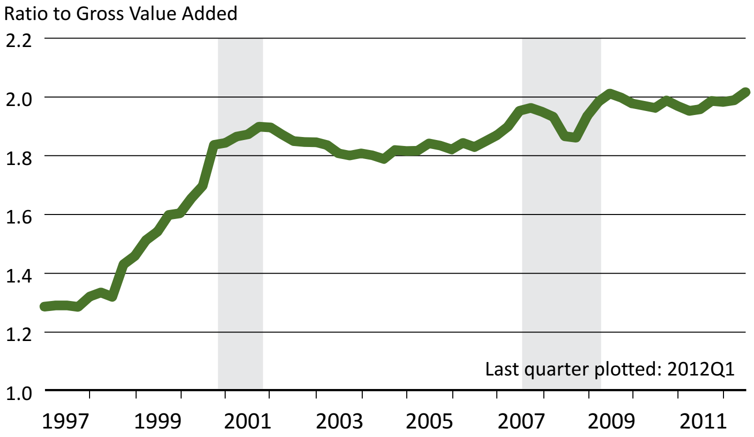
Many current observers of the U.S. economy hold the view that for an economy growing slowly from a depressed state, it does not take much in terms of some adverse shock to tip it into a recession. This being the case, our current slow recovery has engendered greater pessimism about the economy's future growth prospects. An important point that Lamont makes in his article is that in the presence of a debt overhang problem, pessimism about the future can be self-perpetuating.

To understand his point in the context of our example, suppose that the business sector's collective reluctance to invest increases the probability of the bad outcome (low asset value) from 50 percent to 60 percent. Now the "tax" on new investment is 60 percent, and as shown in the top row of Table 2, the average payoff from investing $5 today declines to $6 and the average return declines to 20 percent. The decline in the rate of return would make outside investors (be they equity owners or creditors) more reluctant to pour new money into the firm. Also, while the payoff from the "hold on to cash" option declines to $6.60 and its rate of return to 32 percent, the difference in the rate of return between the two strategies *widens* to 12 percent from 10 percent. Thus, the strategy of just hanging on to the cash will seem even more attractive to business owners.

In sum, an increase in pessimism (by which we mean a greater probability weight on the bad outcome) makes the "tax" imposed by the debt

FIGURE 8

Nonfinancial Corporations: Financial Assets as Share of Gross Value Added



Sources: BEA, FRB Flow of Funds, Haver

TABLE 2

Investment Strategy	Payoff in Bankruptcy (60 percent chance)	Payoff in Bankruptcy (40 percent chance)	Average Payoff	Average Return (Average Payoff − 5)/5 * 100
Invest $5 Now	$0	$15.00	$6.00	20 percent
Hold $5 in Cash & Invest Tomorrow If Not Bankrupt	$1.00	$15.00	$6.60	32 percent

overhang problem higher and retards business investment even more. Slow growth in business investment, in turn, can keep a lid on the speed of economic recovery and makes pessimism about the future self-perpetuating.

CONCLUSION

Recovery from financial crises tends to be slow, and one reason for this is the debt overhang problem. The declines in asset values that accompany a financial crisis lower firms' net worth. If these firms are carrying debt, the loss of net worth brings them closer to default. Debt overhang occurs when there is a significant probability that a firm will go bankrupt in the near future. The overhang of existing debt reduces the incentives of new investors to invest in business capital because, in the event of default, part of the return on new investment accrues to existing creditors. Debt overhang also increases owners' incentives to invest their current profits in financial assets because these assets are easier to liquidate when business conditions deteriorate and bankruptcy becomes more likely. On both counts, the rate of investment in business capital is adversely affected. Thus, debt overhang is one potential explanation for why firms have been reluctant to expand capacity in this recovery. The macroeconomic consequence of this reluctance to invest is a slow recovery. To the extent that a slow recovery engenders pessimism, it exacerbates the debt overhang problem.

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DSGE Models and Their Use in Monetary Policy*

BY MICHAEL DOTSEY

The past 10 years or so have seen the development of a new class of models that are proving useful for monetary policy: dynamic stochastic general equilibrium (DSGE) models. Many central banks around the world, including the Swedish central bank, the European Central Bank, the Norwegian central bank, and the Federal Reserve, use these models in formulating monetary policy. In this article, Mike Dotsey discusses the major features of DSGE models and why these models are useful to monetary policymakers. He outlines the general way in which they are used in conjunction with other tools commonly employed by monetary policymakers and points out the promise of using these models as well as the pitfalls.

The past 10 years or so have witnessed the development of a new class of models that are proving useful for monetary policy: dynamic stochastic general equilibrium (DSGE) models. The pioneering central bank, in terms of using these models in the formulation of monetary policy, is the Sveriges Riksbank, the central bank of Sweden.[1] Following in the Riksbank's footsteps, a number of other central banks have incorporated DSGE models into the monetary policy process, among them the European Central Bank, the Norge Bank (Norwegian central bank), and the Federal Reserve.[2]

This article will discuss the major features of DSGE models and why these models are useful to monetary policymakers. It will indicate the general way in which they are used in conjunction with other tools commonly employed by monetary policymakers. These other tools include purely statistical models, often not tied to any particular economic theory, but instead are solely based on historical regularities found in the data. Such tools also include large macroeconomic models that contain many sectors of the economy but generally do not place many theoretical restrictions on the interrelationships between the various economic sectors. Other tools include economic surveys of consumers, firms, or forecasters, as well as policymakers' own expertise.

These other tools provide valuable insights into the state of the economy that complement the insights derived from explicit theoretical models, which account for important interactions between sectors of the economy. Together, the various modeling approaches comprise the toolkit that policymakers commonly rely on. This article will concentrate on DSGE models, which share the strengths of many theoretically grounded models but are designed with the intention of providing forecasts and identifying the key drivers of current economic activity. In doing so, I will point out the promise of this modeling strategy as well as its pitfalls.

Economic models, in general, provide valuable guidance when formulating monetary policy. Because the economy is so complex and key economic components are intertwined, it is necessary to develop frameworks that capture these interrelationships. In order to capture, say, the effect that an increase in productivity has on consumption, we must have a model that incorporates the behavior of many

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[1] See the article by Malin Adolfson and coauthors.

[2] Examples of these models can be found in Smets and coauthors; Bruback and Sveen; and Chung, Kiley, and Laforte.

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

variables, such as income, investment, labor supply, and consumption, if we are to understand this effect. Simply looking at one equation that attempts to only model consumption is likely to produce an incomplete and misleading interpretation. Thus, a model that integrates many economic components is necessary for understanding and predicting economic behavior.

However, because all models are approximations of actual economic behavior, it is often useful to combine the insights from a number of models along with statistical forecasts and the individual experience of policymakers. That is generally what many central banks do, and DSGE models are increasingly becoming a part of policymakers' toolkits.

AN OVERVIEW OF DSGE MODELS

DSGE models are small to medium size economic models that incorporate the major sectors of the economy into a coherent and interrelated whole. They are general equilibrium in nature, meaning that prices and interest rates adjust until supply equals demand in every market. In particular, the demand for goods equals the supply of goods, the demand for assets equals the supply of assets, and the demand for labor equals the supply of labor.

Further, these models include a private sector composed of households and firms, as well as a public sector made up of a government fiscal authority and a central bank. A distinguishing feature of these models is that consumers and firms in the model make decisions that maximize welfare and profits, respectively. Individuals make decisions about consumption and labor supply that maximize their economic well-being subject to constraints based on their wealth. For instance, individuals in the model cannot consume more than they can afford. Firms set prices that maximize profits and demand factors of production, such as labor and capital, in ways that minimize their costs. This depiction of behavior places restrictions on the actions of firms, households, and the government in the model, and the validity of these restrictions can be formally tested. Doing so allows model builders a way of analyzing the strengths and weaknesses of the underlying theory. Model restrictions that are not consistent with economic data indicate a weakness that calls for further development of the model. When various restrictions are consistent with the data, we can have more confidence in the model. It is safe to say that no model has been developed that is consistent with all features of the actual economy, but great strides have been made, and the underlying methodology incorporated into the development of these models makes further improvements likely.

DSGE models are small to medium size economic models that incorporate the major sectors of the economy into a coherent and interrelated whole.

The models are also stochastic, meaning that they incorporate the random components that play an important role in explaining the cyclical behavior of the economy. Common disturbances include shocks that change consumer demand, shocks that influence the behavior of financial markets, and changes in economic productivity that affect the efficiency of production. What is key to the DSGE paradigm is that these shocks can be estimated as can the proportions of changes in economic activity that are due to a particular disturbance. For instance, we may ask what part of the latest recession was due to financial shocks as opposed to changes in productivity or fiscal policy shocks. The restrictions imposed on the model's economic structure imply that each of these types of shocks has very different implications for the economic predictions of the model, and the estimation of the model places weights on each type of disturbance that allows the model to fit the data as best as possible.

Finally, the models are inherently dynamic. Current behavior does not depend only on the current economic climate but also on anticipation of what the future holds. For example, firms' hiring and investment decisions depend on whether they believe that economic demand will be weak or strong in the future, not just on current demand conditions. This dynamism implies that expectations of the future play an important role, and although such an assumption is not required, most DSGE models assume that the actors in the model — individuals and firms — form expectations that are consistent with the underlying theoretical framework of the model. This does not imply that households and firms perfectly anticipate future outcomes but that, on average, they do not make systematic errors. This type of expectations formation is referred to as "rational expectations," and it is a common feature of a broad set of economic models.

Combining these ingredients — the use of explicit maximizing behavior that is also dynamic in nature and forward-looking rational expectations — makes the output of DSGE models, whether that output is an economic forecast, the results of a policy experiment, or the analysis of the sources of economic fluctuations, readily interpretable in terms of economic theory.

Thus, DSGE models paint a coherent picture with respect to a host of issues that are of interest to policymakers.

MAKING THE MODELS OPERATIONAL

All of the relationships that govern the economic behavior of any DSGE model include parameters, and these parameters must be assigned values before the model can be used. For instance, we need to know how much individuals value current consumption relative to future consumption in order to understand their consumption and saving decisions. The parameter that governs that aspect of behavior is called a discount factor, and it must be given a specific value. Also, we need to understand the costs associated with a firm's adjustment of its capital stock if we are to understand investment behavior, and there are parameters that govern the magnitude of these costs. They too must be either calibrated or estimated. Generally, the models are estimated using historical data because it is not obvious what the appropriate values of many of the parameters are. Furthermore, estimation allows us to establish the uncertainty surrounding any particular parameter value. That, in turn, allows us to better understand the uncertainty inherent in the predictions of the model. Thus, all the mathematical relationships that govern the economic behavior of any DSGE model include parameters that require estimation.

Usually, the estimation is done using a methodology called Bayesian statistics, which allows the user to incorporate prior knowledge of the economy. For example, this information may come from microeconomic studies and thus may contain information that is not formally part of the model but is nonetheless useful for gauging the likely value of the model's parameters. For example, microeconomic evidence on how frequently firms adjust their prices is helpful information in estimating the price-setting parameters of the typical DSGE model.

Estimation also pays dividends. One outgrowth of statistical estimation is that it allows us to characterize the data uncertainty surrounding the parameter estimates. Are we fairly certain of a given parameter's value, or could that parameter take values that span a wide range? The estimation also allows us to capture the uncertainty surrounding the economic forecasts, as well as the uncertainty surrounding the results regarding the likely consequences of using an alternative monetary policy.

Using a number of different models allows economists and policymakers to ascertain the extent of model uncertainty, which involves the uncertainty that arises because all economic models are approximations of behavior, and no model accurately captures all facets of economic activity.

Further, using a number of different models allows economists and policymakers to ascertain the extent of model uncertainty, which involves the uncertainty that arises because all economic models are approximations of behavior, and no model accurately captures all facets of economic activity. Thus, different models analyzing the same question will come up with different implications, and as a result, there is uncertainty about those implications. Along with this type of uncertainty, there is uncertainty that characterizes each particular model because the parameters of each model are estimated and not known exactly. Economists are, in general, more uncertain about their models than they are about the parameters of any particular model, making the degree of model uncertainty an important property for policymakers to understand in using economic models for informing particular policy actions.

Therefore, it is useful to look at the implications of a number of models in order to compare the performance of different theories and evaluate which particular ways of thinking about the economy lead to a better understanding of actual behavior. Thus, examining model uncertainty is an important part of analyzing the output of DSGE exercises, since like all economic models, DSGE models are, to some extent, misspecified. Comparing the output of many DSGE models sheds light on the confidence we have in any particular implication of the models as a whole. Hence, looking at a number of different models helps policymakers assess the risk of any particular viewpoint based on a particular model. As indicated in the June 2011 minutes of the Federal Open Market Committee meeting, DSGE models are being studied by staff members at the Board of Governors and at the Federal Reserve Banks of Chicago, New York, and Philadelphia. If models that differ along various dimensions all point to the same conclusion, the policymaker can be more reassured about the outcome of a particular decision.

A MORE DETAILED DEPICTION OF A BASIC MODEL

The structure of a basic DSGE, namely, the model developed by staff members at the Federal Reserve Bank of Philadelphia, is displayed in the figure.[3] The model is nicknamed PRISM, which stands for Philadelphia Research Intertemporal Stochastic Model. As is true of much of the DSGE modeling framework, the foundations are based on New Keynesian economics, which explicitly models various forms of price and wage rigidity thought to be an integral part of a modern economy's structure. The firms in PRISM employ workers and rent capital in order to produce goods, and they do so in a manner that minimizes the cost of producing output. Production is also subject to productivity shocks. Firms also enjoy some monopoly or pricing power, and they set prices in order to maximize profits over time. The price of each good is adjusted at randomly selected intervals, with only a subset of firms adjusting their prices at any point in time.[4] Thus, the price level is sticky, which means that it does not adjust instantaneously to economic disturbances. The particular pricing behavior that maximizes economic profits over time is one in which firms reset their prices as a markup over a weighted average of current and future marginal costs. Price rigidities are an important feature of the model and are an important element in aligning the model with the data.

While the production function, which indicates the amount of output that can be produced by combining labor and capital, can be viewed as unaffected by changes in monetary policy — independent of the level of interest rates, the same amount of machines and workers produce the same amount of output — it is questionable whether the price-setting mechanism enjoys that property. For example, as inflation changes, we would expect the frequency with which prices are changed to vary as well, but this behavior is not part of the theoretical pricing mechanism in the model.

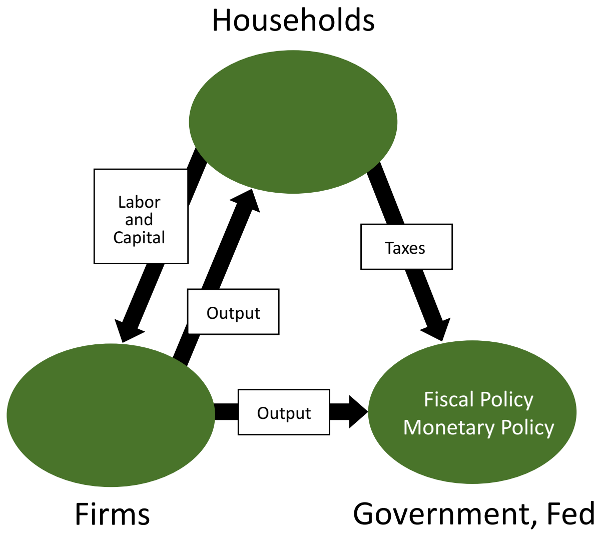
Along with a productivity shock, firms' decisions are influenced by shocks to the markup of price over marginal cost. We may think of this type of shock as a random variation in a firm's market power, perhaps influenced by the random inflow and outflow of the number of competing firms.

Households in the model own the firms and the capital stock. They choose how much to consume and invest as well as how much labor to supply. Importantly, the function that specifies how consumption is valued involves habit persistence, meaning that consumers value their current level of consumption relative to previous levels of consumption. This implies that consumers value a given level of consumption differently depending on whether that level was less than or greater than the amount of consumption they experienced in the past. If that level of consumption corresponds to a relatively high amount, then the consumer is happier than if it corresponds to a relatively low amount. This aspect of behavior turns out to be a relatively important ingredient for the model's ability to generate the type of economic persistence that is typically found in U.S. economic data.

Unlike the choice of consumption, which is fairly standard, the labor supply decision in PRISM is much different than is typically used in basic real business cycle models. These models view labor markets as purely competitive, but in PRISM and most DSGE models, households are viewed as being able to influence wages in much the same fashion that firms set

FIGURE

PRISM



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[3] The features described are fairly similar across first-generation DSGE models. Current model development has proceeded along a number of lines, of which the most important are the addition of more sophisticated financial markets and more detailed depictions of labor markets using search theory. In terms of models employed at various central banks, the model developed by the Federal Reserve Bank of New York and one of the models used by the European Central Bank include separate financial sectors.

[4] This framework is based on Calvo.

prices. They then supply all the labor demanded by firms at that wage. As is the case with prices, only a subset of wages is adjusted in any period, and the average wage is thus sticky.

The evolution of the capital stock is also determined by households' investment decisions, and the accumulation of capital is subject to adjustment costs such as those that accompany the installation of new equipment. These costs are also random and affect the efficiency of investment. The more costs associated with adjusting the capital stock, the less new capital is obtained from any particular level of investment. This shock can be given a financial interpretation (see the article by Alejandro Justiniano, Giorgio Primiceri, and Andrea Tambalotti). In particular, when the financial system is not operating efficiently, it is more difficult for firms to purchase investment goods, and the allocation of investment also becomes less efficient. The authors show that a shock to the efficiency with which firms transform investment into increases in the stock of capital is highly negatively correlated with the interest premiums charged to firms, and these premiums are related to financial constraints.

Another common random disturbance that influences households' decisions involves shocks to the rate of time preference. This shock affects the degree to which households are willing to sacrifice current consumption and thereby increase saving, which then allows the household to consume more in the future. As a result, shocks to the rate of time preference can be important in generating differential growth patterns in consumption and investment. Shocks to the value of leisure (which affect labor supply) are also featured in PRISM and most DSGE models. Shocks to leisure are intended to capture any imperfections in labor markets beyond those involving wage rigidity.[5]

As is true with most current DSGE models, PRISM contains a nonproductive government sector that consumes resources, but that is generally the extent to which fiscal policy is incorporated into the model. Monetary policy is modeled as a simple Taylor rule in which interest rates respond to inflation relative to target, an output gap, and the past setting of the interest rate. The output gap in PRISM is the difference between current output and the output that would occur in the absence of any economic disturbances. That is, it is the difference between current output and its trend. In this regard, we find differences across various DSGE models, with some going so far as to construct gaps based on statistical procedures similar to those employed in actual statistical measures of the gap.[6] The Taylor rule also specifies a gradual adjustment of policy to movements in inflation and the gap and is also subject to a random disturbance to monetary policy. In reality, the conduct of monetary policy is more nuanced than the behavior specified in the Taylor rule, with policymakers reacting to more than just output and inflation. The shock reflects these deviations of actual policy from the Taylor rule.

Model development is ongoing, and although many models, including those being studied by staff at various Reserve Banks and the Board, share most of the above features, they do differ along many dimensions. Thus, the field of DSGE modeling provides a rich set of models, which unsurprisingly often present different interpretations of economic events.

> As is true with most current DSGE models, PRISM contains a nonproductive government sector that consumes resources, but that is generally the extent to which fiscal policy is incorporated into the model.

USES OF THE MODELS IN MONETARY POLICY

Once a DSGE model is estimated, it can be used to provide economic forecasts and to identify the disturbances that are driving the forecast. All central banks find it important to forecast economic activity when arriving at a policy decision, and to that extent, these models provide another forecasting platform. Regarding the quality of the forecasts made with DSGE models, they are generally of similar quality to forecasts based on other types of forecasting methods or forecasts that are more judgmental in nature.[7] For example, a 2012 study by Marco Del Negro and Frank Schorfheide indicates that, at short horizons (one quarter), DSGE models do about as well as purely statistical procedures when forecasting output and inflation, but at horizons of one year, they do somewhat better. This is also the message of the study by Maik Wolters, who additionally shows that taking forecast averages across various DSGE models can improve their forecasting performance.

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[5] Although shocks to the wage markup are not present in PRISM, most DSGE models feature such shocks, which affect the costliness of labor.

[6] For a detailed discussion of various ways that output gaps are measured, see the *Business Review* article by Roc Armenter and the study by Michael Kiley. A particular DSGE model that calculates a statistically based output gap is the DSGE model being developed by staff at the Chicago Fed (see the article by Charles Evans and coauthors).

[7] However, forecasts that use various model restrictions in forming priors still generally outperform those from DSGE models (see the 2004 study by Del Negro and Schorfheide).

The models can also be used to benchmark policy, since one of their forecasts is for the behavior of interest rates. Also, standard error bands can be placed around the forecasted path of the interest rate, allowing policymakers to perceive the likelihood of a particular benchmark path. The Riksbank employs its DSGE model for this purpose.

A relative strength of the DSGE framework lies in its ability to identify shocks. For example, many DSGE models identify shocks associated with the impairment of financial markets as being primarily responsible for the most recent recession and the current slow recovery. Identifying the most important shocks in any given economic episode is particularly important for a monetary policymaker, since the optimal response to demand shocks is often much different than the optimal response to supply shocks. Thus, it is important to identify what types of economic disturbances are affecting the economy if a policy decision is to be a fully informed one.

DSGE models are also used to explore the effects of alternative policies. Because all the sectors of the model are formally linked together, along with the assumption that the estimated parameters are invariant to changes in policy, we can carry out policy exercises that are easily interpreted.[8] For example, we can analyze the effects of policies following alternative interest rate paths, paths that differ from the model's forecasted path. Further, we can ask what the models predict if a disturbance was somewhat larger than estimated or if it were to turn out to be more long-lived than usual. Doing so lets policymakers gauge risks associated with particular economic events.

SOME WEAKNESSES OF THE MODELS

My overview would be incomplete if I did not point out some of the inherent weaknesses of the current generation of DSGE models. Perhaps the most important is model misspecification. Currently, many of the restrictions imposed by the various DSGE models are at odds with the data. For example, the models specify that, in the long run, variables such as consumption, output, investment, and wages all grow at the same rate, which is somewhat at odds with the data. One outgrowth of this type of misspecification is that many of the economic disturbances in the model must be very persistent in order to align the model with the data. Incorrect estimation of the disturbances can affect the implications for how the economy would react to a change in monetary policy. In a 2009 paper, Del Negro and Schorfheide show that if the estimated DSGE model attributes too much persistence to productivity shocks, it implies that controlling inflation would involve a monetary policy that responds overly aggressively to departures of inflation from target. That would not be the case if the productivity disturbance was less persistent. Thus, when policymakers are deciding the best way to respond to departures of inflation from target, model misspecification can lead to an incorrectly designed policy.

A relative strength of the DSGE framework lies in its ability to identify shocks.

Also, because none of the models are literally true, they do not present a totally accurate depiction of the economy. However, looking at the output of various models can help to clarify the extent of that misspecification.

Of greater significance is the fact that some of the behavioral relationships in the models are not really invariant to monetary policy. As mentioned, the price-setting mechanism precludes changes in price-setting behavior at different inflation rates. Thus, policies that affect the behavior of inflation are likely to affect the actual economy in ways that the model cannot capture. Thus, the implications drawn from the model may not be entirely accurate. This problem is less severe if the variation in inflation associated with an alternative policy is not very large, but the model's prediction will be less reliable if the variation in inflation is significant. Thus, when analyzing alternative policies, policymakers should have more confidence in the model's prediction when the alternative is closer to actual policy.

Furthermore, issues concerning the identification of various parameters sometimes arise. By that I mean an occurrence when the data are not particularly informative about the value of a parameter. In that case, the estimated value of the parameter will reflect only the modeler's prior belief about the parameter no matter what that prior belief happened to be. Hence, very little is actually known about the parameter. In cases like this, we need to be particularly careful when assessing predictions of the model, especially if the parameter in question has an important effect on those predictions.

Finally, the models often lack important sectors, such as a sophisticated financial sector, and, as mentioned, the modeling of fiscal policy is quite simplistic. These problems are not methodological, but they indicate that there is room for continuing evolution in this field of research.

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[8] Formally, this means that the models are, in principle, not subject to Lucas's famous critique regarding the inappropriateness of using relationships that are not based on a theoretical structural model to analyze policy changes.

SUMMARY

This article has outlined the basic structure of a new class of models, DSGE models, which are currently being used to aid monetary policymakers in many countries. They have proven useful in forecasting, in identifying key elements that are affecting the economy, and for conducting counterfactual experiments that can help policymakers understand both the likely outcomes and the uncertainty surrounding the outcomes of various policy experiments. Thus, these models are an important element of a policymaker's toolkit. They provide a coherent and internally consistent way of viewing the economy.

The article has also pointed out some of the problems that currently exist within this class of models. It is important to understand that these problems are not methodological, but rather they reflect the current state of the models. Development is ongoing, and many of the problems are currently being addressed in the next generation of models.

Given the relative strengths and weaknesses of current DSGE models, they should be used in conjunction with other forecasting methodologies and other models in combination with other information and expertise that policymakers bring to the table. Indeed, that is the way they are actually being used by central banks around the world.[9]

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[9] For an excellent and detailed discussion of how DSGE models are used in the context of monetary policy at the Sveriges Riksbank, see the speech by Irma Rosenberg.

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The Diverse Impacts of the Great Recession*

BY MAKOTO NAKAJIMA

The Great Recession had a large negative impact on the U.S. economy. Asset prices, most notably stock and house prices, declined substantially, resulting in a loss in wealth for many American households. In this article, Makoto Nakajima documents how diverse households were affected in a variety of dimensions during the Great Recession, in particular between 2007 and 2009, using newly available data from the 2007-2009 Survey of Consumer Finances. He discusses why it is important to look at the data on households, rather than focusing on the aggregate data, and he reviews some recent studies that look at the recession's diverse effects on different types of households.

The Great Recession, which began in December 2007, had a large negative impact on the U.S. economy.[1] According to a recent study by Emmanuel Saez, average family income (excluding capital gains) dropped by 17 percent between 2007 and 2009. Average income recovered slightly in 2011, but it was still 16 percent lower than income in 2007. A significant part of the decline in income was caused by a rise in the unemployment rate. Figure 1 shows how the unemployment rate and average income changed during the Great Recession. The unemployment rate surged, from 4.7 percent in the fall of 2007 to 10 percent at its peak in October 2009.

Asset prices, most notably stock and house prices, declined substantially during the Great Recession. This decline in asset prices caused a loss in wealth for many American households. As for stock prices, Figure 2 shows that the S&P 500 dropped from 1,496 in the last quarter of 2007 to 808 in the first quarter of 2009, before recovering to around 1,400. The figure also shows how house prices declined. The average house price in 20 major metropolitan areas dropped by 34 percent from its peak in 2006 and has remained low since then.[2]

In this article, I will document how diverse households were affected in a variety of dimensions during the Great Recession, in particular between 2007 and 2009, using newly available data from the 2007-2009 Survey of Consumer Finances (SCF). The SCF provides detailed information on the finances of U.S. households, and the special panel data allow us to compare the same respondents between 2007 and 2009. While we might also like to compare the fate of households over the boom period before the Great Recession, the panel data from the SCF

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[1] In this article, I do not explain why stock prices and house prices dropped significantly during the Great Recession. Some economists, including Andy Glover, Jonathan Heathcote, Dirk Krueger, and Jose-Victor Rios-Rull, argue that shocks to economic productivity or demand spilled over to the stock and housing markets. Nobuhiro Kiyotaki, Alexander Michaelides, and Kalin Nikolov analyze how such shocks to the economy become amplified and have a large impact on asset prices. Other hypotheses exist. For example, Roger Farmer argues that changes in the beliefs of the market caused the decline in housing and stock markets, which spilled over to the rest of the economy. Ulf von Lilienfeld-Toal and Dilip Mookherjee argue that the consumer bankruptcy law reform in 2005 triggered the decline in house prices.

[2] The Case-Shiller Composite-20 index is used. The Case-Shiller national house price index fell similarly.

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

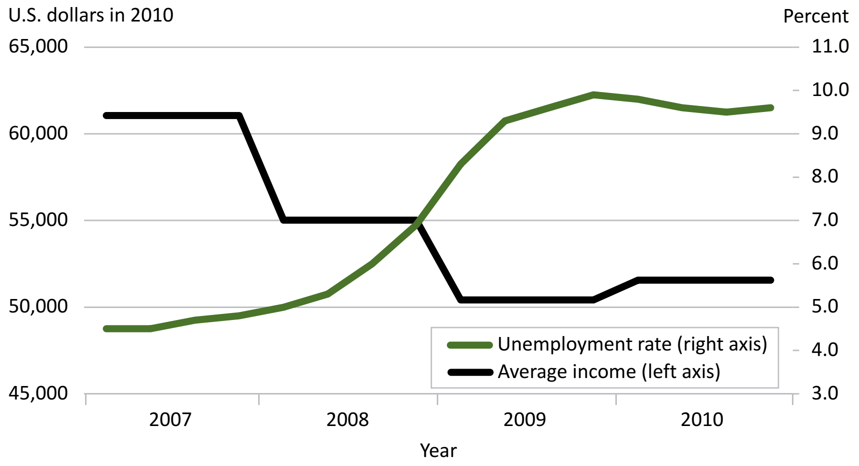
are not available before 2007.[3]

Why is it important to look at data on households instead of focusing on the aggregate data? Although the fall in average family income and the decline in asset prices were large, behind the headline numbers, the effects of the Great Recession varied greatly across households. One reason is that different households suffered different degrees of income loss. Moreover, different households were affected differently by the decline in asset prices because households differed in the amount and composition of wealth when the Great Recession started. For example, a household in Las Vegas (where the house price index has declined by 62 percent since 2006) that owned a house and invested most of its assets in stocks suffered a larger loss in wealth than another household that was renting in Dallas (where the house price index declined by 6 percent) and kept most of its assets in bank accounts. Differences in income and wealth at the time of the Great Recession are also tied, in part, to households having different earnings histories as well as different choices for saving and investment.

In response to the severe recession, economists have been trying to better understand the recession's diverse effects on different types of households, and I will review some recent studies. It is easy to understand that households that suffered a larger loss of income or portfolio values suffered greatly from the recession. However, Wenli Li and Rui Yao argue that when house prices decline, younger renters benefit because they could buy houses at cheaper prices. On the other hand, older homeowners, who tend to be sellers of houses, suffer from a decline in house prices. As Glover and coauthors note, such an effect was stronger during the Great Recession because the prices of houses and financial assets fell significantly. They investigate how the welfare of different types of households has been affected differently by the Great Recession. On the other hand, Sewon Hur argues that

FIGURE 1

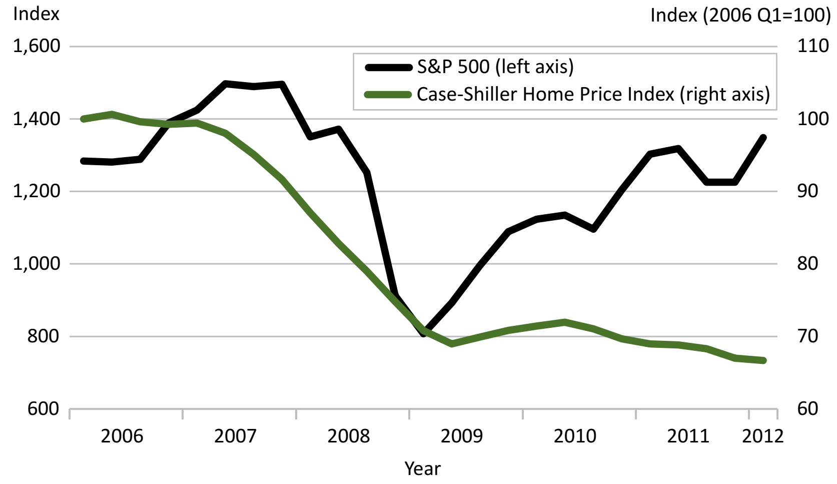
Average Income and Unemployment Rate



Source: Saez (2012) and Bureau of Labor Statistics

FIGURE 2

Stock Market and House Price Indexes



Source: Standard & Poor's

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[3] The regular Survey of Consumer Finances (SCF) has been conducted every three years starting in 1983 to provide detailed information on the finances of U.S. families. Data from the SCF are widely used in economic analyses. In the most recent survey, about 6,500 families were interviewed. Usually, the regular SCF does not follow the same households across different surveys. However, families who participated in the 2007 survey were reinterviewed in 2009 in order to capture how those households had been financially affected by the Great Recession. The paper by Jesse Bricker, Brian Bucks, Arthur Kennickell, Traci Mach, and Kevin Moore summarizes the results of the 2007-2009 SCF.

young households might not be able to seize the opportunity to buy housing and other assets at depressed prices because young households typically do not have a lot of savings with which to buy assets, and it is difficult to borrow, especially during recessions.

LIFE CYCLE AND WEALTH BEFORE THE GREAT RECESSION

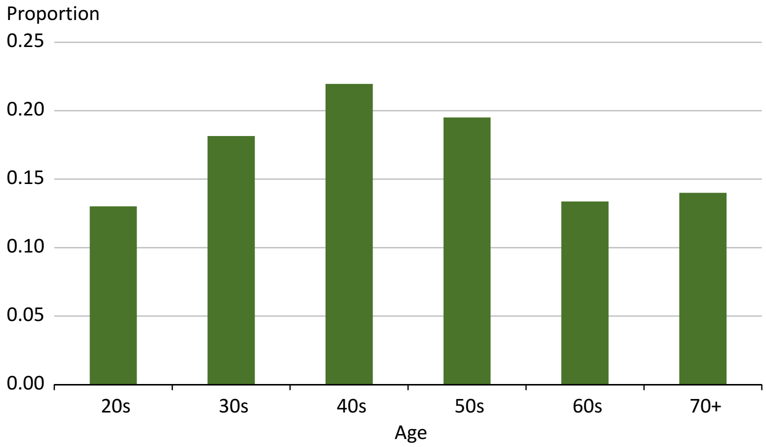
Before looking into how different households have been affected by the Great Recession, let's look at how households differed on the eve of the Great Recession. As you can see in Figure 3, there were more households whose heads were in their 40s and 50s in 2007 than in other age groups.

Net wealth (which is the sum of all assets, including the value of houses, net of the sum of all debts) differs over one's life cycle. It is relatively low for young households but keeps increasing during the working life of households, up to around age 65, and declines after retirement. We can see such a pattern in Figure 4. Why does the life cycle profile look like this? Franco Modigliani and Richard Brumberg provide a simple theory of the life cycle of a household.[4] Young households, whose income is limited, spend most of their income for consumption expenditures, leaving little savings to accumulate wealth. However, as households age and their income increases, they start saving to prepare for retirement. Figure 4 shows that both wealth and income go up for households between their 20s and 50s. Saving for retirement is desirable because after retirement, income is typically lower than it is during middle age, when income is typically the highest over the life cycle. Households do not want to have less money to spend after retirement. After retirement, households use their savings to supplement their (lower) income, gradually reducing savings.

The composition of wealth also shows a distinctive pattern over the life cycle. Let's start with housing. Figure 5 shows the proportion of households in each age group with a positive amount of housing assets, stocks, and businesses. The homeownership rate was 71 percent in 2007 overall, but it was only 28 percent for households in their 20s.[5] The homeownership rate increases to

FIGURE 3

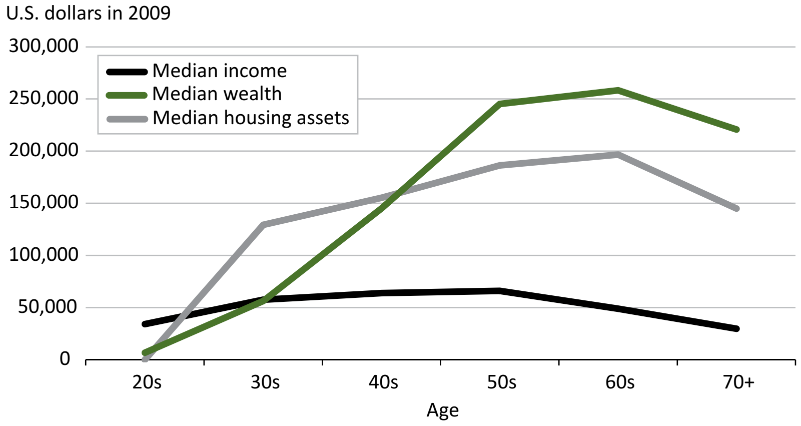
Proportion of Households in Different Age Groups in 2007



Source: Survey of Consumer Finances, 2007-09

FIGURE 4

Income, Housing, and Total Wealth of Households in 2007



Source: Survey of Consumer Finances, 2007-09

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[4] Satyajit Chatterjee's *Business Review* article provides a more detailed explanation of the theory.

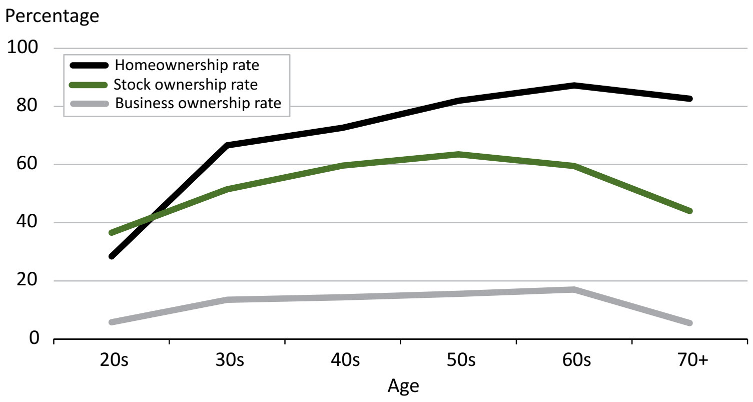
67 percent for households in their 30s and reaches 87 percent for those in their 60s, before shifting down to 83 percent for those above 70. We can see the hump-shaped pattern in Figure 5. The proportion of wealth invested in housing assets (shown in Figure 6) is also hump shaped, but the peak comes much earlier than it does for wealth or the homeownership rate. Figure 6 shows the portfolio allocation grouped by different types of assets of households with median wealth.[6] All values of assets and debt are normalized by the wealth holdings of the median households. For example, the value of housing assets for median households in their 20s is 1.63, which implies that the value of housing assets of the median households is 163 percent of the value of the wealth of these households. Debts are shown in negative value. "Safe assets" include all assets except housing, stocks, and businesses, e.g., checking and saving accounts, U.S. Treasury bills, and saving bonds. Therefore, for each age group, the sum across all assets and debts is one. In other words, if the bar in Figure 6 is stretched long, it means the groups of households are taking a leveraged position, by borrowing and using the extra money to have more assets.

What can we see in Figure 6? First, the proportion of wealth invested in housing increases between the 20s and the 30s and declines after that. Second, households in their 20s and 30s borrow significant amounts compared with their wealth holdings. In other words, these young households are highly leveraged.

Let's go back to the comparison between Figure 5 and Figure 6. The homeownership rate picks up between the 20s and the 30s because, by then, more households have accumulated enough wealth to make a down payment. When these households purchase their first house, many of them have to invest most of their wealth in home equity in the form of a down payment. That's why the proportion

FIGURE 5

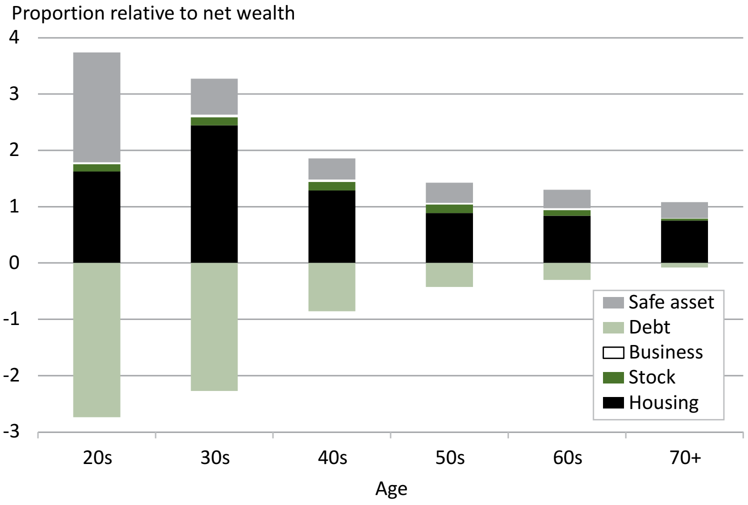
Percentage of Households with Homes, Stocks, and Businesses



Source: Survey of Consumer Finances, 2007-09

FIGURE 6

Portfolio Allocation by Median Households (relative to total value of wealth)



Source: Survey of Consumer Finances, 2007-09

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[5] The homeownership rate remained stable at around 64 percent between 1965 and 1995, before rising to around 70 percent. However, the hump-shaped pattern described in the article remained stable. Matthew Chambers, Carlos Garriga, and Don E. Schlagenhauf investigate reasons behind the increase.

[6] Instead of looking at the single household with median wealth, I take the average of households in the middle quintile (between 40 and 60 percent when ranked by wealth holdings). By doing this, I can avoid the situation that the results are affected by the behavior of one household. See the next footnote as well.

of wealth invested in housing peaks for households in their 30s. However, after households buy their first house, they repay the mortgage and start accumulating financial assets, which decreases housing assets as a proportion of household wealth. As we can see in Figure 6, for median households in their 20s to 40s, the average value of housing assets is higher than the value of their net wealth. As households continue to accumulate wealth for retirement, the proportion of the value of housing assets included in households' wealth keeps shrinking. In other words, households keep deleveraging.

The proportion of households with a positive amount of stocks (including directly held stocks as well as those held indirectly through mutual funds, retirement funds, etc.) is also hump shaped, as in Figure 5. The proportion is 37 percent for households in their 20s, peaks at 64 percent for households in their 50s, and then goes down to 44 percent for households in their 70s. Why is it hump shaped? Annette Vissing-Jorgensen argues that many households do not hold stocks because of the costs of participating in the stock market. Since younger households tend to have lower wealth, they tend to stay away from the stock market because the cost of participation is too high for the small gain that households expect from investing in the stock market. Young households also want to use their money to own housing rather than to invest in stocks. On the other hand, older households withdraw from the stock market to reduce their exposure to risky assets. In terms of the proportion of wealth invested in stocks, the size is relatively small, as seen in Figure 6. Average households invest relatively small proportions of their wealth in stocks. For example, the proportion is about 15 percent for median households in their 30s to 50s and 10 percent among households in their 60s.

The proportion of households that have an equity interest in a privately held business also exhibits a hump shape, as shown in Figure 5. Among households in their 20s, only 6 percent have business equity, while the proportion is highest among households in their 60s, at 17 percent. The proportion is 5 percent for households age 70 and above. I will come back to the wealth allocated to businesses in the next section, since investment in business is closely related to large wealth holdings. Figure 6 shows that the proportion of wealth invested in businesses by median households is less than 5 percent for all age groups.

RICH AND POOR ON THE EVE OF THE GREAT RECESSION

There are large differences across households if we look at them in different quintiles of wealth distribution.[7] As shown in Figure 7, the amount of assets held by households in different quintiles of the wealth distribution differed significantly in 2007. The median wealth holding of the wealthiest 20 percent was $972,000, while the least wealthy 20 percent of households held almost zero wealth. The median wealth among the wealthiest 1 percent was almost $13 million.[8]

Figures 7 and 8 show that there is a substantial difference in stock holdings across households with different amounts of wealth. Among the wealthiest 20 percent, 90 percent hold stocks. On the other hand, among the households in the bottom 20 percent in terms of wealth in 2007, only 17 percent own stocks. Richer households tend to invest more in stocks as well. The median value of stocks held by the wealthiest 20 percent of households is $183,000, while the median stock value is zero among the bottom 20 percent and the median stock value of the middle quintile of wealth distribution is about $1,000.

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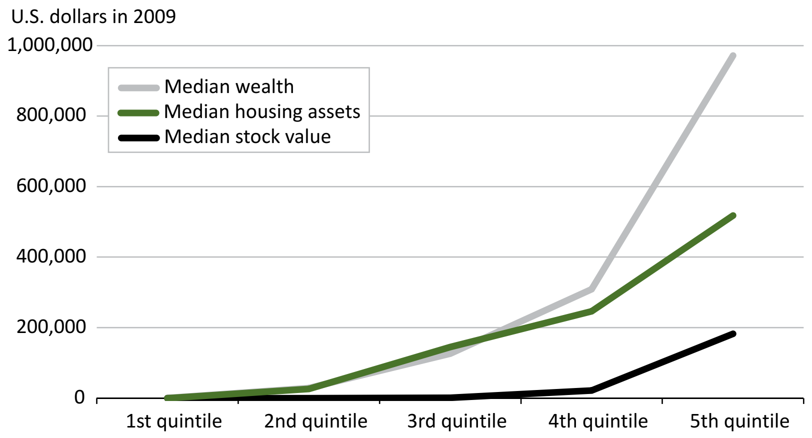
[7] A quintile is one-fifth of all households. The first quintile represents the bottom 20 percent of households when households are sorted by the amount of wealth holdings. In other words, the first quintile includes households with the least amount of wealth, and the fifth quintile includes the top 20 percent of the wealthiest households.

[8] It was about $11 million in 2004, according to the SCF.

FIGURE 7

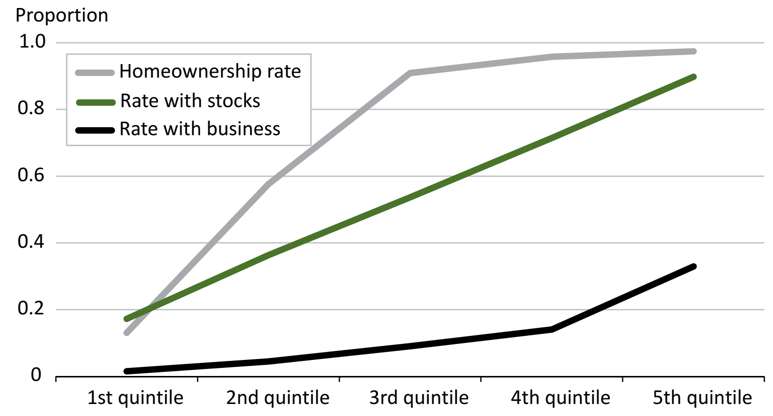
Asset Holdings for Different Wealth Quintiles



Source: Survey of Consumer Finances, 2007-09

FIGURE 8

Proportion of Households with Home, Stocks, and Businesses in Different Wealth Quintiles



Source: Survey of Consumer Finances, 2007-09

The homeownership rate is also higher for wealthier households (Figure 8). Among the top 20 percent in wealth holdings, 97 percent are homeowners. On the other hand, the homeownership rate was 13 percent for the bottom 20 percent of the wealth distribution in 2007. Naturally, the median value of housing assets is higher for wealthier households (Figure 7). It is $518,000 for the wealthiest 20 percent, while it is zero for the bottom 20 percent. However, the proportion of wealth invested in housing is decreasing as a share of household wealth among homeowners, precisely because households with lower wealth have to spend more of their wealth on a house in order to buy one. For example, among households in the middle quintile, the value of housing relative to wealth is 115 percent. On the other hand, the ratio is only 53 percent among the top 20 percent of the wealth distribution.

The proportion of households that own businesses increases significantly with the level of wealth (Figure 8). In other words, wealthier households are more likely to be entrepreneurs. For example, 33 percent of the wealthiest 20 percent of households own interests in business, while the ratio is less than 2 percent among the least wealthy 20 percent. The ratio is even higher for the wealthiest 1 percent: 74 percent of these households invest in businesses. The proportion of wealth invested in businesses also increases significantly with the level of wealth (Figure 7).

WHAT SHOULD WE EXPECT?

From the way assets are distributed, one can guess how changes in asset prices affect different households differently. When house prices drop, middle-aged and older households, especially wealthy ones, suffer more because they are more likely to own a house. In terms of the *absolute* level, the negative effect on wealth is larger for older and wealthier households, which tend to own larger houses. However, in *relative* terms, younger homeowners, who tend to invest a larger proportion of their wealth in housing, suffer the most in terms of the damage relative to their wealth. Remember Figure 6, which shows that younger households tend to be highly leveraged. As for other assets such as stocks, again, middle-aged and older households, especially the wealthy ones who invest more in the stock market, suffer from a decline in stock prices. The unfavorable business environment during recessions damages the wealthiest households, which are more likely to own businesses, the most.

THE GREAT RECESSION'S DIVERSE EFFECTS ON INCOME

Before looking at wealth, let's start with income. The Great Recession had a large effect on income. According to a recent study by Saez that uses data on individual tax returns, average income per family in the U.S. declined by 11 percent between 2007 and 2009 if income from capital gains is excluded. If capital gains are included, average income dropped by 17 percent.[9] Andy Glover and coauthors computed that overall average earnings declined by 8.3 percent, according to the Current Population Survey (CPS). Moreover, Glover and coauthors computed that earnings of households in their 20s declined by 11 percent, while earnings of households in their 60s dropped by only 6 percent. These facts are consistent with the ones presented by Michael Elsby, Bart Hobijn, and Ayşegül Şahin, who report that, in recessions, the unemployment rate rises more for younger workers.

Elsby and coauthors also report that the unemployment rate of workers with less education tends to rise more during recessions, including the Great Recession. This fact implies that workers with relatively lower levels of education (and lower income) suffered a larger percentage drop in income during the Great Recession.

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[9] The drop was larger if capital gains are included because capital gains tend to react strongly to economic booms and recessions.

In contrast, Saez reports that, in general, top income earners experience a larger percentage decline in income from recessions. The explanation is that the source of a large part of income for top income earners is capital gains. Saez computed that the top 1 percent of the income distribution suffered an income loss as large as 36 percent between 2007 and 2009, while the income loss was lower in proportion for the rest, at 12 percent.

In sum, between 2007 and 2009, U.S. households suffered a large drop in income. The groups of households that suffered a larger loss than average were younger households, lower-income households in each age group, and extremely wealthy households. Retired households, many of whom no longer rely on labor income, suffered the least in terms of a percentage decline in income.

HOUSEHOLDS' WEALTH IN THE GREAT RECESSION

In this section, I document how wealth and its components changed between 2007 and 2009, using the SCF. According to the SCF, the average net wealth of all households decreased from $595,000 in 2007 to $481,000 in 2009, a 19 percent ($114,000) decline. Median wealth declined even more, from $126,000 in 2007 to $97,000, a 23 percent decline ($29,000). For comparison, according to the 2004 SCF, median household wealth was $107,000. Simply put, between 2007 and 2009, more than the gains in wealth between 2004 and 2007 and about one-fifth of the wealth held by households in 2007 disappeared. For comparison, average household earnings (wage income) declined by 3 percent, from $56,000 to $54,000, and average household total income dropped by 9 percent, from $89,000 to $81,000.

Although I compare the data from 2007 and 2009 because the SCF kept track of the same households only in these two years, housing prices continued to stagnate even after 2009. In *How About 2010?*, I compare households' income and wealth in 2009 and 2010, using the newly available data from the SCF, although a direct comparison is difficult because the 2010 SCF does not keep track of the same households as in 2007 and 2009.

Housing. Let's look at important components of wealth individually. The average value of housing assets dropped by 13 percent, from $262,000 to $228,000. The size of the drop is smaller than the size of the drop in the national house price index during the interval between the two surveys (19 percent). There are two reasons for this. First, the value of housing assets is self-reported in the SCF, so there is possibly an upward bias, especially in a

How About 2010?

The table compares the data on income and wealth across the 2007, 2009, and 2010 Survey of Consumer Finances (SCF) provided by the Federal Reserve Board. Note that the households included in computing the statistics are different across the 2007-2009 SCF and the 2010 SCF. The 2007-2009 SCF includes households that were age 20-99 in 2007 and surveyed in both 2007 and 2009. On the other hand, households between ages 20 and 99 in 2010 are included in the 2010 SCF. Although housing prices and stock prices recovered somewhat between 2009 and 2010, median total net wealth dropped from $97,000 to $76,000. Median housing assets declined slightly, from $180,000 in 2009 to $176,000 in 2010. Median income declined as well, from $50,000 in 2009 to $45,000 in 2010. The proportion of households that own housing and that own stocks also declined. However, a large part of these changes appears to be generated by differences in the households included in the SCFs. In particular, statistics in 2009 tend to be higher because 2009 data do not include households that were younger than 20 in 2007 or moved residence between 2007 and 2009 and thus were not followed in 2009. These households tend to be younger and thus earn less and hold less wealth. As evidence, the Census Bureau reports that the homeownership rates in 2009 and 2010 were 67.4 percent and 66.9 percent, respectively. This homeownership rate is substantially lower than the homeownership rate in the SCF in 2009 (71.8 percent) but is closer to the homeownership rate in the 2010 SCF (68.9 percent).

Comparison Between 2007, 2009, and 2010

	2007	2009	2010
Median income (dollars)	50,000	50,000	45,000
Median total wealth (dollars)	126,000	97,000	76,000
Median house value (dollars)	207,000	180,000	176,000
Homeownership rate (%)	71.0	71.8	68.9
Proportion of stockholders (%)	53.7	55.6	50

Note: Income and wealth are in 2009 dollars. For 2007 and 2009 data, households of age 20-99 in 2007 and surveyed in both 2007 and 2009 are included, while all households of age 20-99 in 2010 are included in 2010 data.

Source: Survey of Consumer Finances, 2007-2009 and 2010 down market. Households interviewed for the survey might tend to think (or believe) that the value of their house is higher than it actually is. Second, the majority of households are at a stage in life during which they are increasing their holdings of housing assets. Note that we are talking about the value of the houses that households own. If households buy a house for the first time or move up to a larger house, the value of the house owned by the household probably increased, even if the same house was cheaper in 2009 compared with 2007. The median value of housing assets declined less, from $135,000 in 2007 to $125,000 in 2009, a 7 percent decline.

Stocks. Between 2007 and 2009, the total value of stocks held directly or indirectly per household dropped by 29 percent, from $125,000 to $88,000. The total value of directly held stocks (which do not include those held by pension funds or mutual funds) per household dropped even more, by 37 percent, from $45,000 to $28,000. The drop in the average value of stocks is consistent with the size of the drop in the stock market index. Although these numbers are large, the long-run effects of this drop are probably limited, because, as seen in Figure 2, the stock market rebounded strongly after 2009. As long as households were able to wait until the stock market recovered, they were able to minimize the damage caused by the temporary slump in the stock market. The average value of businesses owned also dropped sharply, by 23 percent, from $135,000 to $104,000.

Financial Assets and Debt. The total value of nonhousing assets per household, which includes stocks, business interests, and other financial assets, declined by 18 percent, from $435,000 to $357,000. On the other hand, the average size of debt was stable: $103,000 in 2007 and $104,000 in 2009. The average total value of safe assets, which are defined as total assets minus the value of housing assets, stocks, and businesses, was also relatively stable, at $175,000 in 2007 and $165,000 in 2009 (a 6 percent decline). This is not surprising, since the prices of safe assets such as bank accounts and Treasury bills remained relatively stable during the Great Recession.[10]

Life Cycle. Figures 9 to 12 exhibit how households in different age groups were affected during the Great Recession. For example, in Figure 9, each grey line represents how the median wealth of one age group changed between 2007 and 2009; the points on the left and right side of each line represent the median wealth in 2007 and 2009, respectively. Figure 9 also shows how the median value of housing assets and stocks changed between 2007 and 2009. Figure 10 exhibits the changes in mean value of wealth, housing, and stocks.

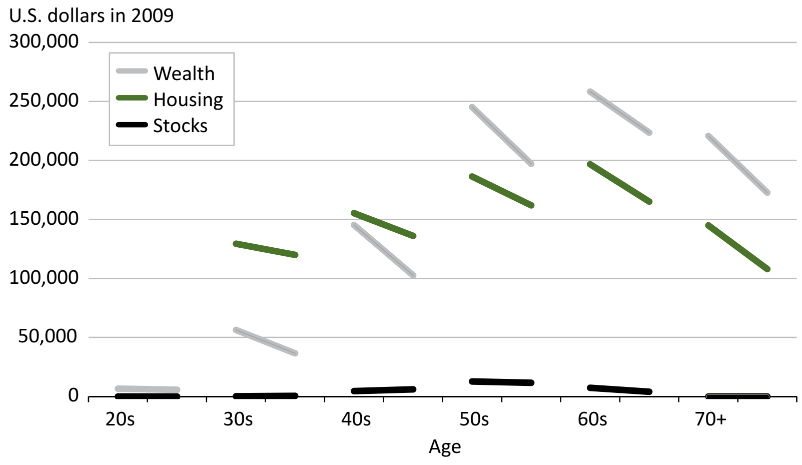
Households in their 30s and 40s suffered a large loss in terms of median wealth between 2007 and 2009.

Looking at different households separately in Figures 9 and 10, we see that average wealth declined for all age groups between 2007 and 2009. However, there are interesting differences across different age groups.

First, the loss of wealth suffered by households headed by those in their 20s was limited in terms of the absolute level. The loss, however, was large relative to the wealth they had in 2007. The mean value of wealth for households in their 20s dropped by 23 percent between 2007 and 2009. The median wealth held by households in their 20s declined by 14 percent, which

FIGURE 9

Changes in Median Value of Wealth, Housing, and Stocks, 2007-09



Source: Survey of Consumer Finances, 2007-09

was smaller than the size of the decline in the median wealth of all households (23 percent). This is mainly due to the characteristics of the median household among those in their 20s. In particular, since less than half of households in their 20s own a home, the household with median wealth was a renter and did not suffer from a decline in house prices, while homeowners suffered a large loss in wealth relative to their wealth holdings, because they were highly leveraged (taking out a mortgage that is large relative to their wealth holdings to buy a house). The mean value of housing assets increased slightly for this age group, but that is because they were at the stage in life during which they were buying houses. Figure 11 shows that homeownership for households in their 20s increased even during the Great Recession and that more and more of them started participating in the stock market. For households ages 20 to 29, the life-cycle effect strongly influences the changes in the data.

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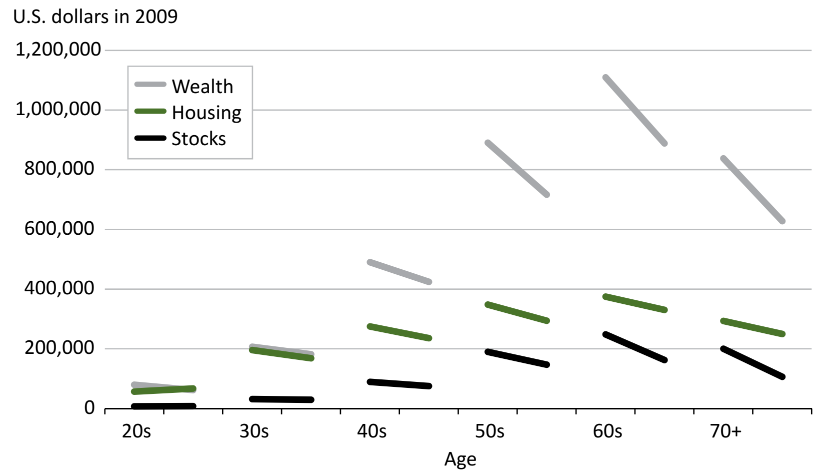
[10] In 2004, the total value of nonhousing assets per household was $368,000 (in 2009 U.S. dollars). The per-household debt was $90,000. The value of safe assets per household was $159,000. Roughly speaking, the values in 2004 are not far from those in 2009.

FIGURE 10

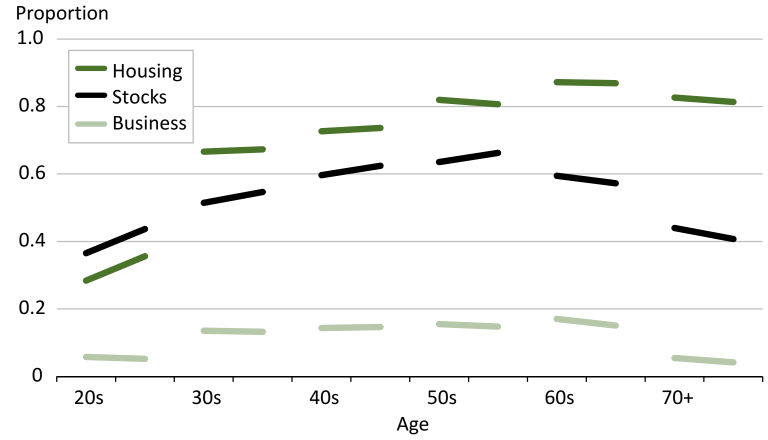
Changes in Mean Value of Wealth, Housing, and Stocks, 2007-09



Source: Survey of Consumer Finances, 2007-09

FIGURE 11

Changes in Ratio of Households with Housing, Stocks, and Businesses, 2007-09



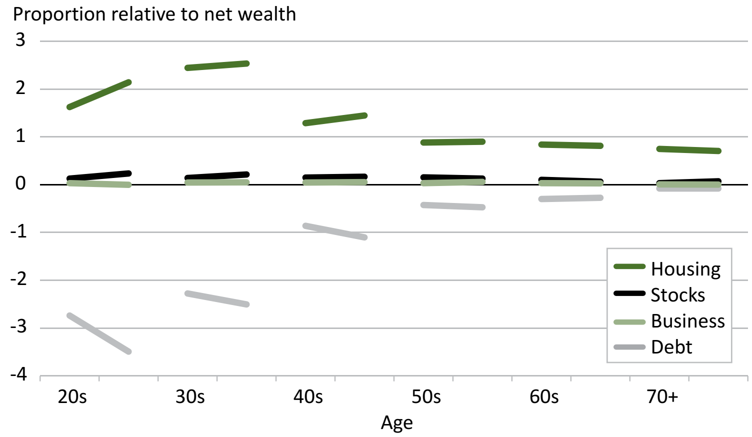
Source: Survey of Consumer Finances, 2007-09

Figure 12 is the counterpart to Figure 6. Figure 12, which shows how the proportion of the value of housing assets relative to net wealth for median households changed between 2007 and 2009, is consistent with the fact that younger households were buying houses even during the Great Recession. We can see that the proportion of wealth invested in housing increased between 2007 and 2009 for households in their 20s. The value of debt relative to wealth also increased. Although we often hear that American households have been deleveraging (reducing debt) since the onset of the Great Recession, young households were still leveraging, implying that, for these households, the life-cycle effect (borrowing and buying houses when they are young) has dominated the deleveraging in which older households were engaged. Figure 12 also shows that the proportion of wealth invested in stocks or businesses by households with median wealth remained low during 2007-2009.

Households in their 30s and 40s suffered a large loss in terms of median wealth between 2007 and 2009 (Figure 9). Median wealth declined by 35 percent and 29 percent for households in their 30s and 40s, respectively. Their wealth declined even though stock

FIGURE 12

Changes in Portfolio Allocation by Households with Median Wealth



Survey of Consumer Finances, 2007-09

holdings are limited, especially for households in their 30s. Their wealth declined significantly mainly because the median household is a homeowner with a highly leveraged portfolio and thus exposed to a higher risk of declining housing and stock prices. On the other hand, mean wealth declined less because changes in wealth holdings of renters, who were not affected by declining housing prices, affect the mean more than the median. Figure 12 shows that the proportion of wealth invested in housing by households with median wealth continued to increase because of the life-cycle effect. The size of debt relative to wealth also increased between 2007 and 2009 for middle-aged households.

For households in their 50s and 60s, wealth declined between 2007 and 2009, as seen in Figures 9 and 10, but the loss was relatively small, because these households had already accumulated wealth and invested a larger part of their wealth in safer assets (see also Figure 6). Therefore, their exposure to risky assets such as housing and stocks was lower. The median wealth of households in their 50s and 60s declined by 20 percent and 13 percent, respectively. On the other hand, their mean wealth declined more than their median wealth, but this was due to a large decline in the value of businesses, which was concentrated among a small number of households in their 50s and 60s. Figure 11 shows that the proportion of households with business interests was highest within these age groups. Since the homeownership rate stabilized at ages 50s to 60s, the proportion of wealth allocated to housing assets remained relatively stable between 2007 and 2009 (Figure 12).

The median wealth of households aged 70 and above declined by 22 percent, which was larger than the decline for households in their 50s and 60s. Mean wealth declined by 25 percent. An important part of this large decline was due to life-cycle patterns; households age 70 and above were spending down their accumulated wealth to support consumption expenditures in retirement. In other words, the size of the decline for households in retirement looks larger because the value of their assets fell, and they were actively reducing wealth. Figure 12 is consistent with such an interpretation; the proportion of wealth allocated to housing by older households with median wealth declined between 2007 and 2009, albeit slightly.

Turning to stock holdings, Figure 10 shows that the proportion of households older than 70 with stocks declined between 2007 and 2009. In other words, households age 70 and above were selling stocks. Therefore, the declining value of stocks among older households exaggerates the loss suffered by these households because they were actively selling stocks. However, as shown in Figure 12, households with median wealth do not invest much in stocks. On the other hand, the homeownership rate did not drop during 2007-2009, implying that homeowners age 70 and above suffered a loss in the value of their housing.[11]

Wealth Distribution. There is also a large diversity in how different households in different parts of the wealth distribution were affected by the Great Recession. Figure 13 shows the percentage changes in the mean value of wealth, housing, and stocks for groups of households in different parts of the wealth distribution. We can see clearly that changes in wealth were significantly different for households with different levels of wealth. In particular, households with the lowest amount of wealth increased their wealth holdings between 2007 and 2009, mainly because of life-cycle effects. These households were in the life-cycle stage during which they accumulate wealth. Between 2007 and 2009, the average wealth held by the bottom 40 percent of the wealth distribution increased by 54 percent, from $13,000 to $20,000.

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[11] In an earlier *Business Review* article, I documented how retirees decumulate wealth, with a focus on the distinction between housing and financial assets.

This is due in large part to an increase in average holdings of housing assets, which increased from $39,000 to $44,000. The homeownership rate among these households also increased, from 35 percent to 40 percent. They increased their stock holdings, but stocks' contribution to the increase in wealth is limited because these households invested little in the stock market from the beginning. On the other hand, the average wealth among the top 20 percent in the wealth distribution declined by 21 percent, from $2.5 million to $2.0 million. They experienced a loss in holdings of housing assets, stocks, and businesses. The loss was even more pronounced for the wealthiest 1 percent; their wealth dropped by 29 percent during 2007-2009, although about two-thirds of them remained among the wealthiest 1 percent even after the loss.

WHO GAINED AND WHO LOST IN THE GREAT RECESSION

Who benefited and who suffered from the Great Recession? Before going into details, let me emphasize that the choice of the timing of the comparison matters significantly. Even if a household lost during the Great Recession, because the value of the assets that the household owns declined between 2007 and 2009, the household might have gained if the value of the assets in 2009 is compared with the value in, say, 2002. On the other hand, households that purchased their house at the peak of house prices (around 2006-2007) lost value in their house without benefitting from the boom that preceded the decline.[12] The analysis here is limited in the sense that it cannot account for changes that happened before the Great Recession.

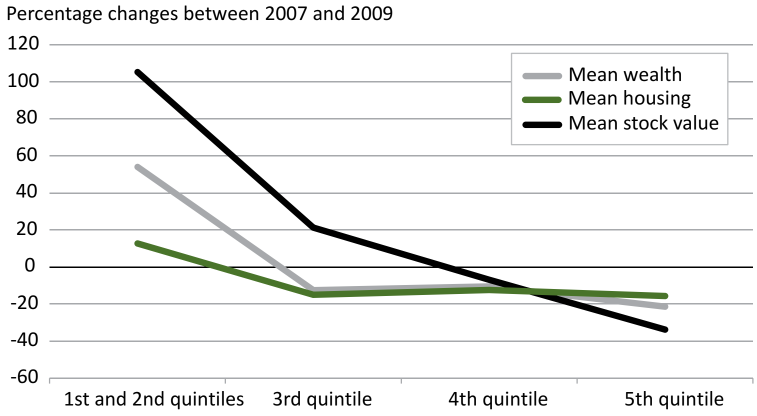
As I have shown, households with different levels of income or wealth and at a different stage of life were affected differently by the Great Recession. Moreover, there are some nontrivial channels that create winners and losers. I will slice households along various dimensions and discuss who gained and who lost from the Great Recession; in particular, I will look at the large drops in income, house prices, and stock prices.

Income. On average, households lost income from the Great Recession. However, young and less educated households tended to suffer a larger percentage drop in income. Moreover, using Canadian data, Philip Oreopoulos, Till von Wachter, and Andrew Heisz show that college students graduating and entering the job market in a recession suffer a large initial income loss, and the loss is persistent, lasting as long as 10 years. On the other hand, Saez shows that households at the top of the income distribution experienced a larger percentage loss from the Great Recession. Middle-aged households suffered less because more of them have stable, full-time jobs. Not surprisingly, retired households suffered little.

Housing. Homeowners, especially those who wanted to sell their house, suffered from the drop in house prices. Younger homeowners suffered less because they could likely wait until house prices recover (if they ever do) to sell. Although house prices have hit bottom and are finally rising, they remain a long way from their levels before the housing crash. Whether and how much homeowners suffer depends on how fast and how much house prices recover in the future. On the other hand, renters who were about to buy their first home or homeowners planning to move up to a larger house could buy houses at lower prices than before the recession. Relatively young renters and younger homeowners were in this category. In their study, Wenli Li and Rui Yao investigate these asymmetric effects of house-price changes. At the same time, they are likely to have suffered a loss in income, and lost savings to be used for a down payment

FIGURE 13

Percentage Changes in Mean Value of Wealth, Housing, and Stocks, 2007-09



Source: Survey of Consumer Finances, 2007-09

with the declining asset prices. Therefore, whether these households gained, all things considered, is not certain.

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[12] Many people, including economist Robert Shiller (who helped to develop the Case-Shiller house price index), perceive the substantial rise in housing prices before the Great Recession to be a "bubble." Please see my previous *Business Review* article for a discussion of the "bubble" theory of house prices.

Note that the timing of a home purchase also matters. Homeowners who purchased their house when house prices were still low might not have suffered too much from the Great Recession, even with a large decline in house prices, because the purchase price was also low. To give an extreme example, the average price of new homes was $229,000 in 2002, $314,000 in 2007, and $273,000 in 2010.[13] For a person who purchased his house in 2002, selling in 2010 is worse than selling in 2007, but still his selling price would be higher than the purchase price. For a person who purchased his house in 2007, that's not the case.[14] On the other hand, homeowners who purchased their house recently are the ones who suffered the most from the large decline in prices.

Stocks. Similarly, households that were about to sell stocks and could not wait until the stock market recovered suffered from the Great Recession. Older households, which tend to sell stocks to support consumption expenditures in retirement, were in this group. Relatively younger households and those experiencing income growth gained in this regard because they tend to be buyers of financial assets, and they were able to buy assets at depressed prices.

Wealth and Debt. Households with little wealth or those that were heavily indebted did not suffer from declining asset prices but could suffer from the Great Recession from a different channel. How? If such a household experienced a loss of income, even if it wanted to borrow money to avoid a large drop in consumption expenditures, it might not be able to do so if borrowing was difficult. A household that wants to borrow but cannot is called *borrowing constrained*. Households that are planning to buy houses or other assets suffer from the borrowing constraint as well because, even though they want to buy houses or assets at depressed prices, they cannot do so because they have little wealth and are unable to borrow. This point is emphasized in a recent paper by Sewon Hur.

Young and Old. Glover and coauthors argue that age is an important determinant of the impact of the Great Recession, especially if the decline in stock and house prices is temporary and prices recover in the not-too-distant future. Under such circumstances, young households that have assets such as housing and stocks can hold on to these assets until prices recover and avoid losing wealth from the decline in asset prices. On the other hand, older households might not have time to wait until asset markets recover. Time is especially important when they want to sell the assets to support current consumption expenditures; holding on to assets with depressed prices hurts them because they might not be able to buy what they want if they do not sell these assets.

A similar argument can be made about income. Relatively younger workers might have experienced a decline in income during the Great Recession, but they have more time to bounce back, with possible booms in the future canceling the Great Recession's negative effects on income. Older workers, on the other hand, have a shorter time horizon because they will retire sooner.

Welfare. All things above considered, how did the Great Recession affect the welfare (well-being) of diverse households? The discussion above indicates that young households suffered more in terms of income, but older households suffered more from declining asset prices. Using a sophisticated economic model, Glover and coauthors computed that the size of the decline in the average welfare of households age 70 and above associated with the Great Recession was equivalent to an 8 percent drop in consumption every year for the rest of their lives. On the other hand, the decline in the welfare of young (20s) households was equivalent to a less than 0.5 percent decline in consumption every year.

Why did young households suffer less than older households? First, young households are expected to live longer. As long as the economy recovers from the Great Recession in the future, the young can smooth out the losses from the Great Recession over their lifetime. Second, young households tend to be accumulating assets, and thus they benefit from lower asset prices. As we have seen, younger

> Although house prices have hit bottom and are finally rising, they remain a long way from their levels before the housing crash. Whether and how much homeowners suffer depends on how fast and how much house prices recover in the future.

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[13] According to the Census Bureau, the median house price was $188,000 in 2002, $248,000 in 2007, and $222,000 in 2010.

[14] Here I assume that these are the prices with which households buy or sell their houses. Of course, the first person "suffered" as well if he thought the value of his house was actually $314,000, but that's a different story.

households suffered a larger percentage loss in income on average, but according to the calculation by Glover and coauthors, this effect is weaker than the two favorable effects for the young. However, we should remember that this calculation did not take into account the possibility that young households with little or zero wealth could suffer due to the borrowing constraint, as discussed above.

CONCLUSION

In this article, I summarized the diverse economic impact of the Great Recession on different groups of households. In terms of income, young, lower-income, and extremely high-income households suffered a larger percentage decline. Moreover, a large decline in asset prices caused a larger drop in the value of wealth for homeowners, stockholders, and business owners. In terms of age, middle-aged households tended to suffer a larger decline in wealth because they tend to own those risky assets more than younger and retired households. The wealthiest households suffered more than the less wealthy in proportion because they tend to invest more of their wealth in risky assets, although the majority of those wealthy households remain relatively wealthy even after experiencing a large loss.

There are also nontrivial channels. Older households tend to suffer more because they tend to have less time to wait for asset prices to recover. On the other hand, young households that buy assets indirectly benefit from lower asset prices, but how much they benefit from the Great Recession depends on whether they can actually afford to buy these assets even after suffering a loss in income.

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USING AN ASKING PRICE MECHANISM

In many markets, sellers advertise their goods with an *asking price*. This is a price at which the seller is willing to take his goods off the market and trade immediately, although it is understood that a buyer can submit an offer below the asking price and that this offer may be accepted if the seller receives no better offers. Despite their prevalence in a variety of real-world markets, asking prices have received little attention in the academic literature. The authors construct an environment with a few simple, realistic ingredients and demonstrate that using an asking price is optimal: It is the pricing mechanism that maximizes sellers' revenues, and it implements the efficient outcome in equilibrium. The authors provide a complete characterization of this equilibrium and use it to explore the positive implications of this pricing mechanism for transaction prices and allocations.

Working Paper 13-7, "Competing with Asking Prices," Benjamin Lester, Federal Reserve Bank of Philadelphia; Ludo Visschers, Universidad Carlos III; and Ronald Wolthoff, University of Toronto

STUDYING THE AGENCY CMO MARKET

The agency CMO market, an often overlooked corner of mortgage finance, has experienced tremendous growth over the past decade. This paper explains the rationale behind the construction of agency CMOs, quantifies risks embedded in agency CMOs using a traditional and a novel approach, and offers valuable lessons learned when interpreting these risk measures. Among these lessons is that to fully understand the risks in agency CMOs, a full bond-by-bond analysis is necessary and that interest rate risk is not the only risk that needs to be considered when conducting risk management with CMOs.

Working Paper 13-8, "Understanding and Measuring Risks in Agency CMOs," Nicholas Arcidiacono, Federal Reserve Bank of Philadelphia; Larry Cordell, Federal Reserve Bank of Philadelphia; Andrew Davidson, Andrew Davidson & Company; and Alex Levin, Andrew Davidson & Company

INVESTIGATING WORKER FLOWS AND JOB FLOWS

This paper studies the quantitative properties of a multiple-worker firm matching model with on-the-job search in which heterogeneous firms operate decreasing-returns-to-scale production technology. The authors focus on the model's ability to replicate the business cycle features of job flows, worker flows between employment and unemployment, and job-to-job transitions. The calibrated model successfully replicates (1) countercyclical worker flows between employment and unemployment, (2) procyclical job-to-job transitions, and (3) opposite movements of job creation and destruction rates over the business cycle. The cyclical properties of worker flows between employment and unemployment differ from those of job flows, partly because of the presence of job-to-job transitions. The authors also show, however, that job flows measured by net employment changes differ significantly from total worker separation and accession rates because separations also occur at firms with positive net employment changes, and similarly, firms that are shrinking on net may hire workers to partially offset attritions. The presence of job-to-job transitions is the key to producing these differences.

Working Paper 13-9, "Worker Flows and Job Flows: A Quantitative Investigation," Shigeru Fujita, Federal Reserve Bank of Philadelphia, and Makoto Nakajima, Federal Reserve Bank of Philadelphia

THE LINK BETWEEN TFP GROWTH AND THE VALUE OF U.S. CORPORATIONS

This paper documents a strong association between total factor productivity (TFP) growth and the value of U.S. corporations (measured as the value of equities and net debt for the U.S. corporate sector) throughout the postwar period. Persistent fluctuations in the first two moments of TFP growth predict two-thirds of the medium-term variation in the value of U.S. corporations relative to gross domestic product (henceforth value-output ratio). An increase in the conditional mean of TFP growth by 1 percent is associated with a 21 percent increase in the value-output ratio, while this indicator declines by 12 percent following a 1 percent increase in the standard deviation of TFP growth. A possible explanation for these findings is that movements in the first two moments of aggregate productivity affect the expectations that investors have regarding future corporate payouts as well as their perceived risk. The authors develop a dynamic stochastic general equilibrium model with the aim of verifying how sensible this interpretation is. The model features recursive preferences for the households, Markov-Switching regimes in the first two moments of TFP growth, incomplete information, and monopolistic rents. Under a plausible calibration and including all these features, the model can account for a sizable fraction of the elasticity of the value-output ratio to the first two moments of TFP growth.

Working Paper 13-10, "Risk, Economic Growth, and the Value of U.S. Corporations," by Luigi Bocola, University of Pennsylvania, and Nils Gornemann, University of Pennsylvania

EXPANDING EMPLOYMENT THROUGH STATE DEFICIT POLICIES

Using a sample of the 48 mainland U.S. states for the period 1973-2009, we study the ability of U.S. states to expand their own state employment through the use of state deficit policies. The analysis allows for the facts that U.S. states are part of a wider monetary and economic union with free factor mobility across all states and that state residents and firms may purchase goods from "neighboring" states. Those purchases may generate economic spillovers across neighbors. Estimates suggest that states can increase their own state employment by increasing their own deficits. There is evidence of spillovers to employment in neighboring states defined by common cyclical patterns among state economies. For large states, aggregate spillovers to their economic neighbors are approximately two-thirds of the large state's job growth. Because of significant spillovers and possible incentives to free ride, there is a potential case to actively coordinate (i.e., centralize) the management of stabilization policies. Finally, when these deficits are scheduled for repayment, the job effects of a temporary increase in a state's own deficits persist for at most one to two years, and there is evidence of a negative impact of state jobs.

Working Paper 13-11, "Local Deficits and Local Jobs: Can U.S. States Stabilize Their Own Economies?," Gerald Carlino, Federal Reserve Bank of Philadelphia, and Robert Inman, The Wharton School, University of Pennsylvania