Can We Explain Banks' Capital Structures?*

BY MITCHELL BERLIN

Bank capital has been much in the news during the recent financial crisis. In 2008 and 2009 the U.S. government injected $235 billion of capital into the banking system as part of the Troubled Asset Relief Program (TARP). In 2009, bank regulators carried out a full-scale evaluation of the capital adequacy of 19 large banking organizations, ultimately requiring 10 of these organizations to increase their capital levels. While most commentators agree that regulatory capital levels are too low for large organizations — especially large organizations that create systemic risks — financial economists have only recently been paying attention to what factors actually govern banks' capital choices. In this article, Mitchell Berlin discusses how understanding bank capital decisions over the 20-year period prior to the recent crisis can provide insights that may help us to evaluate reform proposals.

After posing the question, "Why are banks so averse to raising equity?" a recent column in *The Economist* answers, "The usual laws of corporate finance do not seem to apply to banks." The reason the column suggests is that deposits are insured; so uninsured sources of funding (such as equity) are relatively expensive. This view is fairly widespread, and not just among business columnists. Indeed, most theoretical models of the banking firm assume that banks hold the minimum amount of equity required by regulation.[1]

While this view appears plausible, it actually contradicts the evidence of the last 20 years, which shows that banks do not appear to hold the minimum amount of equity required by regulators. Furthermore, while banks are typically highly leveraged compared with most nonfinancial firms, this doesn't mean that similar forces are not at work when banks and nonfinancial firms choose their capital levels. To the contrary, empirical work by banking scholars supports the view that market forces have been an important determinant of banks' capital decisions since the early 1990s.

Bank capital has been much in the news during the recent financial crisis. In 2008 and 2009 the U.S. government injected $235 billion of capital into the banking system as part of the Troubled Asset Relief Program (TARP).[2] And in 2009, bank regulators performed a full-scale evaluation of the capital adequacy of 19 large banking organizations, ultimately requiring 10 of these organizations to increase their capital levels.[3] While most commentators agree that regulatory capital levels are too low for large organizations — especially large organizations that create systemic risks — financial economists

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[1] To be fair, theorists often assume that banks hold the minimum capital level mainly as a matter of convenience when they are not primarily concerned about the bank's choice between debt and equity.

[2] This total includes capital injected into a range of financial institutions, not all of which were commercial banking organizations. See the report from the Government Accountability Office for more details about TARP.

[3] See the Board of Governors' two accounts of the Supervisory Capital Assessment Program (SCAP).

have only recently been paying attention to what factors actually govern banks' capital choices. Understanding bank capital decisions over the 20-year period prior to the recent crisis can provide insights that may help us to evaluate reform proposals. (See *Some Bank Capital Reform Proposals*.)

CAPITAL STRUCTURE IN NONFINANCIAL FIRMS

While banks may be special along a number of dimensions, in the first instance, banks are firms. So to understand bank capital, a sensible starting point is to take stock of our current knowledge about capital structure decisions by firms in general. First, some terminology: We can think about capital structure in a few equivalent ways. Sometimes it is easiest to talk of the firm's *leverage ratio*, the value of the firm's debt divided by the value of its total assets. Alternatively, we sometimes talk of its *capital ratio*, the value of the firm's equity (or, often in the case of banks, some broader measure of regulatory capital) divided by the value of its assets.[4]

The Dynamic Tradeoff Model. Capital structure has been an active area of research in financial economics for the last 50 years.[5] Despite inevitable differences of opinion among researchers, the current consensus is that the empirical evidence is consistent with a dynamic tradeoff model in which firms choose a target leverage ratio to which they actively adjust over some period of time. Furthermore, alternative views in which firm managers make financing decisions with little or no thought to hitting a target leverage ratio have received little empirical support to date. But even its proponents recognize that the standard model has limited power to explain firm capital structure decisions.[6]

In the standard model, a firm

[4] Regulators use the term "leverage ratio" to refer to the value of a bank's tier 1 capital over total assets. (See *Bank Capital Regulation* for a definition of tier 1 capital and other regulatory terminology.) Throughout the text, I will use the term "capital ratio" to refer to common equity divided by assets and I will specify whenever I use some regulatory measure of capital or assets.

[5] Most accounts of the modern theory of capital structure begin with the *capital structure irrelevance* theorem of Nobel laureates Franco Modigliani and Merton Miller, who showed conditions under which a firm's capital structure does not affect its value. Subsequent researchers have systematically examined the effects of relaxing these conditions.

[6] See, for example, two recent reviews of the capital structure literature by Christopher Parsons and Sheridan Titman and by Murray Frank and Vidhan Goyal.

Some Bank Capital Reform Proposals

In addition to the widespread view that banks should be required to maintain higher capital levels than under Basel I, banking researchers and policymakers have made a number of proposals to reform bank capital regulation.

A number of researchers have proposed that banks be required to maintain a layer of contingent convertible debt. The element common to all versions of this proposal is that when bank capital falls below some level, the debt converts to equity, thereby reducing the bank's leverage automatically. Proposals differ in the details of how conversion is triggered. For example, in Mark Flannery's proposal, conversion is triggered when the market value of equity falls below a predetermined level. Alternatively, the Squam Lake Working Group for Financial Institutions proposes that conversion should be triggered only when both the book value of equity falls below a predetermined level and bank regulators announce that there is a systemic crisis.*

Other researchers have proposed that banks be assessed a higher capital charge based on some measure of their contribution to systemic risk. This approach seeks to address the issue that banks will not take into account the costs they impose on other institutions, and ultimately taxpayers, when they take risks that increase systemic risk. For example, Viral Acharya, Lasse Pedersen, Thomas Philippon, and Matthew Richardson have proposed that bank capital requirements (or a systemic risk insurance fee) be partially based on a financial institution's contributions to episodes of severe stock market declines. Other researchers have proposed other measures of an institution's contribution to systemic risk; for example, Tobias Adrian and Markus Brunnermeier propose that capital charges be based on the covariance between an institution's stock price and those of other large financial institutions.

It is important to note that contingent capital schemes and schemes that impose capital charges for systemic risk are potentially complementary approaches.

* The various proposals contain extended discussions of the main issues in dispute. Flannery views his scheme more as a means of mobilizing market discipline and early regulatory intervention than as a mechanism for recapitalizing a financial system already in serious crisis. The Squam Lake group worries that conversion triggers based on the market price of equity will lead to market manipulation that would increase instability. It views conversion primarily as a means of recapitalizing institutions once the system is already in crisis.

chooses its target leverage to balance the benefits and costs of increasing its debt level. Much of the literature has focused on the deductibility of interest payments as the primary benefit of higher debt: A firm's interest payments to bondholders and other lenders are treated by the firm as an expense and, thus, lower the firm's tax bill. In contrast, dividend payments to the firm's stockholders are not deductible. If this were the whole story, firms would choose to be fully debt financed. But debt also generates costs. A highly levered firm with a lot of interest payments can get into trouble in difficult financial times. At the minimum, a firm may be forced to postpone investment projects and use all incoming cash to meet interest payments. At the worst, a firm might actually face default and bankruptcy if it can't pay its creditors. (In contrast, postponing or cutting dividend payments do not lead to default.) These costs are usually grouped under the term *costs of financial distress*.

Factors That Reliably Affect Leverage. Empirical studies that cover different time periods, samples of firms, and countries indicate that a firm's leverage tends to be higher when a firm is larger, when it has more *tangible assets*, and when its *market-to-book* ratio — the value of the firm's stock divided by the book value of its assets — is lower. Most researchers interpret these factors as evidence that concerns about financial distress play an important role in the firm's capital structure choice. Large firms have more diversified sources of cash, and thus, they are less likely to face a sudden cash shortfall. A firm's tangible assets include machines and inventories, assets that could potentially be sold much more easily than a firm's intangible assets: its trademarks, its reputation for quality, brand recognition, or the accumulated knowledge of its workforce. In the event of a decline in cash flows, a firm may be able to avoid default by selling some of its tangible assets. The market-to-book ratio is often interpreted as a measure of the firm's *growth opportunities*, for example, future investment activities that investors see as valuable — and, thus, raise the firm's stock price — but which are not yet embodied in assets in place. When a firm has valuable growth opportunities, it may be particularly costly when declines in cash flow force it to delay new investments.[7]

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In addition, researchers have found that a firm's leverage depends importantly on its industry and that its leverage is high when the firm's own profitability is low. These factors don't fit as comfortably into the tradeoff model. The importance of industry effects simply shifts the inquiry one step further back: What is it about an industry that explains high or low leverage? And while the negative relationship between profits and leverage can be squared with some versions of the tradeoff model, the effect is probably best viewed as an unexplained empirical regularity.[8]

Firms Actively Adjust Toward a Target. While firms may have a target leverage ratio, factors often shift a firm away from its target; for example, a sudden increase in sales might increase retained earnings, thereby reducing the firm's actual leverage ratio. Since new debt issuance is costly, the firm may take some time to get back to its target. In surveys of chief executive officers and chief financial officers, over 70 percent of the firms report that they have either a strict target or a target range for their leverage ratio.[9] This survey evidence is supported by formal empirical studies, but researchers report widely disparate estimates of the speed with which firms adjust, with estimates ranging from very slow (Eugene Fama and Kenneth French estimate that firms adjust at a rate of 7 to 10 percent per year) to very fast (Mark Flannery and Kasturi Rangan (2006) estimate an adjustment rate of 34 percent per year), and researchers are far from achieving consensus. Furthermore, studies disagree as to whether the target is fixed or whether it may vary over time in a systematic way.

Most economists would agree with the statement, "It takes a model to beat a model." This means that to evaluate a particular model, researchers compare it to alternative models, mainly by asking how well

[7] The reader may note that none of the enumerated factors are clearly related to the tax benefits of debt. Until John Graham's work, the consensus view was that taxes had limited ability to explain firms' leverage decisions. Recent dynamic models have uncovered more evidence for the importance of taxes, but research continues to suggest that firms do not take on as much debt as models would predict. See Graham's article, as well as the literature reviews cited in footnote 6 for fuller discussions of taxes and capital structure.

[8] This negative relationship is consistent with Stewart Myers's pecking order model, examined in the next section.

[9] See John Graham and Campbell Harvey's article.

each explains the facts, in this case, firms' capital structure choices.[10] To date, no alternative to the dynamic tradeoff model has found strong empirical support. In particular, researchers have found only limited support for alternative models that predict no target leverage ratio. The most influential of these is Stewart Myers's pecking-order model, in which firms finance investments out of cash whenever possible, sell debt only if cash flows are too low, and sell new equity only as a last resort. According to this view, a firm's leverage ratio increases when its cash flows drop and it is compelled to sell new debt to finance expenditures, and its leverage ratio declines when cash flows increase and internal funds build up. In contrast to the assumption of tradeoff models, a firm manager in a pecking-order type world will make no attempt to actively adjust toward some target.[11]

Limits of the Dynamic Tradeoff Model. The empirical importance of industry effects and of other variables that might be interpreted in ways that have little to do with a tradeoff between tax savings and the costs of financial distress, for example, firm size, firm profitability, or market-to-book value, limits our confidence in the dynamic tradeoff model. Furthermore, in an important recent paper, Michael Lemmon, Michael Roberts, and Jaime Zender highlight the limited explanatory power of the model. They find that, even including industry effects, the traditional model explains at most 30 percent of the variation in firms' capital structures; an economist would say that the model has *limited power* to explain the data. Perhaps more important, Lemmon and his co-authors find that firm *fixed effects* have a lot more explanatory power than all of the traditional factors put together. A fixed effect is a persistent factor associated with a particular firm: We know it's there, and we know that it helps explain the firm's choice of capital structure; we just don't know what it is. This finding is a challenge for the tradeoff theory because it suggests that much of the variation in firms' leverage is potentially explicable by some model of firm decision-making, just not the one we have.

The controversy over the speed of adjustment toward the target and the stability of the target presents further challenges for the theory. The model is less persuasive when the speed of adjustment is slow; a firm that adjusts to its target over a period of 10 or 15 years begins to look more and more like a firm with no target at all. And the problem with time-varying targets is much like the problem with firm fixed effects and industry effects. A theory that depends on factors (firm, industry, time) that help "explain" a firm's leverage ratio in the statistical sense, but without any underlying economic intuition, may not be very useful as a guide to understanding or prediction.[12]

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BANK CAPITAL STRUCTURE

Bank Capital Levels Over Time. Banks are highly levered firms. In Reint Gropp and Florian Heider's international sample of large banks in 2004, median leverage was nearly 93 percent in book value terms and just over 87 percent when measured in market value terms. Compare this with the median book and market leverage of Frank and Goyal's sample of nonfinancial firms in 2004 of 24 percent and 23 percent, respectively.[13]

Bank capital levels have not always been so low. In the U.S., commercial banks had equity-to-asset ratios (measured at book value) of over 50 percent in 1840.[14] This ratio fell continuously until 1945, at which point it remained roughly stable in the 6 to 8

[10] Of course, it is possible for different models to help explain different aspects of a firm's decision-making or for one model to explain decision-making by some types of firms, for example, large firms, but not others.

[11] See Frank and Goyal's review article for further discussion of the empirical evidence for and against the pecking-order model and other models that predict no target, for example, Malcolm Baker and Jeffrey Wurgler's view that managers' decisions to issue securities are driven by attempts to time the market.

[12] Other recent challenges to the dynamic tradeoff model are even more fundamental. For example, Xin Chang and Sudipto Dasgupta show that simulations with random stock and bond selling can generate dynamic capital structures that look a lot like a firm moving toward a target.

[13] That said, banks are not unique in maintaining high leverage ratios. For example, in Ivo Welch's listing of the 30 most highly levered firms in February 2006, only 11 were financial firms and none were commercial banks.

[14] The numbers prior to 1980 come from the article by Allen Berger, Richard Herring, and Giorgio Szegö. Note that the numbers are not strictly comparable over time and so should be viewed as an indicator of trends.

percent range until the 1970s. Examining the figure at the bottom of the page, we see that the weighted average book value equity ratios for bank holding companies (BHCs) had declined to the 4 to 6 percent range by 1980 and then rose to 6 percent in the latter half of the 1980s, mainly in response to the imposition of uniform capital guidelines in 1985.[15] (*See Bank Capital Regulations* for a summary description of U.S. bank capital regulation and for definitions of all terms.)

Bank capital ratios increased dramatically after 1990, when Basel I capital requirements were first imposed. Book equity-to-asset ratios for large BHCs rose from approximately 6 percent in the late 1980s to over 8 percent in the 1990s and 9 percent until the financial crisis of 2008. The rising trend since 1990 is even more striking in market value terms. The average market value of bank equity to the market value of assets for the largest 100 BHCs rose from 6 percent in 1990 to over 15 percent from 1996 through the second half of 2007.[16]

Banks Hold More Capital Than the Regulatory Minimum. The rise in bank capital ratios since 1990 also corresponded to an increase in *regulatory* capital ratios. For their sample of large BHCs, Flannery and Rangan (2008) find that risk-weighted tier 1 capital ratios rose from under 8 percent in 1986 to over 10 percent by 1995. This ratio showed a declining trend through 2006 but remained above 8 percent throughout the period, comfortably above the 6 percent level required for a bank to be considered well-capitalized for regulatory purposes and well above the regulatory minimum of 4 percent.[17]

Examining the entire distribution of large BHCs' regulatory capital ratios, Flannery and Rangan (2008) show that by 1992 more than 95 percent of large BHCs had tier 1 capital ratios at least 1.5 percentage points higher than the regulatory minimum. This percentage rises to 100 percent for most years through 2001. Berger and his co-authors (2008) examine a larger sample of BHCs and show that this trend continued through 2006.[18] They show that 99 percent of large BHCs had tier 1 capital ratios that qualified them as well capitalized in 2006. The lion's share of these firms had tier 1 risk-weighted capital ratios between 10 and 12 percent.

Banks Actively Manage Toward a Target. It is clear that throughout the 1990s and into the 2000s, banks overwhelmingly held capital levels greater than the regulatory minimum, but this raises a question: What factors determine banks' capital levels? One possibility is that the bank capital

[15] A bank holding company is any company that controls one or more commercial banks. The figure displays bank capital ratios both for the largest 100 BHCs and for a larger group of BHCs. The figure also displays unweighted average capital ratios to show that the main trends are not driven by a small number of very large banks.

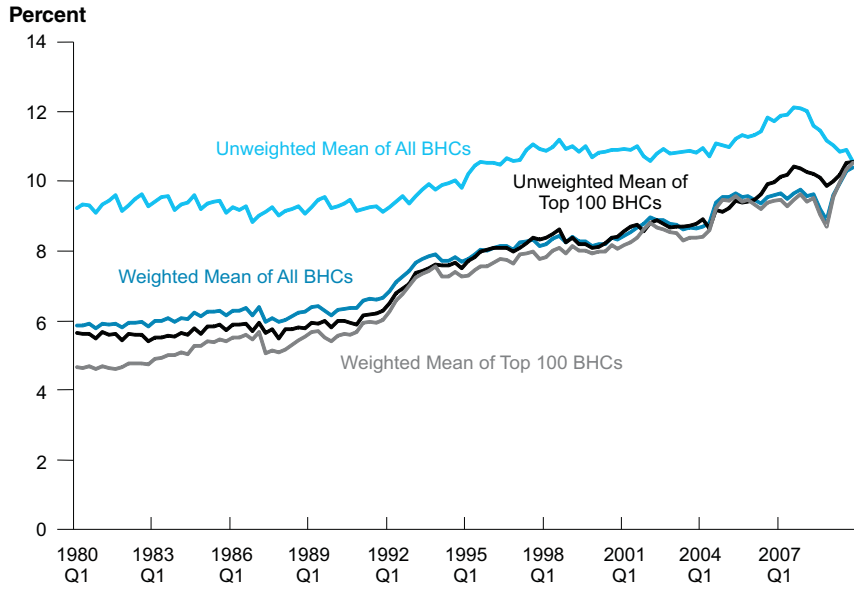
[16] Flannery and Rangan (2008) show that the increase in the average capital ratio corresponds to a rightward shift in the entire distribution of market values of equity from the 1986-1989 period to the 1998-2001 period. The 2008 article by Berger and co-authors suggests that this distribution continued to shift rightward through 2006, although they focus on regulatory capital.

[17] Interestingly, this decline coincided with an increase in tier 2 capital. Two trends appear to be at work: first, a shift toward riskier assets, and second, a shift toward nonequity sources of regulatory capital. This raises a range of important (and difficult) issues about the appropriate way to measure capital adequacy. To the extent that the risk weights on off-balance-sheet assets (or other assets) were too low — for example, regulation may have underestimated BHCs' commitment to support off-balance-sheet vehicles — BHCs may not have been as well capitalized as they appeared in the early 2000s.

[18] Flannery and Rangan's (2008) sample includes the largest 100 BHCs in each year, while Berger and his co-authors (2008) use a larger sample of all BHCs with assets in excess of $150 million.

FIGURE

BHC Capital Ratios*



*The capital ratio is measured as the book value of common equity over total assets.
Source: Bank Reports of Condition. "All BHCs" refers to BHCs with assets greater than $150 million.

Bank Capital Regulation

Prior to the 1980s, bank regulators had no formal uniform capital requirements, although regulators evaluated banks' capital levels as a part of their regulatory review. In 1985, U.S. bank regulators imposed uniform requirements, largely in response to concerns about the secular decline in bank capital. Banks were required to maintain at least a 5.5 percent *primary capital ratio* — equity plus loan-loss reserves/total assets — and a 6.0 percent *secondary capital ratio* — primary capital plus various subordinated debt instruments/total assets.

The Basel Accord of 1988 first imposed binding capital requirements in 1990, although these were phased in over the next two years. The goals of the Basel Accord were to: (i) raise capital levels for most banks; (ii) increase international uniformity in regulatory capital standards; (iii) adjust capital requirements to better reflect actual credit risk; and (iv) impose capital requirements for some off-balance-sheet exposures. The following provides the basic elements of Basel I capital requirements. (See, for example, Anthony Saunders and Marcia Millon Cornett's textbook for a more complete treatment.) European (but not U.S.) banks have been subject to Basel II capital requirements since 2008.

Tier 1 capital = Common equity + Preferred noncumulative stock + Minority interests in consolidated subsidiaries.[a]

Tier 2 capital = Tier 1 capital + Allowances for loan losses + Perpetual preferred stock + Subordinated debt + Various hybrid capital instruments.[b]

Note: The amounts of some of the components of tier 1 and tier 2 capital are limited to some maximum value. For example, preferred noncumulative stock can be no more than 25 percent of tier 1 capital.

Risk-weighted assets: Each asset has a risk weight, reflecting the risk of default. For example, a Treasury security carries a zero risk weight, while a commercial loan carries a 100 percent risk weight. In addition, off-balance-sheet assets, such as commitments to lend, are assigned a *conversion factor.* For example, an unused two-year loan commitment increases on-balance-sheet assets 50 cents for each dollar of the commitment; that is, the conversion factor is 0.5. Total risk-weighted assets are the sum of all assets, with each asset weighted by its risk weight.

Each BHC, each bank within a BHC, or any stand-alone bank is subject to three basic capital requirements:

Leverage requirement: Tier 1 capital/Total assets must exceed 4 percent.

Tier 1 capital requirement: Tier 1 capital/Total risk-weighted assets must exceed 4 percent.

Total capital requirement: Tier 2 capital/Total risk-weighted assets must exceed 8 percent.

BHCs that wish to engage in international activities and pay lower deposit insurance premiums, among other benefits, must be *well capitalized*. To be well capitalized, the BHC must maintain a tier 1 capital ratio no less than 5 percent, a tier 1 risk-based capital ratio no less than 6 percent, and a tier 2, risk-based capital ratio no less than 8 percent.

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[a] Preferred stock confers no voting rights and pays a fixed dividend. Dividend payments on preferred stock must be paid before common stockholders are paid any dividends, but contractual payments to debt holders have priority over preferred dividends. Unlike a missed interest payment, a missed dividend payment is not an event of default. Unlike for cumulative preferred stock, missed dividend payments on noncumulative preferred stock are not added to future dividend payments. When a BHC owns a majority of the shares of a subsidiary, the subsidiary is consolidated into the balance sheet of the parent BHC. If the BHC owns less than 100 percent of the shares, the equity share is considered a minority interest in its consolidated subsidiary.

[b] Perpetual preferred stock has no fixed maturity and any missed dividend payments are added to future dividend payments. The interest payments on subordinated debt instruments are contractual payments that must be paid before any stockholders receive dividend payments. Failure to make interest payments leads to default. Subordinated debt has lower priority than deposits or senior debt, so depositors (or the FDIC standing in for depositors) or senior debt holders must be fully paid off before subordinated debt holders receive any payments. Hybrid capital instruments included in tier 2 capital refer to a range of securities, including deeply subordinated debt instruments. These have lower priority than ordinary subordinated debt and make interest payments only under specified contractual conditions.

buildup reflected pecking-order behavior and that the capital buildup was an accidental byproduct of the strong revenue growth for banks during this period. This behavior might have been reinforced by regulators' preference to see better capitalized banks.

The evidence strongly suggests that this is not the case. Beginning

with a study of the 1980s, Berger and co-authors, in their 2008 paper, find that banks sold new equity when their earnings increased, a finding at odds with pecking-order behavior. Examining the capital buildup of the 1990s, Berger and co-authors find that BHCs systematically offset new equity issues carried out to finance mergers by redeeming existing shares, also consistent with active management of their capital ratios. Furthermore, Flannery and Rangan (2008) estimate an empirical model of bank market capital ratios for the 1990s and conclude that the mechanical effect of increases in earnings accounts for only 3 percent of the capital buildup in the 1990s. So, as in the literature for nonfinancial firms, researchers do not find much support for pecking-order models of bank capital.

What Do We Know About Banks' Target Leverage? It is important to note that the literature on what determines banks' target leverage ratios is relatively small, the samples and model specifications are different, and not all findings are consistent; so all results should be regarded as preliminary.[19] I focus primarily on those results that are consistent across studies and that pertain to leverage ratios or capital ratios (common equity/assets) measured at market prices.[20]

Consistent with the literature on nonfinancial firms — and also with many other studies in the banking literature — all researchers find a positive relationship between banks' asset size and target leverage. That is, larger banks are less well capitalized. This finding is consistent with the view that larger banks are better diversified and less likely to breach their target leverage.[21] Also in line with the previous capital structure literature, researchers find that most of their models' explanatory power comes from a firm-specific fixed effect, again, a reflection of our limited understanding of the cross-sectional variation in bank capital structure choices. Existing research also agrees that banks adjust quickly toward their target; indeed, the adjustment speeds exceed the top end of the range previously estimated for nonfinancial firms.[22]

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Finally, the studies by Gropp and Heider and by Flannery and Rangan (2008) document a negative relationship between bank leverage ratios and a measure of bank asset risk, although Flannery and Rangan (2008) find this result only for the second half of their sample period, 1994-2000. This result is consistent with the view that bank leverage decisions are driven by market pressures; that is, investors or other bank counterparties demand that a bank with more portfolio risk be better capitalized.[23] The view that market pressures increased in the late 1990s is in tune with other empirical research showing that the costs of uninsured funding sources became more risk sensitive in the 1990s. Interestingly, Flannery and Rangan (2008) find no such relationships for the 20 largest U.S. banks. They argue that market participants view the largest banks as too big to fail and that this suppresses the relationship between risk and leverage.

Researchers have tried to distinguish between two possible types of explanations to explain variations in capital levels over time and across banks. The first possibility

[19] I focus on the results of Berger and co-authors (2008), Flannery and Rangan (2008), and Gropp and Heider, all of which cover sample periods through at least 2000. These articles contain references to earlier contributions that address similar questions for earlier time periods.

[20] The leverage ratio is comparable to the measure typically used in studies of nonfinancial firms. Furthermore, regulatory definitions of capital pose difficult questions about the quality of the capital, for example, whether the instruments included in capital should be thought of as equity or debt. And risk-weighted measures of assets raise a host of questions about whether the risk weightings are reasonable.

[21] It is also consistent with the view that larger banks were undercapitalized, in particular, that their capital provisions were too low given the probability of very bad economic outcomes, so-called tail risk.

[22] Interestingly, Flannery and Rangan (2008) find that adjustment speeds are faster for banks nearer their minimum capital requirement and that banks with poor regulatory ratings adjust relatively slowly. They interpret the latter result as evidence of the difficulties such banks face in selling new equity.

[23] Flannery and Rangan (2008) do not find a negative relationship between leverage and risk for the first half of their sample period, 1987-1994. Their interpretation is that market forces became more important in determining bank capital structure decisions throughout the sample period. We should be cautious in our interpretation of a negative relationship between asset risk and bank leverage. Better capitalized banks may simply choose to take fewer risks, perhaps reflecting the risk preferences of the owners or managers.

is that regulatory capital requirements actually determine bank capital but that banks hold some cushion above the required capital level to reduce the likelihood of a regulatory intervention or the need to raise capital or reduce assets at short notice. The second possibility is that bank capital levels are determined in the market, perhaps according to some tradeoff model similar to the model in the standard capital structure literature. (Indeed, Gropp and Heider estimate a canonical tradeoff model, with only small alterations to account for certain distinctive characteristics of banking firms.)

To this point, researchers have not found a way to persuasively distinguish these hypotheses in the data, although, in my view, Flannery and Rangan (2008) present the most convincing evidence against the equity cushion view. They show that bank asset volatility is not positively related to the excess of book capital over required capital (the cushion), inconsistent with the view that the cushion is chosen to protect the bank against the risk of poor outcomes that would breach the regulatory capital requirement.[24]

THEORIES OF BANK CAPITAL STRUCTURE

Although there is a large theoretical literature on what makes banks special, a surprisingly small number of banking theorists have addressed banks' capital structure decisions. While the empirical evidence doesn't yet firmly reject the view that banks hold the regulatory minimum plus some cushion, the high capital levels of the last 20 years have led some theorists to explore optimal capital decisions driven by market pressures, in the context of the modern theory of the banking firm.[25]

Banks Hold Illiquid Assets and Provide Liquid Liabilities. The high leverage we observe for banks is closely related to what makes banks special. First, unlike those of nonfinancial firms, banks' liabilities are used as money (for example, demand deposits) and as a safe store of savings that can be called on at short notice (for example, certificates of deposit). More recently, other types of bank liabilities, for example, asset-backed securities, have served as collateral for a host of financial transactions.[26] Since liquid liabilities are a primary output of the banking firm, we should expect banks to be highly levered. At the same time, to be useful in exchange or as a source of liquid savings, banks' liabilities need to have little risk of default and, even more important, should not require customers to carry out a careful evaluation of the bank's assets. (Imagine having to examine a bank's annual report each time you accept a check drawn on that bank.)

Meanwhile, bank assets are risky. While a diversified portfolio of loans is less risky than any single loan, a bank must monitor its loans to ensure that portfolio returns are adequate to pay off the bank's depositors and other creditors. Besides the view that bank capital is determined by regulatory requirements, there are (broadly) two different views of the role of bank capital, both of which revolve around the view of banks as specialists in monitoring borrowers. But the underlying mechanisms are quite different.

Bank Capital Promotes Monitoring. In a number of models, the banker's incentive to monitor borrowers depends on stockholders' equity investment. In particular, recent articles by Franklin Allen, Elena Carletti, and Robert Marquez, and by Hamid Mehran and Anjan Thakor use this idea to explain why banks would hold capital in excess of regulatory requirements. In these models the banker acts in the interests of the bank's stockholders, perhaps because he or she has substantial stockholdings or because his or her pay is tied to the bank's stock price. Although the models differ in many significant ways, they share a similar basic intuition: Stockholders gain only when profits are positive, that is, when enough loans are repaid to cover the bank's debt payments. The more equity invested by stockholders, and thus the lower the bank's leverage, the smaller the share of the loan revenues that must be paid out to debt holders when revenues exceed debt payments. Thus, the gains from increasing the

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[24] This is consistent with the results of Berger and co-authors (2008), who do not find any relationship between earnings volatility and book leverage or any other measures of regulatory capital.

[25] Samu Puera and Jussi Keppo's article presents a formal model in which a bank holds an equity cushion above its regulatory capital requirement. The size of the cushion reflects the bank's costs of securing funds from outside investors in the event that it suffers losses.

[26] See Gary Gorton's account of securitization and the repo market.

likelihood of successful loans through monitoring are greater when the equity investment is greater.

This is only half of the story because it doesn't explain the limits on the bank's equity. In both models, the authors simply assume that equity is a relatively costly means of funding loans, mainly to focus attention on the relationship between monitoring and leverage. Among other factors, a higher relative cost for equity funding might arise if (i) deposits are insured; (ii) insiders have more information about the quality of the bank's portfolio than potential outside equity investors; or (iii) we take into account the value of producing bank liabilities that facilitate exchange.

Each of the models contains interesting empirical predictions. In particular, Allen and his co-authors show theoretically that banks will hold more capital when they lend in more competitive markets. This prediction illustrates an important feature of their model: market discipline is imposed by borrowers, rather than capital markets. Intuitively, borrowers gain when they are monitored more closely by banks, and banks' incentives to monitor are stronger both when bank capital is higher and when borrowers pay higher loan rates. Everything else equal, borrowers prefer that banks charge lower loan rates; so when loan market competition is strong, banks compete for borrowers by lowering rates and holding more capital. When competition is weak, banks can charge higher loan rates and hold less capital without undermining their commitment to monitor. This prediction has yet to be tested empirically.

Mehran and Thakor's paper has a host of empirical predictions, most notably the prediction that bank equity capital and bank value will be positively related in the cross-section. Intuitively, a bank with a low cost of capital has a comparative advantage in monitoring borrowers, and a bank that monitors more will have a higher value. In the cross-section, Mehran and Thakor argue that we should observe that banks with more equity capital will also be more valuable. They find support for this hypothesis in their empirical analysis of merger deals in the U.S. between 1989 and 2007.[27]

Deposits Promote Monitoring; Bank Capital Reduces Bank Failures. Douglas Diamond and Raghuram Rajan present a model in which bankers are hired by the bank's suppliers of funds, for example, depositors or stockholders, to monitor borrowers. In their model, bankers seek to grab as large a share of borrowers' payments as they can; that is, bankers don't automatically share a common interest with any of the bank's claimants, either its borrowers or its suppliers of funds. If there were a single banker and a single depositor, the banker would threaten to withdraw his expertise and knowledge about the borrower, that is, to stop monitoring and force the depositor to accept lower interest payments. Since the loan is much less valuable without the banker, the banker can use his or her threat to walk away to capture a significant share of the firm's loan payments at the expense of the depositor.[28]

But things are different if there are lots of depositors. Diamond and Rajan argue that, in this case, the deposit contract has a strong disciplinary effect if, when multiple depositors withdraw funds at once, a run on the bank develops.[29] Faced with the threat of a depositor run, the banker will choose to monitor borrowers (or else the loan will not pay off) and will make promised payments to depositors. Deposits are *hard* claims that impose discipline on bankers.

If a hard-working banker could always pay off his or her depositors, Diamond and Rajan's model would predict that banks could be fully funded by deposits. The threat of a run would impose discipline, but the threat would never actually be carried out. But bank loans can go bad for reasons other than poor monitoring or an attempt by the banker to keep loan revenues, for example, an economic downturn. In this case, the banker may be unable to pay off depositors, depositors will run, and many loans will have to be liquidated inefficiently.

This is where bank capital comes in. Bank capital serves as a buffer in the event of a decline in loan revenues. Equity is a *soft claim*. In the event that depositors withdraw their funds, stockholders take a loss to ensure that all depositors can be paid off and fewer loans have to be liquidated.[30] But this creates a tradeoff: The better capitalized the bank, that is, the more heavily

[27] Using goodwill — the difference between the purchase price of a bank and its book value of assets — as a proxy for the value of the bank's continuing relationships with its borrowers, Mehran and Thakor also predict (and find empirical support for) a positive relationship between equity capital and goodwill. This result is consistent with Flannery and Rangan's (2008) and Gropp and Heider's finding that a BHC's leverage is lower when its market-to-book ratio is higher.

[28] The reader who finds this story too melodramatic should view it as a metaphorical way of modeling the very realistic conflicts between managers and claimants that can't be easily resolved through incentive contracts.

[29] For a run to develop, the deposit contract must require the bank to pay off depositors who want to withdraw their funds on a first-come, first-served basis. In the banking literature this is called a *sequential service constraint*.

[30] Actually, in the model, bank capital might also take the form of long-term subordinated debt. It is important that the depositors have priority, but in the model, there is no real distinction between equity and long-term subordinated debt. Thus, in Diamond and Rajan's model, market forces would affect regulatory capital, not just equity.

the bank is financed by soft claims, the weaker the discipline imposed on the banker. Since it reduces the threat of a run, bank capital ensures that the banker captures a larger share of the bank's profits.

While Diamond and Rajan's model has been quite influential — increasingly so, since the financial crisis reminded banking scholars that banks might actually fail — there has been no systematic attempt to test whether it helps explain variations in bank capital over time or in the cross-section.[31]

CONCLUSION

While the experience of the 1990s and 2000s is inconsistent with the view that banks hold only the minimum required amount of equity, it is difficult to address *The Economist's* claim that the usual laws of corporate finance do not apply to banks. Over 50 years of theoretical and empirical research into nonfinancial firms' leverage decisions has identified factors that are consistently related to leverage, but one would be hard pressed to say that we have a firm understanding of the usual laws of corporate finance. Empirically, too much of the variation in nonfinancial firms' capital structures is explained by dummy variables representing the firm's industry and the firm itself. While this is better than no explanation at all, it is more an invitation to further research than a settled set of laws.

Furthermore, while banking researchers have rejected the simple view that capital requirements are binding, they have only begun to explore the determinants of bank leverage decisions empirically or theoretically. For example, the banking literature has yet to establish convincingly whether bank capital decisions are determined by market pressures — perhaps including pressures from borrowers as well as investors — or whether they are best explained as banks meeting regulatory requirements while holding an extra equity cushion.

While these issues do not directly answer the pressing question of how much capital banks should hold, they are directly relevant to the inquiry. In particular, capital requirements are much more difficult to enforce when they are binding; if banks wish to hold less than the regulatory minimum (or the minimum plus a cushion), they have a strong incentive to evade these requirements through a variety of strategies. This incentive increases as the difference between the regulatory requirement and the desired level of capital increases. Understanding the extent to which market forces are working with or against a new capital regulation should help policymakers understand the costs of enforcement.

[31] Mehran and Thakor argue that Diamond and Rajan's model counterfactually predicts a negative relationship between a bank's value and its capital level in the cross-section.

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Why Do Markets Freeze?*

BY YARON LEITNER

In normal times, investors buy and sell financial assets because there are gains from trade. However, markets do not always function properly — they sometimes "freeze." An example is the collapse of trading in mortgage-backed securities during the recent financial crisis. Why does trade break down despite the potential gains from trade? Can the government intervene to restore the normal functioning of markets? In this article, Yaron Leitner explains what a market freeze is and some of the theories as to why these freezes occur.

A puzzling feature of the recent financial crisis is the collapse of trading volume and the lack of transactions in many financial markets that were historically quite liquid. This is strange because we expect demand and supply forces to generate a price at which trade will occur. However, like everything else in life, markets are not perfect, and they may not always function properly. Why do markets seize up, even when there are potential gains from trade? Can the government intervene to restore the normal functioning of markets? We begin by explaining what we mean by a market freeze.

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WHAT IS A MARKET FREEZE?

In normal times, investors buy and sell financial assets for various reasons. First, they may have different opinions as to what assets are worth. Those who think an asset is worth more than its current price will buy, and those who think the asset is worth less will sell. Second, investors may have different needs. For example, one investor is about to retire and would like to hold relatively safe assets; another investor is young and may prefer to hold risky assets, taking the chance of getting a higher return. The first investor can reduce the risk in his portfolio by selling shares of stocks he owns to the second investor. Another example is the sale of mortgage-backed securities: A bank originates a mortgage and then sells it to other investors. In this way, the bank replenishes its funds and can use the sale's proceeds to originate another loan.

One way to think of the examples above is to say that each investor attaches a different "value" to the asset, where this value incorporates his own assessment about the asset's cash flows (for example, stock dividends) as well as his own preferences (for example, attitude toward risk). If one investor attaches a high value and another investor attaches a low value, there are potential gains from trade. As long as trade takes place at a price that is between the two values, both investors are better off. If there are many buyers and sellers, trade will take place until the market "clears." The market-clearing price is the price at which demand equals supply. That is, no one wants to sell below the price, and no one wants to buy above the price. In normal times, market-clearing prices represent "fair values," which reflect expected cash flows and individuals' attitudes toward risk. You can think of fair values as the price that would be agreed on between a willing buyer and a willing seller, with neither being required to act, and both having reasonable knowledge of the relevant facts.[1]

A *market freeze* refers to a situation in which trade does not occur despite

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

[1] This is the IRS definition (Publication 561). The Financial Accounting Standards Board (FASB) defines fair value as the "price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date." FASB then explains each term in the definition above in more detail. (See Statement of Financial Accounting Standards No. 157, September 2006.)

the potential gains from trade. An example is the collapse of trading in mortgage-backed securities during the recent financial crisis. (See the figure.)

One of the challenges during a market freeze is the lack of market prices from which we can infer fair values. While in practice some transactions may occur, these transaction prices may not represent fair values because only a limited number of transactions take place and/or some investors trade only because they must. For example, to avoid bankruptcy, a firm might be forced to sell its assets at a very low price, one that does not represent the fair value. While a lack of market prices is a symptom of one problem, it can also cause additional problems, since potential buyers may not know how much to bid for the assets. For example, when you buy a house, you look at the prices at which similar houses in the area were sold. However, if no houses were sold recently, it may be hard to come up with a price.[2] The lack of market prices also led BNP Paribas, France's largest bank, to halt withdrawals from three of its investment funds in 2007. In a statement, BNP Paribas said that "the complete evaporation of liquidity in certain market segments of the U.S. securitization market has made it impossible to value certain assets fairly regardless of their quality of credit rating." Alain Papiasse, head of BNP Paribas's asset management and services division, said in an interview, "For some of the securities there are just no prices…As there are no prices, we can't calculate the value of the funds."[3]

In practice, it is hard to tell precisely whether gains from trade exist because we do not observe investors' needs and we do not know the valuations they have in mind. Thus, a simple explanation for the lack of trade might be that investors do not trade because they do not need to; for example, they have exhausted all the gains from trade and have reached the desired outcome. While possible in theory, it is difficult to imagine that changes in preferences or portfolio objectives could explain the dramatic collapse in trading we observe in the figure.

Another simple explanation for a market freeze is that assets have become more risky, so investors are reluctant to hold them. However, there is no simple relationship between changes in asset risk and the volume of trading. Increased risk may actually result in more trade, since those who already hold the assets may rush to sell them. And if the price is low enough, other investors may be willing to buy, as in our example in which the investor who wants a safe portfolio sells shares of stock to the investor who wants to take more risk. Thus, when assets become more risky, we may see a market crash in which prices drop significantly but not necessarily a market freeze.

Other explanations involve a more puzzling situation in which investors do not trade even though it may seem that trade can make them better off. In particular, we explain why Investor A, who owns an asset, may not sell it to Investor B, even though both investors know that Investor B attaches a higher value to the asset.[4]

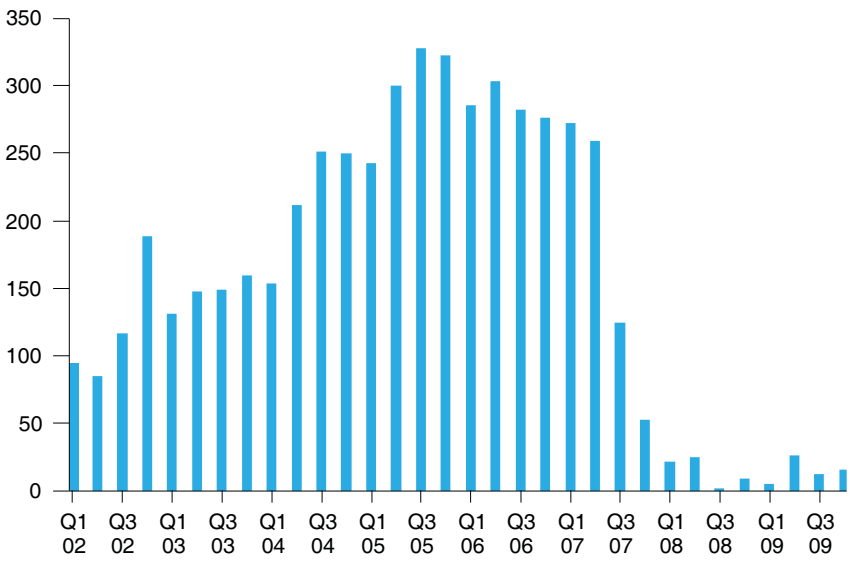
[2] William Lang and Leonard Nakamura provide a formal model for this. They show that a lack (or a low amount) of recent home sales reduces the precision of appraisals. This, in turn, forces lenders to require larger down payments, thereby affecting current sales.

[3] See the article, "BNP Paribas Freezes Funds as Loan Losses Roil Markets," Bloomberg, August 9, 2007.

[4] In a related *Business Review* article, Ronel Elul discusses some other features of a liquidity crisis, such as a large decline in prices, a flight to quality, and a liquidity spiral, wherein an initial drop in prices propagates to a large decline.

FIGURE

Nonagency MBS Issuance



Source: Inside Mortgage Finance MBS Database (2002-2007), Inside MBS & ABS (2008-2009)

INVESTORS MAY NOT KNOW HOW TO QUANTIFY RISK

Introductory finance classes usually teach students how to calculate present values, that is, how to answer the question, "How much is an asset worth?" An important ingredient in this process is an estimate of the asset's expected cash flows. Another important ingredient is the asset's risk or, in other words, how likely you are to obtain each potential outcome. Financial companies use various models to quantify assets' risk. In normal times, these models seemed to have worked pretty well. However, when house prices started falling, and homeowners defaulted on their mortgages, investors realized that the models did not work; that is, the assumptions behind the models were incorrect. Investors knew that there was risk, but they did not know how to quantify it.

What should investors do in this case? One response might be to avoid buying the asset and try to sell it if you already own it. As mentioned earlier, in this case, the outcome could be a huge volume of sell orders and a price collapse, but not a market freeze.

Another response, discussed in a paper by David Easley and Maureen O'Hara, is to stay with the status quo, that is, do nothing. This response leads to a market freeze. Investors avoid buying because they do not want to pay too much, and those who already own the asset avoid selling because they do not want to sell at too low a price. For example, suppose you own an asset and someone offers to buy it for $50. You may think this price is too low because the asset might be worth $70. Now suppose someone offers to sell you additional units of the asset at $50 per unit. (So then you would have the units you already own plus additional ones.) If you are sure that the assets are worth $70, buying additional units at $50 would be a good thing. However, if you are afraid that the price might fall to $30, you will not buy additional units at $50. Thus, you may simply sit on the fence and do nothing. If everyone else behaves like you, the market freezes.

The underlying assumption is that if an investor thinks there is more than one plausible way to value the asset, he trades only if he is better off given every plausible scenario.[5] In the example above, you (the investor) thought it was plausible that the asset might be worth $70, but it was also plausible that it could be worth only $30. If you had bought the asset at $50, you would be better off if the asset is actually worth $70, but worse off if the asset is worth only $30. If, instead, you sold the asset at $50, you would be better off if it is worth only $30, but worse off if the asset is worth $70. Therefore, you did nothing.[6]

Quoted Prices May Be Biased Relative to Fair Values. Easley and O'Hara's model has some interesting implications for the debate on how to establish fair values when markets are frozen. For example, FASB suggests using quoted prices.[7] In normal times, quoted prices reflect fair values, since transactions occur at or close to these prices, and it doesn't really matter if we use bid or ask prices, since for highly liquid assets the two prices are roughly the same.[8]

Suppose now that the markets are frozen. Easley and O'Hara show that while investors may continue to quote bid and ask prices, these prices may be biased relative to fair values, since no trades occur at these prices. Consider, for example, the bid price. You might guess that the fair value is above the bid price because investors who do not know how to quantify the risk may play it safe by offering to buy at a low price. While this may be true in some cases, Easley and O'Hara obtain the surprising result that, in other cases, the fair value may actually be below the bid price. The intuition is that the bid price reflects the beliefs of only one investor — the one who is the most optimistic; however, fair values should reflect the beliefs of all investors, including those who are very pessimistic and bid very low prices. Similarly, Easley and O'Hara show that the ask price may overestimate the fair value, but it may also underestimate it. Easley and O'Hara suggest that using the average of the bid and ask spread might be better than using just one of these two quotes. However, they also point out that this measure may be biased relative to the fair value; it may overestimate the fair value, but it may underestimate it.[9]

ASYMMETRIC INFORMATION

Another explanation suggested by economists for the recent market freeze is an increase in *asymmetric information*, that is, a situation in which some investors have better

[5] Different investors may have different scenarios in mind, depending on whether they are optimistic or pessimistic.

[6] Economists have used the words "uncertainty aversion" and "inertia" to describe the behavior of the investor above. Uncertainty aversion means that investors behave as if the worst-case scenario will happen. This type of behavior and its implications for a liquidity crisis are discussed in Ronel Elul's *Business Review* article. Inertia means that investors act (buy or sell) only if they expect to be happy with their decision, given any plausible model for valuing the assets. If they can come up with even one plausible model under which they expect to lose money, they do nothing.

[7] See Statement of Financial Accounting Standards No. 157.

[8] The bid price is the highest price someone is willing to pay for an asset. The ask price is the lowest price a seller will accept when selling the asset.

information than other investors. For example, the seller of a used car may know whether the car is a lemon, but the buyer would have no knowledge of that. This is different from the situation in the previous section in which two investors had different opinions as to what the true value was, but none of them had better information than the other.[10,11]

In a well-known article, George Akerlof, who won a Nobel Prize in economics in 2001, has shown that an information asymmetry, such as that in the example above, can lead to a market breakdown. The idea is this: If you think someone has more information than you do, you will be afraid to trade with him for fear of being exploited.

The following example illustrates this. Bank A (the seller) originates a loan, which it wants to sell to Bank B (the buyer). The value of the loan depends on the borrower's likelihood of default; the value is $60 to Bank A and $80 to Bank B. Both banks know that Bank B has a higher valuation because it can do a better job of monitoring the borrower and collecting the loan. Everyone is better off if Bank A sells the loan to Bank B. Any price between $60 and $80 could work.

The sale above may not go through, however. The problem is that since Bank A originated the loan, it has a better idea of whether the borrower is likely to default. That is, Bank A has more information than Bank B. For example, suppose Bank A knows that the loan is worth $60 to itself and $80 to Bank B. In contrast, Bank B knows only that it values the loan at $20 more than Bank A, and that the value of the loan to Bank A is somewhere between $0 and $100, with each value equally likely. Then Bank A will not sell the loan to Bank B, despite the fact that both banks know that the loan is more valuable to Bank B than to Bank A.

Why won't the sale go through? Whenever Bank A agrees to sell, Bank B can conclude that Bank A values the loan at the sale price or less. For example, if Bank A agrees to sell at $60, Bank B can conclude that the value of the loan to Bank A is between $0 and $60. Since Bank B values the loan at $20 more than Bank A, this means that the value of the loan to Bank B is between $20 and $80, or $50, on average. Thus, if Bank B buys the loan at $60, it expects to lose money, on average. If Bank B offered a higher price, it would expect to lose even more. However, since Bank A knows that its own valuation of the loan is $60, it will agree to sell only if the price is at least $60.

The effects of asymmetric information are magnified when the seller has large inventories of assets but can sell only a fraction of them.

CAPITAL CONSTRAINTS

The effects of asymmetric information are magnified when the seller has large inventories of assets but can sell only a fraction of them. In particular, regulators may use the new sale price to reassess the value of the seller's remaining assets. If the value drops, regulators may require more capital, or even worse, if the seller is a bank, the regulator may shut it down. Potential lenders may also use market prices to decide how much to lend and whether to roll over loans, even if regulators don't require banks to use mark-to-market accounting.[12] Whether the constraints are imposed by a regulator or by market participants, we can simply say that the seller is subject to

[9] The discussion above explains why we may observe large bid and ask spreads during a financial crisis. A small bid and ask spread exists during normal times, even if markets are competitive. The small spread reflects the risk of trading with investors who have better information or the risk that the value of dealers' inventories (that is, the units of assets they may need to hold temporarily when buying and selling) will fall. I discussed these two components of the spread in more detail in an earlier *Business Review* article. During a financial crisis, a spread exists not only for the two reasons above but also because investors do not know how to value the assets.

[10] Many market observers emphasized the problems of asymmetric information in the markets for mortgage-backed securities during the financial crisis. For example, the original TARP proposed that the Treasury Department purchase mortgage-backed securities from banks in an auction. Commenting on this plan, finance professors Glenn Hubbard, Hal Scott, and Luigi Zingales note that "such an approach raises significant problems – most significant is the risk posed by asymmetric information regarding the value of these securities. Because the holders of complex and incomparable mortgage-related securities have more information regarding their worth than does Treasury, Treasury is at a huge disadvantage and will likely overpay." See the article, "From Awful to Merely Bad: Reviewing the Bank Rescue Options," *Wall Street Journal*, February 7, 2009.

[11] Why would asymmetric information increase suddenly? Gary Gorton has suggested that initially investors thought that mortgage-backed securities were "safe," so the fact that the seller might have had more information was not an issue. However, when indexes of subprime risk began to fall, investors realized that mortgage-backed securities were not safe; that is, investors realized that some market participants were willing to pay a premium to protect themselves against subprime loan default. At this point, the fact that the seller may know more about the likelihood of default became an issue.

[12] Under mark-to-market accounting, assets are valued based on the recent market price of identical or similar assets. For example, if you bought a share of stock for $50 and the stock now trades for $20, the "mark-to-market" value of your stock is only $20, even though the "book value" is $50.

capital constraints, meaning that the seller must ensure that the market value of his inventories is high enough relative to the value of his liabilities. The cost of violating the constraint is assumed to be very high.

Depending on Leverage, We May Observe Increased Trade or a Market Freeze. Concerns about the market value of his remaining assets may induce the seller to reject offers that he would accept if he were not subject to a capital constraint. Thus, we may observe less trade compared with the situation in which the only problem was asymmetric information. However, in some cases, we may actually see more trade. The reason is that the buyer may understand that a profitable trade would be scuttled by the seller's capital constraint and may offer to buy the asset at a higher price. Since a higher price increases the chances that the seller will accept the offer, trade is more likely to happen.

In a recent working paper, Philip Bond and I show that whether we see more trade or less trade depends on the seller's "leverage," meaning that it depends on the size of his liabilities relative to the market value of his assets or, alternatively, on how tight his capital constraint is. When leverage is low, inventories have no effect on trade. When leverage is moderate, inventories increase the likelihood of trade. Finally, when leverage is high, the market freezes. We also show that a market freeze may be preceded by increased trade and an increase in leverage. This pattern is consistent with what we have seen in the recent crisis.

The reason is as follows: If the seller has only moderate leverage, the buyer can ensure that the seller's capital constraint is satisfied by increasing the bid. This reduces the buyer's expected profits from the transaction but still allows him to profit, on average. However, if the seller's leverage is too high, such that the value of his assets is just a little bit above the value of his liabilities, the buyer must increase the bid by a lot to ensure that the seller's capital constraint remains satisfied after the transaction. However, with such a high price, the buyer expects to lose money and may prefer not to bid at all.

The reasoning above also explains why we may see increased trade before the market freezes. Like the seller, the buyer may also have inventoried assets, and the buyer may be concerned about their market value. Under some circumstances, when the buyer purchases new assets, the market value of his existing assets falls.[13] In turn, he becomes more leveraged and his capital constraint tightens. This forces him to bid a higher price in the next trade, which increases the chances that the next seller will accept the offer — so we may see more trade. However, at some point, when the buyer continues to accumulate assets, he becomes overleveraged and he can no longer bid for the asset because whatever he does, he will either expect to lose money or he will violate his capital constraint. This is when the market freezes.[14]

Policy Implications. Our model suggests a caveat to proposals that would require sellers of asset-backed securities to retain a stake on their own books. In particular, regulatory interventions to buy up assets may need to be large enough to buy *all or most* of a seller's assets. Selling assets helps the seller raise cash — which strengthens his balance sheet. However, selling assets also reduces the value of the assets that remain on the balance sheet — which weakens the balance sheet. Buying all of the seller's assets eliminates this second effect. Thus, requiring sellers to retain some stake in the assets they sell may lead to a market freeze.[15]

Another implication is that piecemeal government interventions to facilitate asset sales may not be feasible. When potential buyers are highly leveraged, they are reluctant to buy assets for fear of creating a new price that will reduce the value of their inventoried assets. The government could then unfreeze the market by buying the assets, rather than having the highly leveraged buyers buy the assets. Since the government may have less information than the seller, it must offer a low enough price so that it can break even, on average.[16] However, by creating this lower price, the government may harm other potential buyers who previously chose not to trade, since the new price can be used to reevaluate their inventoried assets. Alternatively, if the government does not want to hurt potential buyers, it could offer them a subsidy or could increase the price it pays to the seller. However, these options impose a cost on taxpayers.

[13] This might happen, for example, if the buyer already has some assets similar to the one he purchases, and if the fact that the seller was willing to sell indicates that the value of these assets is lower than initially thought.

[14] For our results, we do not need to assume mark-to-market accounting, where inventoried assets are being evaluated "technically" based on the price of the last transaction. We could assume instead that regulators or potential lenders make inferences from the sale price, just as the buyer did in the previous section, and that they use these inferences to assess the value of inventoried assets.

[15] This possibility must be weighed against the possible benefits of requiring the seller to retain a stake in his own assets. Such a requirement may discourage loan originators from making bad loans in the first place. See, for example, Senate bill S. 3217 - Restoring American Financial Stability Act of 2010 (April 15, 2010).

[16] This assumes that the government has a higher valuation for the asset. Otherwise, the government can never break even, on average.

FEAR OF FIRE SALES CAN LEAD TO A MARKET FREEZE

During the recent financial crisis, we observed not only a market freeze but also a contemporaneous credit crunch, during which banks were reluctant to make loans. Douglas Diamond and Raghuram Rajan suggest that both problems may have a common root: the fear of a fire sale, that is, the fear that banks will be forced to sell their assets at prices that are well below fair values.

Why Do Fire Sales Occur? Suppose a firm runs into liquidity problems and needs to raise cash. Ideally, the firm would sell its assets to the buyer who values them the most, such as another firm in the same industry. However, this buyer may be experiencing financial difficulties at the same time as the firm and may be unable to raise the money to buy the assets at a fair value. The firm may then attempt to sell its assets to a firm outside its industry, but this other firm might place a lower value on the assets. For example, if all airlines are losing money, an airline that runs into bankruptcy might need to sell its assets to a financial firm with an airplane leasing subsidiary. This financial firm may not value the assets as much because it may take time for it to find a lessee and put the aircraft in service, especially during a recession. In this case, the sale price might be well below the price that firms in the airline industry would pay if they had the money.[17]

Similarly, when a bank runs into financial problems, it may need to sell its assets at fire sale prices simply because other banks that value its assets don't have enough cash to pay fair prices. (Or, alternatively, if there is only one bank with cash, that bank may use its monopoly power to lower its bid.) In our context, different valuations may arise because of different expertise. For example, some financial firms specialize in mortgage-backed securities (they know how to value and how to market these securities), while other firms don't. These less knowledgeable firms may be willing to buy the assets only if they get a large enough discount, which may also reflect the fact that they have less information about the assets. Note, however, that once conditions in the financial sector improve and the banks that value the assets the most are no longer cash constrained, the price of the asset is expected to return to its fair value.

During the recent financial crisis, we observed not only a market freeze but also a contemporaneous credit crunch, during which banks were reluctant to make loans.

Viral Acharya, Douglas Gale, and Tanju Yorulmazer expand the intuition above to explain why a bank may not be able to roll over short-term loans, even though the bank posts collateral whose value is expected to be high in the long term. In their paper, the problem is that if the bank defaults, the lender must sell the collateral in a fire sale to another bank, which also borrows short term and which can also default on its loan. If this second bank defaults, its lender must also sell the collateral in a fire sale to a third bank, which can borrow short term and default, and so on. Anticipating this, the initial lender may not be willing to lend against the full value of the collateral. (In the language of the finance profession, the initial lender may require a large "haircut."[18])

The Prospect of a Fire Sale May Cause a Market Freeze. The prospect of a fire sale will be reflected in the price today because, instead of buying today, a potential buyer can wait and buy later. For example, if investors think that there is a 50 percent chance that the price next month will be $100 and a 50 percent chance that the price will be only $20 (because of a fire sale), the most they will be willing to pay today is the average price of $60.[19]

Douglas Diamond and Raghuram Rajan show that the possibility of a fire sale can lead to what financial economists call "debt overhang" and, in turn, a market freeze. In their model, a bank is reluctant to sell its assets today, even though this could save it from potential bankruptcy in the future, because the gains from selling at today's low price are captured by the firm's creditors rather than its shareholders. To see that, let's continue with the example above. Suppose the bank owes $60 to its creditors, to be paid next month. If the bank does not have any financial problems,

[17] The discussion above is based on the paper by Andrei Shleifer and Robert Vishny. Todd Pulvino provides empirical evidence consistent with Shleifer and Vishny's model. Using aircraft sale transactions that occurred from 1978 to 1991, he shows that during a recession, an airline that is more financially constrained is more likely to sell to a financial institution (rather than to another airline) and that financial institutions pay, on average, 30 percent less than the market price.

[18] For example, if the face value of a bond used as collateral is $100, but the lender is willing to lend only $80 against it, we say that the haircut is 20 percent.

[19] If the investor does not care about risk (that is, he is risk neutral) and if the interest rate is very low, say 0 percent, the price today will be $60. Otherwise, the price will be lower.

it can sell its asset next month for $100, pay its creditors, and distribute the rest ($40) to its shareholders. However, if the bank runs into a financial problem and is forced to sell its assets at a price of only $20, it cannot fully pay its creditors and its shareholders get nothing. On average, the bank's shareholders expect to obtain $20 (0.5*40+0.5*0) and the bank's creditors expect to obtain $40 (0.5*60+0.5*20). Now suppose instead that the bank can sell its assets today at $60. Then the bank can pay back its creditors, but nothing is left for its shareholders. Hence, the bank's shareholders will prefer not to sell, despite the financial risk. And if the bank's manager acts on behalf of its shareholders, he will not sell, and the market will freeze.[20]

The Prospect of a Fire Sale Can Also Make Banks Reluctant to Lend. Diamond and Rajan's model explains not only a freeze in asset markets but also a contemporaneous credit freeze, which is consistent with what we saw in the recent recession. Banks may be induced to hoard cash rather than to lend because if there is a fire sale, cash on hand could make them a fortune, since they would pay less for assets than what they are truly worth.[21]

Diamond and Rajan discuss various interventions through which the government can reduce the prospects of fire sales and unfreeze the market. For example, the government can induce banks to sell their assets by offering to pay more than other potential buyers offer. However, as in the previous section, this does not necessarily imply that the government is expected to lose money. In particular, if the government can hold the assets until the price comes back to fair value, the government could potentially make money. However, this argument ignores the potential costs involved in managing those assets.

CONCLUSION

Economists have suggested a few explanations for the recent freeze in asset markets, such as: (1) investors did not know how to quantify risk; (2) asymmetric information has increased; (3) banks were concerned about the effect of transactions on the value of their inventories; or (4) banks did not want to sell their assets at low prices that reflected the possibility of a future fire sale.

While it is unlikely that a single model will explain everything — after all a model is not reality — each model sheds light on some aspect of the crisis. For example, one model explains the large bid-and-ask spreads and the relationship to fair values, another explains the increased trade before the market froze, and yet another explains the contemporaneous freeze in credit markets.

The models also help us think about the effects of government interventions. For example, if banks are worried about the effects of transactions on their inventoried assets, the government may need to buy all or most of the assets on the seller's balance sheet in order to unfreeze the market; however, creating a lower market price may impose a cost on other market participants. If banks are worried about future fire sales, the government may help by reducing the chance of fire sales, for example, by closing weak banks, infusing capital into banks that face liquidity problems, buying assets, or injecting capital into potential buyers.[22]

[20] Note that if the bank's creditors were in control, they would decide to sell the asset today. The conflict of interest between shareholders and creditors (debt holders) described above is a common problem in corporate finance. See, for example, the well-known paper by Michael Jensen and William Meckling and the well-known paper by Stewart Myers.

[21] In a recent working paper, Lucian Bebchuk and Itay Goldstein suggest a different explanation for the recent credit freeze. In their paper, a bank is reluctant to lend to a firm with a good investment opportunity because the bank is afraid that other banks won't lend and the firm will fail. In another paper, Ricardo Caballero and Arvind Krishnamurthy show that banks that are worried about worst-case scenarios may hoard liquidity instead of lending to one another.

[22] These government interventions are discussed in Diamond and Rajan's paper.

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Understanding House-Price Dynamics*

BY MAKOTO NAKAJIMA

For most homeowners, housing is the single most important component of their nonpension wealth. Therefore, a change in house prices greatly affects the total wealth of many households. Furthermore, movements in house prices can affect people's lives indirectly. For example, the surge in the number of mortgage defaults and foreclosures during the recent recession was triggered in part by a drop in house prices, and this surge damaged the health of the financial institutions that either directly or indirectly owned mortgage loans. In turn, the deteriorating health of the financial sector was one of the factors contributing to the recession. Naturally, for both policymakers and for people who want to make sound financial decisions, it is important to understand how and why house prices move. In this article, Makoto Nakajima explains a simple theory that helps us better understand house-price dynamics. The theory — called the user cost-rent equivalence — is based on the close relationship between user costs, which are the costs of owning a house for a year, and rents.

The ups and downs of house prices affect our lives substantially.

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About two-thirds of U.S. households own a house, and for most homeowners, housing is the single most important component of their nonpension wealth. Therefore, a change in house prices greatly affects the total wealth of many households.

*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.

For example, if there is a large drop in the price of a house, the homeowner is more likely to receive less money when selling his house in the future. Under this circumstance, it is probably a sound decision to cut back on household expenditures. House prices are also important for the one-third of households who are not homeowners, since many of them are young households that are saving money to buy their first house. Higher house prices could force many of them to delay or give up their plans to buy a house. Lower house prices help young households while hurting homeowners.[1]

Moreover, the recent recession seems to suggest that movements in house prices also affect people's lives indirectly. The surge in the number of mortgage defaults and foreclosures was triggered in part by a drop in house prices. Furthermore, this surge damaged the health of the financial institutions that either directly or indirectly owned mortgage loans, and the deteriorating health of the financial sector was one of the factors contributing to the recession.

Naturally, for both policymakers and for people who want to make sound financial decisions, it is important to understand how and why house prices move. This article presents a simple theory that helps us better understand house-price dynamics. The theory — called the user cost-rent equivalence — is based

[1] See the *Business Review* article by Wenli Li and Rui Yao for a more detailed analysis of how house-price changes affect the consumption and well-being of American households.

on the close relationship between user costs, which are the costs of owning a house for a year, and rents.

We'll start with some observations about the housing market, then review recent economic research that analyzes house-price dynamics. Since economists are still trying to improve their understanding of how house prices move, there are many theories that explain house-price dynamics other than the one presented in this article. We will take a brief look at some of the other theories. Then we'll discuss the theory that we focus on in this article and examine how elements that affect house prices, according to our theory, change over time and the implications of such changes for house prices. Finally, we'll carry out a simple numerical exercise to see what fraction of the recent rise in house prices can be accounted for by the theory presented here and by the data.

Interested readers are encouraged to look at Wenli Li and Fang Yang's related *Business Review* article, which analyzes the economic benefits and costs of homeownership.

SOME OBSERVATIONS ABOUT HOUSE PRICES

The trend of the average house price between 1975 and 2009 is shown in Figure 1. This is a *real* index in the sense that the house prices shown in the figure are relative to the prices of nonhousing goods and services. A constant *real* house price doesn't mean that the *nominal* house price (the ones we see in newspaper ads) is constant; rather, it most likely means that house prices are, on average, rising at the same pace as other goods we regularly purchase. The average house price rose about 1.5 percent faster than other prices per year over this period. What is striking about the figure is that the trend is relatively flat until the mid-1990s. Since then, there has been a substantial increase (until the end of 2006) and a substantial drop (since 2007). Around the end of 2006, when the average house price peaked, house prices were about 60 percent higher than their level in the mid-1990s.

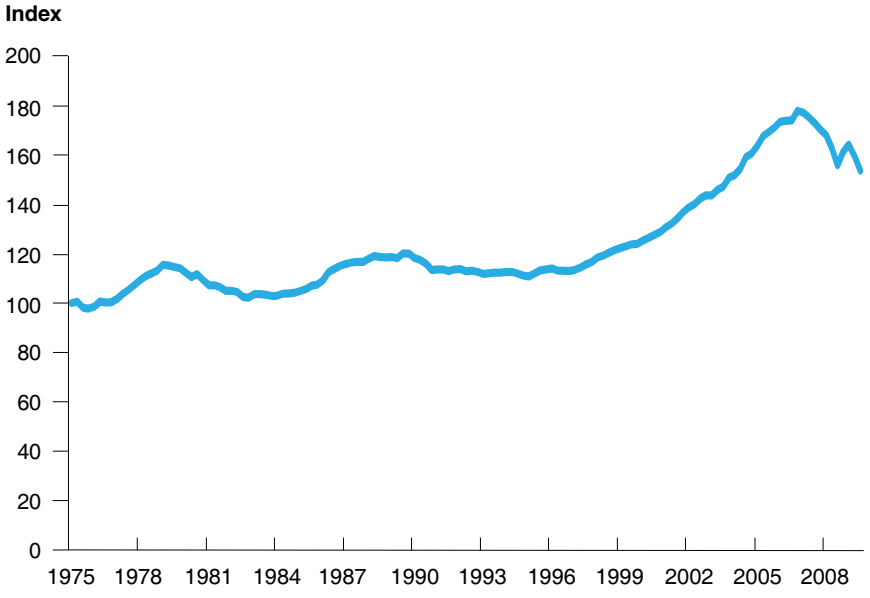
The recent increase and decline in the average house price have been accompanied by similar changes in the homeownership rate (Figure 2). The figure plots both the homeownership rate (left scale) and the average real house-price index (right scale), which was shown in Figure 1. Until the mid-1990s, about 64 percent of U.S. households lived in housing that they owned. But in 2005, the homeownership rate went up to 69 percent and then came down to 67 percent. Matthew Chambers, Carlos Garriga, and Don Schlagenhauf find that the increase is an outcome of demographic changes as well as developments in the mortgage loan market, in particular, the proliferation of new types of mortgage loans with low down-payment requirements and low introductory rates.

Although this article focuses on how and why the national average house price moves, it is important to keep in mind that behind the average house-price dynamics, there are substantial differences across regions of the U.S. (Figure 3). The Pacific, New England, and Middle Atlantic regions exhibit the most volatile movements. On the other hand, the average house price in the West-South Central region changed very little between 1975 and 2009. The house-price bubble and subsequent burst that we often hear about does not apply equally to all regions of the U.S. In general, the regions that experienced a larger increase in house prices are also experiencing a larger drop in house prices. The level of average house prices in regions with volatile house-price movements is still high compared with that in the mid-1990s.

House-price dispersion across U.S.

FIGURE 1

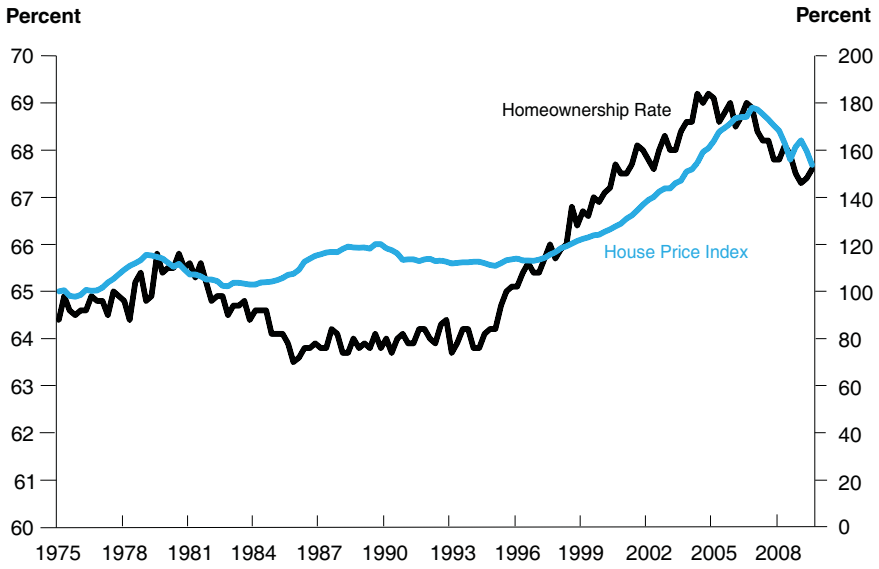
Real House Price Index for the U.S. (1975 = 100)



Data source: Federal Housing Finance Agency

FIGURE 2

Homeownership Rate and House Price

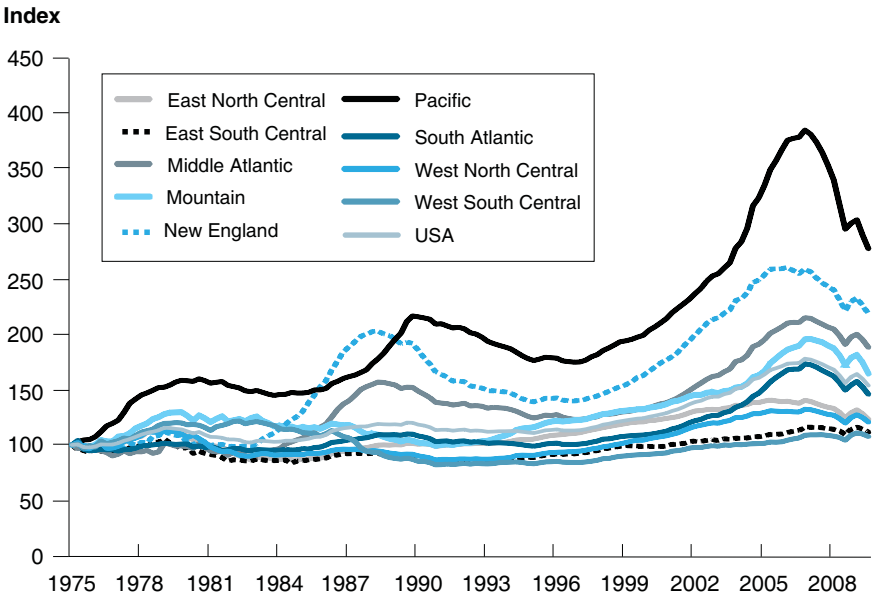


Data source: U.S. Census Bureau and Federal Housing Finance Agency

Note: Homeownership rate is computed by dividing the number of households living in owner-occupied housing units by the total number of households.

FIGURE 3

Real House Price Index for U.S. Regions (1975 = 100)



Data source: Federal Housing Finance Agency

cities also increased, and the dispersion across cities is even larger than the dispersion across regions. A study by Stijn Van Nieuwerburgh and Pierre-Olivier Weill focuses on this increasing dispersion of house prices across U.S. cities. They show that house-price dispersion across U.S. cities can increase when the dispersion of wages across cities increases. For example, higher house prices in San Francisco reflect the higher wages earned by people living in San Francisco.

Finally, let's look at the trend of average rents. It is important to know the dynamics of rents because, as mentioned above, the theory presented in this article suggests a strong link between house prices and rents. Figure 4 shows the trend of average real rents for primary residences since the 1970s. Like average house prices, average rents have gone up since the mid-1990s. However, the fluctuations are much less pronounced. The average annual growth rate of rents is 0.5 percent, compared with a 1.5 percent average annual growth rate of house prices. However, we need to be aware that rents have some measurement issues. In their study, Theodore Crone, Leonard Nakamura, and Richard Voith argue that the growth rate of rents has been higher than the official data suggest.

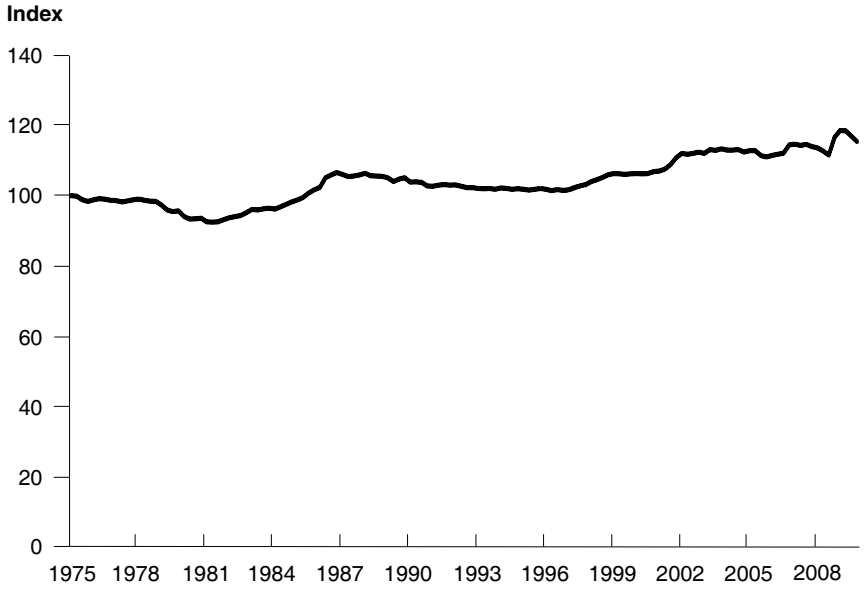
RECENT ATTEMPTS TO UNDERSTAND HOUSE-PRICE DYNAMICS

Because of their obvious importance, particularly in recent years, house-price dynamics have been an active area of research. Perhaps the most important question is, why did house prices go up substantially? Theories that attempt to explain rising housing prices can be placed into three groups.

The first group of studies deals with the inflexible nature of housing supply; it takes time to build a

FIGURE 4

Real Rent of Primary Residence (1975 = 100)



Data source: Bureau of Labor Statistics

Note: Real rent is computed by dividing the "rent of primary residences" (notice this does not include the imputed rents of owner-occupied housing) by the consumer price index (CPI) less shelter.

house, and land is not always available, especially in a city's center (think of Manhattan). Motivated by the observation that house prices went up more in metropolitan areas, where space is tighter, Edward Glaeser, Joseph Gyourko, and Raven Saks investigate the role of supply-side restrictions, such as land-use restrictions, in the recent house-price boom. They find that tightened housing-supply regulations played some role in generating an upward trend in house prices. Morris Davis and Jonathan Heathcote, in their study, break down the changes in house prices into changes in land prices and changes in the price of building materials and find that changes in land prices drive house-price dynamics. If the prices of building materials are volatile, it could explain at least a part of house-price dynamics, but they show that that is not the case. In another study, Nobuhiro Kiyotaki, Alexander Michaelides, and Kalin Nikolov look at the role that a limited supply of land plays in shaping house-price dynamics. Their model indicates that in an economy in which the total value of land is large relative to the total value of real estate (consisting of land and the structures built on it), house prices react more strongly to changes in the economy's economic growth or interest rate. We can interpret their result as confirming the importance of the limited availability of housing supply in shaping house-price dynamics.

The second group of theories investigates why demand for housing increased over time. In interesting but controversial work, Gregory Mankiw and David Weil argue that house prices are driven by demographic changes. When baby boomers were in their prime (30s and 40s), a time when people tend to buy bigger houses, total housing demand was larger. A natural consequence is that as baby boomers age and retire, housing demand and house prices decline. Whether and to what extent Mankiw and Weil's theory is true remains to be seen. In my 2005 study, I argued that demand for housing, especially owner-occupied housing, increases when income is more volatile. This is because housing is a big part of people's total wealth (housing made up about 40 percent of total wealth in 2004, according to the Survey of Consumer Finances), and it is natural for people to save more and prepare for bad times when income is more volatile. I find that a part of the rise in house prices can be attributed to the fact that individual wages have become more volatile since the 1970s.

The third group of theories focuses on the role of expectations in shaping house-price dynamics. The role of expectations might be important because house prices seem more volatile than factors that are naturally thought to affect house prices (often called *fundamentals*), such as income and mortgage rates. I will briefly describe three studies in this group. The *irrational exuberance* theory of Robert Shiller is the most well known.[2] If everybody thinks that house prices will go up, house prices could go up only because more people try to buy now, expecting capital gains from owning a house. When house prices are increasing only because people expect prices to go up, and not because the fundamental drivers of house prices are changing, the increase is commonly called a *bubble*. When increases in house prices are a bubble, there is no reason for prices to stay at a higher level.[3] If people suddenly start thinking that house prices will drop, house prices could actually

[2] See Robert Shiller's 2005 book. Shiller analyzes the U.S. housing market in his 2007 article.

[3] The *Business Review* article by Timothy Schiller analyzes the bubble hypothesis.

drop. Shiller discusses a variety of factors that contribute to bringing about such irrational exuberance, including cultural and psychological factors.

Monika Piazzesi and Martin Schneider look at survey evidence to analyze expectations. They use the Michigan Survey of Consumers, which is a useful data set for this purpose because it asks respondents about current and future house prices. According to Piazzesi and Schneider's study, the proportion of households that are optimistic about future house prices is about 9 percent, on average. However, what is more interesting is that they also find that the proportion of such optimistic households increased from 10 percent to 16 percent during the recent house-price boom. Motivated by this evidence, Piazzesi and Schneider propose a theory whereby some households' expectations are driven by *momentum*. When house prices are increasing for a while for some reason, these momentum households can keep house prices going up for a bit longer, because they believe that house prices will keep increasing, based on their recent experience, and they behave like households with irrational exuberance.

James Kahn proposes an alternative theory as to how house prices are linked to expectations. When the economy is growing faster, as in the 1990s, people's income increases faster, and thus, future rents rise faster. Notice that house prices today reflect future rents because if you buy a house today, you don't need to pay higher rents in the future. Therefore, if income, and thus rents, are expected to grow faster, people try to buy rather than rent a house today. Consequently, house prices go up today just because of a positive change in expectations about future income growth. According to Kahn's theory, expectations for sustained high income growth were the driving force for the recent increase in house prices.

How are the various studies presented above related to the user-cost theory of house prices that I will present? In what follows, a rising trend in rents, which is consistent with the combination of inflexible supply and growing demand for housing, and expectations for future house-price growth will be important in generating house-price growth. I will use these factors similar to the way they're used in a study by James Poterba and another by Charles Himmelberg, Christopher Mayer, and Todd Sinai. The latter study, using the same approach employed in this article, concludes that "as of the end of 2004, our analysis reveals little evidence of a housing bubble." Himmelberg and co-authors also look at differences in house-price dynamics across U.S. cities, while this article focuses on movements in average house prices nationally. This article also emphasizes the importance of expectations in driving house prices.

The user-cost theory is based on two elements: how user costs are determined, and the equivalence between user costs and rents.

THEORY OF THE USER COSTS OF HOUSING AND RENTS

The user-cost theory is based on two elements: how user costs are determined, and the equivalence between user costs and rents. Let's look at these elements one at a time.

User costs are the costs of owning a house for a year instead of renting it. What are the components of user costs? As explained by Poterba and by Himmelberg and co-authors, there are five major components of the user costs of housing. First, there is the interest cost, which can be interpreted in two ways. If a person buys a house with a mortgage loan, he has to pay interest on the mortgage every year. The total mortgage interest payment is approximately the annual mortgage interest rate multiplied by the house's value (house price). However, some people buy houses without mortgage loans. Even if a person buys a house without taking out a mortgage, there is an *opportunity cost*, which is the profit missed by taking one action over another. In the current context, he loses the interest income that he would have earned if he had saved and invested the money instead of using the money to buy a house. The forgone interest income can be expressed as the interest rate multiplied by the house's value (house price). In either case, the interest cost can be represented as the house price times the annual interest rate.

Second, homeowners are required to pay property taxes. Since property taxes also depend on the house's value, property tax payments can be computed as the house price times the property tax rate.

Third, in the U.S., homeowners can deduct mortgage interest payments and property tax payments from their taxable income, up to some limit.[4] This deduction indirectly reduces the cost of ownership. The benefit derived from the deduction can be represented as the sum of mortgage interest payments and property tax payments multiplied by the deduction rate.

Fourth, homeowners have to pay

[4] The amount of mortgage interest payment deduction is capped at the interest on the first $1 million in mortgages.

for maintenance and repairs. It is also natural to assume that the cost is approximately proportional to the house's value. A bigger or more valuable house requires more money for maintenance and repairs.

Finally, expectations about future changes in house prices affect user costs today, even before the changes are realized. For example, suppose you expect that the value of your house will drop by 5 percent in the near future. That means that you will lose 5 percent of the house's value by keeping the house. The expected cost of owning would be higher, taking this future 5 percent loss into account. On the other hand, if you expect that the house's price will go up by 10 percent, this makes owning profitable by exactly 10 percent of the house's value. Thus, the cost of owning a house, taking into account the expected gain just by holding on to it, will decrease by the same amount. In sum, a change in the expected future value of the house has the effect of indirectly changing user costs.

How can we use these components of user costs to understand house-price dynamics? This is where the other important element of our theory — the close relationship between user cost and rent — comes into play. If there is a house that can be either rented or purchased, the cost of renting the house must be close to the user costs if the house is owned. Why? If the rent is much higher than the user costs, somebody can buy the house, rent it out, and make a profit because the costs of owning and maintaining the house (user costs) are lower than the income from renting the house (rent). Under this circumstance, demand for housing will rise as people try to buy houses and exploit the opportunity, and this pushes up house prices. On the other hand, if the rent is much lower than the user costs, the opposite is likely to happen: A homeowner can save money by selling his house and renting one instead. If there are a lot of people trying to sell their houses and rent, house prices would fall, reflecting the weak demand for housing. In the end, we should expect that user costs and rents will end up close to each other when houses are both rented and purchased.[5] We will use this (approximate) closeness between user costs and rents to examine how house prices are affected by changes in interest rates, rents, and so forth.

From the discussion above, we know how user costs are determined, and we also know that user costs should be close to rents. In addition, all of the major components of user costs — interest cost, property taxes, deduction of mortgage interest payments, maintenance and repair costs, and expectations about future changes in house prices — are approximately proportional to house prices. In other words, in general, all of the components will be larger if the house price is higher. Now, consider a normal situation in which user costs are equal to rents. Suppose the interest rate goes up. Since the interest cost is a part of the user cost, when the interest rate goes up, user costs should go up if nothing else changes. However, as discussed above, when the user cost exceeds rent, it is beneficial for homeowners to sell their house and rent instead. This decline in demand for housing would put downward pressure on house prices, bringing house prices and thus user costs back to their initial level. As a result, user costs and rents will be equalized, with a higher interest rate and lower house prices.

Let's look at another example. What happens if rents turn out to be higher than in the normal situation, but other things remain unchanged? When rents are higher than user costs, renters would become homeowners and save money. This would push up housing prices. House prices would rise until user costs and rents are balanced again. In summary, here's how each element in user costs and rents is related to house prices: House prices are higher when rents are higher, interest rates are lower, property tax rates are lower, the tax deduction rate is higher, maintenance and repair costs are lower, and house prices are expected to rise in the future. (See *User Cost-Rent Equivalence* for a more formal representation of the theory.)

However, these relationships are valid only when all other things do not change. For example, suppose the government decides to raise the property tax rate. Higher property taxes mean higher user costs and lower house prices, if nothing else has changed. However, a landlord's natural response might be to increase rents so that (at least a part of) the additional property tax is passed on to the tenants. When rents and the property tax rate both increase, it is hard to say what should happen to house prices, according to our theory.

THEORY MEETS DATA

Now let's look at how three of the six elements that affect user costs — rents, interest rates, and expected changes in house prices — have changed over time and discuss whether and to what extent such changes help us rationalize the changes in house prices. I do not discuss the other three — property tax rate, tax deductions,

[5] In the language of finance and economics, this condition, which indicates that prices of substitutable things should be close to each other, is called an arbitrage-free condition: Nobody can make a profit by taking advantage of the price difference between two assets (arbitrage), because the prices will adjust to eliminate the arbitrage opportunity.

and maintenance and repair costs — since it is hard to capture changes in the trends of these factors.[6]

Rents. As we saw in Figure 4, house prices and rents tend to move together (for example, look at the early 1980s). These synchronized dynamics are exactly what the equivalence between user costs and rents would suggest. Although rents have been less volatile than house prices, real rents and real house prices, on average, have been steadily increasing over time. To understand why, we will look at both the supply side and the demand side. On the supply side, a natural answer is the limited supply of land, especially in and around metropolitan areas. House prices and rents are increasing because the land on which houses and apartments are built has become more and more scarce. The two studies mentioned earlier — the one by Edward Glaeser and his co-authors and the one by Nobuhiro Kiyotaki and his co-authors — find evidence that supports the importance of the limited availability of land for the rising trend in house prices. On the demand side, it is natural that house prices and rents increase when the supply cannot adjust flexibly and the population — and therefore demand — is growing. That is the implication of the work by Mankiw and Weil reviewed earlier. My own research, cited earlier, supports the notion that demand for housing increases when individual income is becoming more volatile. When the availability of land, and thus housing, is limited, such an increase in demand pushes up house prices.

Interest Rates. Let's look at the interest rate, which is the second element that affects user costs. Figure 5 shows two types of interest rates: a 30-year fixed-rate conventional mortgage interest rate and the interest rate on 10-year Treasury securities. Thirty-year fixed-rate conventional mortgage loans are the type of mortgage loans the majority of homeowners obtain when purchasing a house. According to the American Housing Survey, in 2005 90 percent of U.S. primary mortgages were fixed-rate mortgage loans.

As easily seen in Figure 5, both interest rates have been dropping steadily since the early 1980s. According to the theory of user costs and rents, when the interest rate is declining, so is the user cost of owning a house, and house prices will increase.

Moreover, the effect of changes in interest rates on house prices becomes stronger when the interest rate is lower. For example, suppose the mortgage interest rate declines from 2 percent to 1 percent. This 1 percentage point decline in the interest rate halves the interest rate and, thus, the interest cost. On the other hand, suppose the interest rate drops from 10 percent to 9 percent. Although the interest rate drops by 1 percentage point again, this reduces the interest cost by only one-tenth.

Expected Changes in House Prices. The third element that determines user costs is expectations. Although expectations about future changes in house prices are difficult to measure precisely, the literature discussed earlier supports the idea that people might have expected possibly rapid increases in house prices to continue in the future, especially from the mid 1990s through 2006. These expectations lowered the user cost of housing and resulted in an increase in house prices.

In summary, there is evidence to suggest that rents gained consistently, interest rates fell steadily, and people

User Cost-Rent Equivalence

Formally, the equivalence between user costs and rents can be written in the following way:

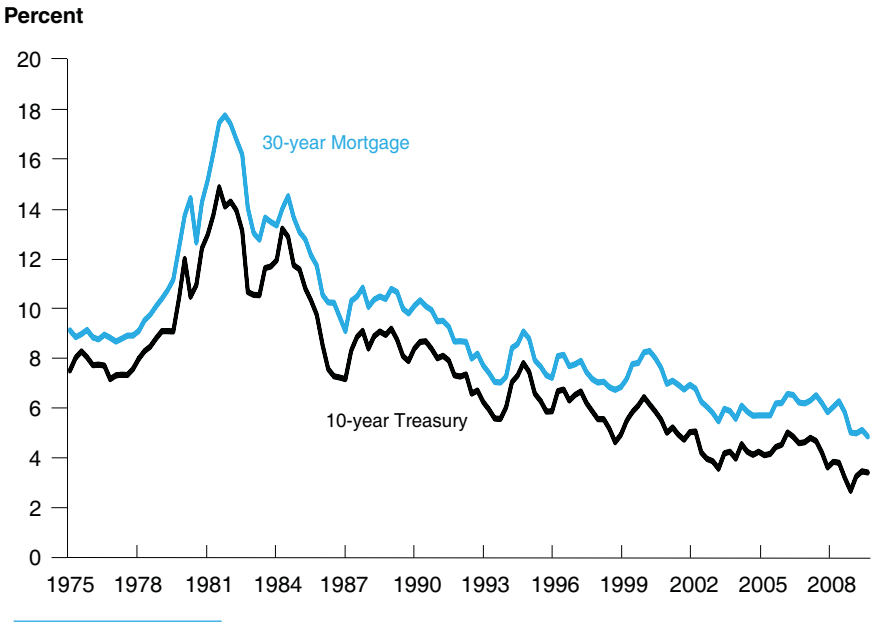
Rent = User cost = (Interest rate + Property tax rate – (Mortgage interest rate + Property tax Rate) * Tax deduction rate + Maintenance cost rate – Expected rate of capital gain) * House price

For the simple exercise on page 27, I set the parameters as follows. The property tax rate is set at 1.5 percent per year. Maintenance and repair costs are set at 2.5 percent of house value per year. The tax deduction rate is set at 25 percent. These are the numbers used in the study by Charles Himmelberg, Christopher Mayer, and Todd Sinai. The expected nominal house-price growth rate is set at 3.7 percent per year, which is the average between 1975 and 2004. Finally, I add 2 percent as the risk premium of owning instead of renting, following Himmelberg and co-authors. Rents are 102 in 1997 (normalized such that the 1975 level is 100) and 115 in 2007. The interest rate is 6.6 percent in 1997 and 4.7 percent in 2007.

[6] Property tax rates differ state by state, and thus, it is hard to capture the trend of the *average* property tax rate. The effect of tax deductions on house prices is difficult to measure because the federal income tax features a progressive structure and various kinds of deductions and exemptions. Moreover, there has been no clear trend in terms of different levels of the income tax rate since 1975. Finally, there has been no substantial change in maintenance and repair costs.

FIGURE 5

Mortgage and Treasury Interest Rates



Data source: Federal Home Loan Mortgage Corporation and Board of Governors of the Federal Reserve System

expected strong growth in house prices between the mid-1990s and the mid-2000s. According to the theory presented in this article, these elements are consistent with rising house prices during the same period. Moreover, if we were to observe the opposite — that is, rents falling, interest rates rising, and expected house prices falling — the user-cost theory would suggest that it would not be surprising to see house prices decrease.

A NUMERICAL EXAMPLE

By combining the user-cost theory and the actual data on rents and interest rates described above, we can generate house-price dynamics implied by the theory and the data. By comparing the actual house-price data and the data implied by the theory, we can learn to what extent the theory helps us understand house-price dynamics.

As an example, let's look at the question of how much of the observed rapid increase in house prices between 1997 and 2007 can be explained by the user-cost theory. As explained above, the combination of steadily increasing rents and declining interest rates is consistent with an upward trend in house prices. We basically follow the strategy of Himmelberg and co-authors in setting numbers for this exercise. (More details can be found in *User Cost-Rent Equivalence*.) An important assumption is the expected growth rate of house prices. Let's assume that people expect that a nominal house-price growth rate of 3.7 percent per year will continue. This is the average house-price growth rate between 1975 and 2005. Notice that this is a rather conservative assumption because this growth rate is lower than the growth rate we observed between the 1990s and early 2000s.

The user-cost theory, combined with the observed changes in rents and interest rates and a moderate assumption about expectations, implies that house prices went up by an average of 3.3 percent per year (39 percent between 1997 and 2007). This increase is smaller than 4.2 percent, which is the actual annual growth rate in average house prices from 1997-2007 (51 percent during the entire period). The simple theory of user costs accounts for about 80 percent of the growth rate of house prices during the period. The unexplained part might be due to changes in expectations or innovations in the mortgage market, such as the introduction of new types of mortgage instruments.

How sensitive is the result to a different assumption about the expected growth rate of house prices? For example, if we assume a low expected house-price growth rate of 1.85 percent per year (which is half of 3.7 percent), our theory implies that house prices went up by 2.8 percent per year between 1997 and 2007 — lower than 3.3 percent but still a large proportion of the observed 4.2 percent annual growth rate during the same period.

Finally, let me briefly discuss the recent sudden reversal of the trend in house prices. The numerical example generates a sudden reversal of the trend when there is a sudden reversal in expectations about the future trend of house prices. For example, suppose, in 2007, the expected annual growth rate of house prices suddenly dropped from 3.7 percent to zero, but everything else remained the same. Then the house price suggested by the model becomes 12 percent lower. The size of the drop is exactly the same as the drop in the national average house price index between 2007 and the third quarter of 2009. The change in expectations can be related to changes in fundamentals (for example, prospects for future income growth may have suddenly become bleak with the

economy slowing down) or it could be unrelated to changes in fundamentals (for example, the bursting of a bubble). We need a dynamic model that incorporates expectations to systematically analyze the sudden reversal in the trend, and many attempts, some of which are mentioned in this article, are being made to improve our understanding in this area.

CONCLUSION

This article presents a simple theory of house prices based on the equivalence between user costs and rents. Although it is a simple relationship, the theory tells how different types of housing market data are related to each other. For example, we use the theory to show that the observed increase in house prices since the mid-1990s is consistent with the increase in rents, declining interest rates, and reasonable expectations about future house-price growth. The theory indicates that the sudden reversal of the trend in house-price growth is related to changes in expectations.

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TOOLS FOR ASSESSING MULTIVARIATE ASPECTS OF BAYESIAN DSGE MODELS

This paper develops and applies tools to assess multivariate aspects of Bayesian dynamic stochastic general equilibrium (DSGE) model forecasts and their ability to predict co-movements among key macroeconomic variables. The authors construct posterior predictive checks to evaluate the calibration of conditional and unconditional density forecasts, in addition to checks for root-mean-squared errors and event probabilities associated with these forecasts. The checks are implemented on a three-equation DSGE model as well as the Smets and Wouters (2007) model using real-time data. They find that the additional features incorporated into the Smets-Wouters model do not lead to a uniform improvement in the quality of density forecasts and prediction of co-movements of output, inflation, and interest rates.

Working Paper 11-5, "Evaluating DSGE Model Forecasts of Co-movements," Edward Herbst, University of Pennsylvania, and Frank Schorfheide, University of Pennsylvania, and Visiting Scholar, Federal Reserve Bank of Philadelphia

EXPLAINING FLUCTUATIONS IN TRADE DURING THE RECENT RECESSION

The authors examine the source of the large fall and rebound in U.S. trade in the recent recession. While trade fell and rebounded more than expenditures or production of traded goods, they find that relative to the magnitude of the downturn, these trade fluctuations were in line with those in previous business cycle fluctuations. The authors argue that the high volatility of trade is attributed to more severe inventory management considerations of firms involved in international trade. They present empirical evidence for autos as well as at the aggregate level that the adjustment of inventory holdings helps explain these fluctuations in trade.

Working Paper 11-6, "U.S. Trade and Inventory Dynamics," George Alessandria, Federal Reserve Bank of Philadelphia; Joseph P. Kaboski, University of Notre Dame; and Virgiliu Midrigan, New York University

RECENT ADVANCES IN THE ESTIMATION AND EVALUATION OF DSGE MODELS

Estimated dynamic stochastic equilibrium (DSGE) models are now widely used for empirical research in macroeconomics as well as for quantitative policy analysis and forecasting at central banks around the world. This paper reviews recent advances in the estimation and evaluation of DSGE models, discusses current challenges, and provides avenues for future research.

Working Paper 11-7, "Estimation and Evaluation of DSGE Models: Progress

and Challenges," by Frank Schorfheide, University of Pennsylvania, and Visiting Scholar, Federal Reserve Bank of Philadelphia

MEASURING THE EFFECT OF EXTENSIONS OF UNEMPLOYMENT INSURANCE ON THE UNEMPLOYMENT RATE

This paper measures the effect of extensions of unemployment insurance (UI) benefits on the unemployment rate using a calibrated structural model that features job search and consumption-saving decision, skill depreciation, UI eligibility, and UI benefit extensions that capture what has happened during the current downturn. The author finds that the extensions of UI benefits contributed to an increase in the unemployment rate by 1.2 percentage points, which is about a quarter of an observed increase during the current downturn (a 5.1 percentage point increase from 4.8 percent at the end of 2007 to 9.9 percent in the fall of 2009). Among the remaining 3.9 percentage points, 2.4 percentage points are due to the large increase in the separation rate, while the staggering job-finding probability contributes 1.4 percentage points. The last extension in December 2010 moderately slows down the recovery of the unemployment rate. Specifically, the model indicates that the last extension keeps the unemployment rate higher by up to 0.4 percentage point during 2011.

Working Paper 11-8, "A Quantitative Analysis of Unemployment Benefit Extensions," Makoto Nakajima, Federal Reserve Bank of Philadelphia

FIXED VS. FLOATING EXCHANGE RATES: A RECONSIDERATION OF THE CONVENTIONAL WISDOM

According to conventional wisdom, fiscal policy is more effective under a fixed than under a flexible exchange rate regime. In this paper the authors reconsider the transmission of shocks to government spending across these regimes within a standard New Keynesian model of a small open economy. Because of the stronger emphasis on intertemporal optimization, the New Keynesian framework requires a precise specification of fiscal and monetary policies, and their interaction, at both short and long horizons. The authors derive an analytical characterization of the transmission mechanism of expansionary spending policies under a peg, showing that the long-term real interest rate always rises in response to an increase in government spending if inflation rises initially. This response drives down private demand even though short-term real rates fall. As this need not be the case under floating exchange rates, the conventional wisdom needs to be qualified. Under plausible medium-term fiscal policies, government spending is not necessarily less expansionary under floating exchange rates.

Working Paper 11-9, "Floats, Pegs, and the Transmission of Fiscal Policy," Giancarlo Corsetti, Cambridge University; Keith Kuester, Federal Reserve Bank of Philadelphia; and Gernot J. Müller, University of Bonn

USING NEW TIME SERIES TO STUDY THE UK ECONOMY DURING WORLD WAR I AND THE INTERWAR PERIOD

This article contributes new time series for studying the UK economy during World War I and the interwar period. The time series are per capita hours worked and average capital income, labor income, and consumption tax rates. Uninterrupted time series of these variables are provided for an annual sample that runs from 1913 to 1938. The authors highlight the usefulness of these time series with several empirical applications. The per capita hours worked data are used in a growth accounting exercise to measure the contributions of capital, labor, and productivity to output growth. The average tax rates are employed in a Bayesian model averaging experiment to reevaluate the Benjamin and Kochin (1979) regression.

Working Paper 11-10, "UK World War I and Interwar Data for Business Cycle and Growth Analysis," James M. Nason, Federal Reserve Bank of Philadelphia, and Shaun P. Vahey, Australian National University

COMPARING BORROWER OUTCOMES AFTER DIFFERENT TYPES OF CREDIT COUNSELING

This paper compares outcomes for borrowers who received face-to-face credit counseling with similarly situated consumers who opted for counseling via the telephone or Internet. Counseling outcomes are measured using consumer credit report attributes one or more years following the original counseling. The primary analysis uses data from a sample of 26,000 consumers who received credit counseling either in-person or via the telephone during 2003. A

second sample of 12,000 clients counseled in 2005 and 2006 was provided by one of the agencies to examine Internet delivery. Technology-assisted delivery was found to generate outcomes no worse — and at some margins better — than face-to-face delivery of counseling services.

Working Paper 11-11, "Is Technology-Enhanced Credit Counseling as Effective as In-Person Delivery?," John M. Barron, Purdue University, and Michael E. Staten, University of Arizona, and Visiting Scholar, Federal Reserve Bank of Philadelphia

EXPLORING THE LINK BETWEEN LENDERS' HOUSE-PRICE EXPECTATIONS AND SUBPRIME LENDING

This paper explores the link between the house-price expectations of mortgage lenders and the extent of subprime lending. It argues that bubble conditions in the housing market are likely to spur subprime lending, with favorable price expectations easing the default concerns of lenders and thus increasing their willingness to extend loans to risky borrowers. Since the demand created by subprime lending feeds back onto house prices, such lending also helps to fuel an emerging housing bubble. The paper, however, focuses on the reverse causal linkage, where subprime lending is a consequence rather than a cause of bubble conditions. These ideas are illustrated in a theoretical model, and empirical work tests for a connection between price expectations and the extent of subprime lending.

Working Paper 11-12, "Subprime Mortgages and the Housing Bubble," Jan K. Brueckner, University of California—Irvine; Paul S. Calem, Board of Governors of the Federal Reserve System; and Leonard I. Nakamura, Federal Reserve Bank of Philadelphia

HOW IS THE RISKINESS OF THE POOL OF HELOC ORIGINATIONS AFFECTED OVER THE CREDIT CYCLE?

The authors empirically study how the underlying riskiness of the pool of home equity line of credit originations is affected over the credit cycle. Drawing from the largest existing database of U.S. home equity lines of credit, they use county-level aggregates of these loans to estimate panel regressions on the characteristics of the borrowers and their loans, and competing risk hazard regressions on the outcomes of the loans. The authors show that when the expected unemployment risk of households increases, riskier households tend to borrow more. As a consequence, the pool of households that borrow on home equity lines of credit worsens along both observable and unobservable dimensions. This is an interesting example of a type of dynamic adverse selection that can worsen the risk characteristics of new lending, and suggests another avenue by which the precautionary demand for liquidity may affect borrowing.

Working Paper 11-13, "Credit Cycle and Adverse Selection Effects in Consumer Credit Markets: Evidence from the HELOC Market," Paul Calem, Board of Governors of the Federal Reserve System; Matthew Cannon, CoreLogic; and Leonard Nakamura, Federal Reserve Bank of Philadelphia

EFFECTS OF LENDERS' ACCESS TO INFORMATION ABOUT BORROWERS' PAST DEFAULTS

In many countries, lenders are restricted in their access to information about borrowers' past defaults. The authors study this provision in a model of repeated borrowing and lending with moral hazard and adverse selection. They analyze its effects on borrowers' incentives and access to credit and identify conditions under which it is optimal. The authors argue that "forgetting" must be the outcome of a regulatory intervention by the government. Their model's predictions are consistent with the cross-country relationship between credit bureau regulations and the provision of credit, as well as the evidence on the impact of these regulations on borrowers' and lenders' behavior.

Working Paper 11-14, "Bankruptcy: Is It Enough to Forgive or Must We Also Forget?," Ronel Elul, Federal Reserve Bank of Philadelphia, and Piero Gottardi, European University Institute

TRACKING THE PATTERNS OF HOME EQUITY WITHDRAWAL AMONG RETIREES

The authors study empirically and theoretically the patterns of home equity withdrawal among retirees, using a model in which retirees are able to own or rent a home, save, and borrow against home equity, in the face of idiosyncratic risks concerning mortality, health, medical expenditures, and household size and observed house price changes. The estimated model is found to successfully replicate the patterns of homeownership

and the saving/borrowing decisions of retirees. They use the estimated model for several counterfactual experiments. There are three main findings. First, the model predicts that a house price boom suppresses homeownership and increases borrowing, while a decline in house prices has the opposite effect. Second, the costs of home equity borrowing restrict the borrowing of retirees, and thus a reduction of such costs (e.g., lower costs of reverse mortgage loans) might significantly raise home equity borrowing. Third, there are two implications for the retirement saving puzzle. Although the cost of borrowing against equity in the house affects the borrowing of retirees, it does not affect total asset holding, implying that equity borrowing costs do not seem to offer a quantitatively significant contribution to resolving the retirement saving puzzle. On the other hand, the magnitude of the retirement saving puzzle might be exaggerated because a sizable part of "retirement saving" is due to house price appreciation.

Working Paper 11-15, "Home Equity Withdrawal in Retirement," Makoto Nakajima, Federal Reserve Bank of Philadelphia, and Irina A. Telyukova, University of California—San Diego

SOURCES OF THE DECLINE IN EMPLOYMENT VOLATILITY 1956-2002

This study documents a general decline in the volatility of employment growth during the period 1956 to 2002 and examines its possible sources. The authors use a panel design that exploits the considerable state-level variation in volatility during the period. The roles of monetary policy, oil prices, industrial employment shifts and a coincident index of business cycle variables are explored. Overall, these four variables taken together explain as much as 31 percent of the fluctuations in employment growth volatility. Individually, each of the four factors is found to have significantly contributed to fluctuations in employment growth volatility, although to differing degrees.

Working Paper 11-16, "The Long and Large Decline in State Employment Growth Volatility," Gerald Carlino, Federal Reserve Bank of Philadelphia; Robert DeFina, Villanova University; and Keith Sill, Federal Reserve Bank of Philadelphia