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The Crisis

ABSTRACT Geopolitical changes following the end of the Cold War induced a worldwide decline in real long-term interest rates that, in turn, produced home price bubbles across more than a dozen countries. However, it was the heavy securitization of the U.S. subprime mortgage market from 2003 to 2006 that spawned the toxic assets that triggered the disruptive collapse of the global bubble in 2007–08. Private counterparty risk management and official regulation failed to set levels of capital and liquidity that would have thwarted financial contagion and assuaged the impact of the crisis. This woeful record has energized regulatory reform but also suggests that regulations that require a forecast are likely to fail. Instead, the primary imperative has to be increased regulatory capital, liquidity, and collateral requirements for banks and shadow banks alike. Policies that presume that some institutions are "too big to fail" cannot be allowed to stand. Finally, a range of evidence suggests that monetary policy was not the source of the bubble.

I. Preamble

The bankruptcy of Lehman Brothers in September 2008 precipitated what, in retrospect, is likely to be judged the most virulent global financial crisis ever. To be sure, the contraction in economic activity that followed in its wake has fallen far short of the depression of the 1930s. But a precedent for the virtual withdrawal, on so global a scale, of private short-term credit, the leading edge of financial crisis, is not readily evident in our financial history. The collapse of private counterparty credit surveillance, fine-tuned over so many decades, along with the failure of the global regulatory system, calls for the thorough review by governments and private risk managers now under way.

The central theme of this paper is that in the years leading up to the crisis, financial intermediation tried to function on too thin a layer of capital, owing to a misreading of the degree of risk embedded in ever-more-complex financial products and markets. Section II of the paper reviews the causes of the crisis. In section III the nature of financial intermediation is probed. In section IV a set of reforms is proposed that, I trust, address the shortcomings of the existing regulatory structure. In section V the role of monetary policy in the crisis is examined. I offer some conclusions in section VI.

II. Causes of the Crisis

II.A. The Arbitraged Global Bond Market and the Housing Crisis

The global proliferation of securitized, toxic U.S. subprime mortgages was the immediate trigger of the crisis. But the origins of the crisis reach back, as best I can judge, to the aftermath of the Cold War.[1] The fall of the Berlin Wall exposed the economic ruin produced by the Soviet bloc's economic system. In response, competitive markets quietly, but rapidly, displaced much of the discredited central planning so prevalent in the Soviet bloc and the then Third World.

A large segment of the erstwhile Third World nations, especially China, replicated the successful export-oriented economic model of the so-called Asian Tigers (Hong Kong, Singapore, South Korea, and Taiwan): fairly well educated, low-cost workforces, joined with developed-world technology and protected by increasingly widespread adherence to the rule of law, unleashed explosive economic growth.[2] The International Monetary Fund (IMF) estimated that in 2005 more than 800 million members of the world's labor force were engaged in export-oriented and therefore competitive markets, an increase of 500 million since the fall of the Berlin Wall.[3] Additional hundreds of millions became subject to domestic competitive forces, especially in the former Soviet Union. As a consequence, between 2000 and 2007 the real GDP growth rate of the developing world was almost double that of the developed world.

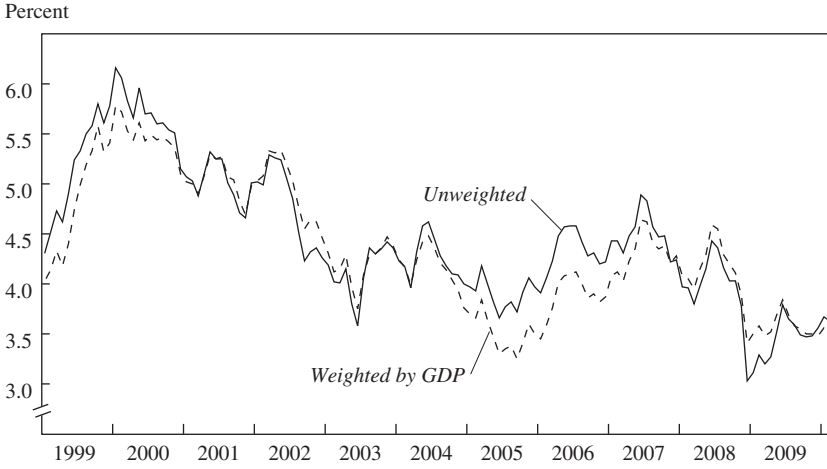
Consumption in the developing world, however, restrained by culture and inadequate consumer finance, could not keep up with the surge of income, and consequently the saving rate of the developing world soared from 24 percent of nominal GDP in 1999 to 34 percent by 2007, far out-

1. For a more detailed explanation see Greenspan (2007, chapter 20).

2. Foreign direct investment in China, for example, rose gradually from 1980 to 1990, but then rose 39-fold by 2007.

3. IMF, *World Economic Outlook,* April 2007, chapter 5, p. 162.

Figure 1. Nominal Yields on 10-Year Government Debt, Average for 15 Countries, 1999–2010[a]



Source: Various country sources.

a. The countries are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

stripping its investment rate. With investment elsewhere in the world slow to take up the slack, the result was a pronounced fall from 2000 to 2005 in global long-term interest rates, both nominal (figure 1) and real.

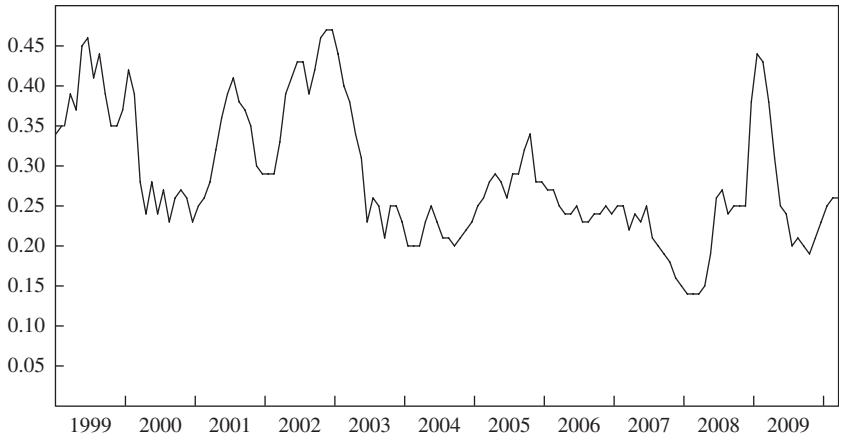
Although the decline in global interest rates indicated, of necessity, that global saving intentions were chronically exceeding global intentions to invest, ex post global saving and investment rates in 2007, overall, were only modestly higher than in 1999, suggesting that the uptrend in the saving intentions of developing economies tempered declining investment intentions in the developed world.[4] Of course, whether it was a glut of intended saving or a shortfall of investment intentions, the conclusion is the same: real long-term interest rates had to fall.

Inflation and long-term interest rates in all developed economies and the major developing economies had by 2006 converged to single digits, I believe for the first time ever. The path of the convergence is evident in the unweighted average variance of interest rates on 10-year sovereign debt of 15 countries: that average declined markedly from 2000 to 2005 (figure 2).[5]

4. That weakened global investment was a major determinant in the decline of global real long-term interest rates was also the conclusion of a March 2007 Bank of Canada study (Desroches and Francis 2007).

5. The variance of the logarithms of the 15 long-term interest rates exhibits similar trends.

Figure 2. Variance of Interest Rates: 10-Year Government Debt in 15 Countries, 1999–2010[a]



Source: Various country sources.
a. Unweighted average for the 15 countries in figure 1.

Equity and real estate capitalization rates were inevitably arbitraged lower by the fall in global long-term real interest rates. Asset prices, particularly home prices, accordingly moved dramatically higher.

The Economist's surveys document the remarkable convergence of nearly 20 individual nations' home price rises during the past decade.[6] Japan, Germany, and Switzerland (for differing reasons) were the only important exceptions. U.S. home price gains, at their peak, were no more than the global peak average.[7] In short, geopolitical events ultimately led to a fall in long-term mortgage interest rates that in turn led, with a lag, to the boom in home prices globally.

II.B. Securitization of Subprimes: The Crisis Story Unfolds

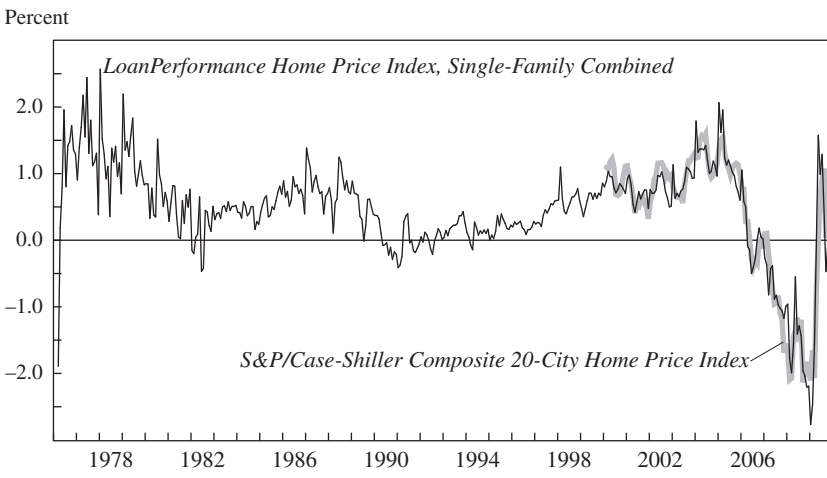
The subprime mortgage market that developed in the 1990s was a small but generally successful market of largely fixed-rate mortgages. It serviced mainly those potential homeowners who could not meet the down payment requirement of a prime loan, but still had income adequate to handle a fixed-rate mortgage.[8] Only a modest amount had been securitized, but with

6. For example, *The Economist,* "Finance and Economics: Houses Built on Sand," September 15, 2007, p. 104.

7. IMF, *World Economic Outlook,* April 2008, chapter 3, p. 113.

8. As recently as 2002, subprime mortgages accounted for 7 percent of total originations.

Figure 3. Monthly Changes in Home Prices, 1976–2010[a]



Source: Author's calculations based on data from LoanPerformance and Standard & Poor's.
a. Both series are seasonally adjusted.

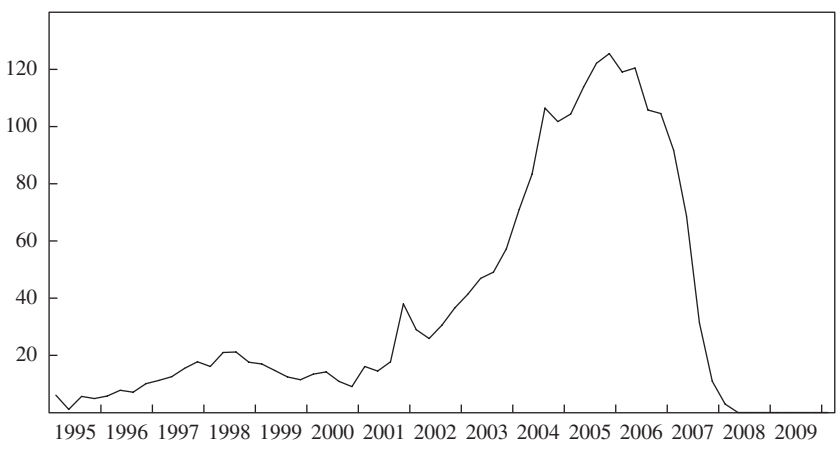
home prices having risen at a quickening pace since 1997 (figure 3), subprime lending was seen as increasingly profitable to investors.

Belatedly drawn to this market, financial firms, starting in late 2003, began to accelerate the pooling and packaging of subprime mortgages into securities (figure 4). The firms clearly had found receptive buyers. Heavy demand from Europe,[9] in the form of subprime mortgage-backed collateralized debt obligations, was fostered by attractive yields and a foreclosure rate on the underlying mortgages that had been in decline for 2 years.

An even heavier demand was driven by the need of Fannie Mae and Freddie Mac, the major U.S. government-sponsored enterprises (GSEs), pressed by the Department of Housing and Urban Development and

9. That many of the investors were European was confirmed by the recent heavy losses on U.S. mortgages reported by European investors. Euro-area banks, for example, exhibit a very high ratio of residential mortgage-backed securities write-downs to the residential mortgage loans they hold (IMF, *Global Financial Stability Report,* October 2009, p. 10). The size of the buildup of subprime securities holdings abroad during the bubble years is unclear. The U.S. Treasury's annual Foreign Holdings Survey reports that by mid-2006, foreign investors held $341 billion of privately issued U.S. mortgage-backed securities, some of which were commercial mortgage-backed securities. The less detailed mid-2002 survey reported a total for all asset-backed securities of $169 billion, compared with $594 billion in mid-2006.

Figure 4. Issuance of Subprime Mortgage-Backed Securities, 1995–2010[a]



Source: *Inside Mortgage Finance.*
a. Quarterly data, seasonally adjusted.

Congress to meet expanded "affordable housing goals."[10] Given the size of the GSEs' expanded commitments to fund low- and moderate-income housing, they had few alternatives but to invest, wholesale, in subprime securities. The GSEs accounted for an estimated 42 and 49 percent of all newly purchased subprime mortgage securities (almost all at adjustable interest rates) retained on investors' balance sheets during 2003 and 2004, respectively (table 1).[11] That was more than five times their estimated share in 2002.

Increasingly, the extraordinary demand pressed against the limited supply of qualified potential subprime borrowers. To reach beyond this limited population, securitizers unwisely prodded subprime mortgage originators to offer adjustable-rate mortgages (ARMs) with initially lower monthly pay-

10. In October 2000 HUD finalized a rule "significantly increasing the GSEs' affordable housing goals" for each year from 2001 to 2003. In November 2004 the annual housing goals for 2005 and beyond were raised still further (Office of Policy Development and Research 2001).

11. Federal Housing Finance Agency, *2008 Annual Report to Congress* (revised), Historical Data Tables 5b, Part 2, and 14b, Part 2 (originally published May 18, 2009, and updated to include a significant reclassification effective September 3, 2009). Before the revision, I estimated the share at less than 30 percent. Data newly reclassified by Fannie Mae account for almost all the revision.

Table 1. Holdings and Market Shares of Subprime Mortgage-Backed Securities by Fannie Mae and Freddie Mac, 2000–08

			Fannie Mae and Freddie Mac single-family private-label mortgages retained in their portfolios[a]			
					Change from end of previous year	
Year	*Total subprime MBSs outstanding (billions of dollars)*	*Change in total subprime MBSs outstanding (billions of dollars)*	*Billions of dollars*	*As percent of total subprime MBSs outstanding*	*Billions of dollars*	*As percent of change in total subprime MBSs outstanding*
2000	88.7					
2001	119.0	30.3	19.0	16.0		
2002	186.2	67.2	24.7	13.3	5.7	8.5
2003	280.8	94.6	64.9	23.1	40.1	42.4
2004	456.5	175.7	150.6	33.0	85.8	48.8
2005	644.3	187.8	179.2	27.8	28.6	15.2
2006	800.9	156.6	169.0	21.1	−10.2	−6.5
2007	774.0	−26.9	133.4	17.2	−35.6	132.5
2008	605.4	−168.6	99.4	16.4	−34.0	20.1

Sources: Federal Housing Finance Agency, *2008 Report to Congress* (revised), LoanPerformance data, and author's calculations.

a. Fannie Mae publishes its subprime securities holdings for each year from 2002 to 2008. For 2001 the sum of subprime and alt-A holdings is approximately reported, with the division between them guided by shares of total outstanding subprime and alt-A mortgage-backed securities (MBSs). Freddie Mac publishes similar data for 2006–08. With minor assumptions, estimates are made for the sum of subprime and alt-A holdings for earlier years. The separation is made essentially to reflect the ratio of total outstanding subprime and alt-A MBSs.

ments. As loan underwriting standards deteriorated rapidly, ARMs soared to nearly 62 percent of first-mortgage subprime originations by the second quarter of 2007.[12] By 2005 and 2006,[13] subprime mortgage originations had swelled to a bubbly 20 percent of all U.S. home mortgage originations, almost triple their share in 2002.

By the first quarter of 2007, virtually all subprime mortgage originations were being securitized, compared with less than half in 2000,[14] and subprime mortgage securities outstanding totaled more than $800 billion, almost seven times their level at the end of 2001. The securitizers, profitably packaging this new source of paper into mortgage pools and armed with what turned out, in retrospect, to be grossly inflated credit ratings, were able to sell seemingly unlimited amounts of these securities into what appeared to be a vast and receptive global market.

II.C. A Classic Euphoric Bubble Takes Hold

As a measure of how far the appetite for risk taking beyond the securitized mortgage market had gone, long-sacrosanct debt covenants were eased as a classic euphoric global bubble took hold.[15] By 2007, yield spreads in debt markets overall had narrowed to a point where there was little room for further underpricing of risk. Our broadest measure of credit risk, the yield spread of bonds rated CCC or lower and 10-year Treasury notes, fell to a probable record low in the spring of 2007, although only marginally so (figure 5). Almost all market participants of my acquaintance were aware of the growing risks, but also cognizant that risk had often remained underpriced for years. I had raised the specter of "irrational exuberance" over a decade before (Greenspan 1996), only to watch the dot-com boom, after a one-day stumble, continue to inflate for 4 more years, unrestrained by a cumulative increase of 350 basis points in the federal funds rate from 1994 to 2000. Similarly in 2002, I expressed my concerns before the Federal Open Market Committee (FOMC) that ". . . our

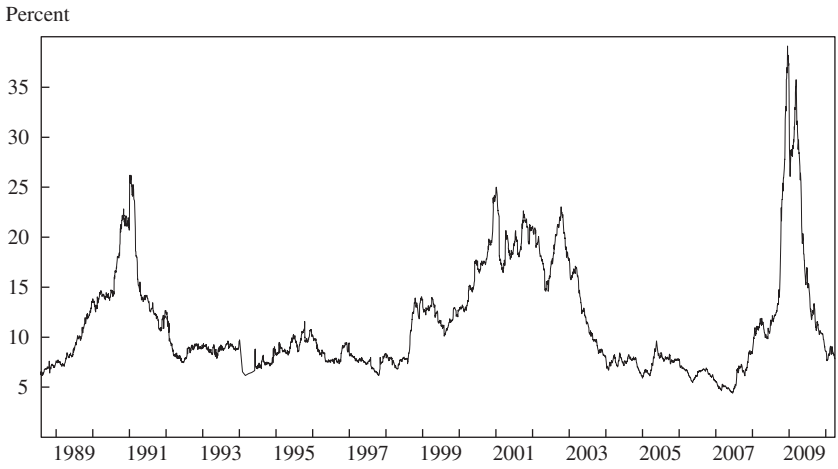
12. Data are from the Mortgage Bankers Association (Haver Analytics).

13. We at the Federal Reserve were aware earlier in the decade of incidents of some highly irregular subprime mortgage underwriting practices. But regrettably, we viewed it as a localized problem subject to standard prudential oversight, not the precursor of the securitized subprime mortgage bubble that was to arise several years later.

14. Inside Mortgage Finance Publications, *The 2009 Mortgage Market Statistical Annual,* vol. I, p. 4, and vol. II, p. 13.

15. These covenants are restrictions put on a borrower by a lender that might, for example, restrict other borrowings, the level of working capital, or debt service cover.

Figure 5. Yield Spread of Bonds Rated CCC and Lower over 10-Year Treasury Notes, 1988–2010[a]



Source: Bank of America Merrill Lynch, Federal Reserve.

a. Average yield on Bank of America Merrill Lynch high-yield cash pay bonds rated CCC and lower minus yield on 10-year Treasury notes at constant maturity.

extraordinary housing boom . . . financed by very large increases in mortgage debt, cannot continue indefinitely." It lasted until 2006.[16]

Clearly, with such experiences in mind, financial firms were fearful that should they retrench too soon, they would almost surely lose market share, perhaps irretrievably. Their fears were given expression in Citigroup chairman and CEO Charles Prince's now-famous remark in 2007, just before the onset of the crisis: "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."[17]

The financial firms accepted the risk that they would be unable to anticipate the onset of crisis in time to retrench. They believed, however, that the seemingly insatiable demand for their array of exotic financial products would enable them to sell large parts of their portfolios without loss. They

16. The failure to anticipate the length and depth of the emerging bubble should not have come as a surprise. Although we like to pretend otherwise, policymakers, and indeed forecasters in general, are doing exceptionally well if we can get market projections essentially right 70 percent of the time. But that means we get them wrong 30 percent of the time. In 18½ years at the Federal Reserve, I certainly had my share of the latter.

17. Michiyo Nakamoto and David Wighton, "Citigroup Chief Stays Bullish on Buy-Outs," *Financial Times,* July 9, 2007.

were mistaken. They failed to recognize that the conversion of balance sheet liquidity to effective demand is largely a function of the degree of risk aversion.[18] That process manifests itself in periods of euphoria (risk aversion falling below its long-term, trendless average) and fear (risk aversion rising above its average). A lessening in the intensity of risk aversion creates increasingly narrow bid-asked spreads, in volume—the conventional definition of *market,* as distinct from balance sheet, liquidity.

In this context I define a bubble as a protracted period of falling risk aversion that translates into capitalization rates falling measurably below their long-term, trendless averages.[19] Falling capitalization rates in turn propel one or more asset prices to unsustainable levels. All bubbles burst when risk aversion reaches its irreducible minimum, that is, when credit spreads approach zero, although success at timing the onset of the deflation has proved elusive.

Some bubbles burst without severe economic consequences—the dotcom boom and the rapid run-up of stock prices in the spring of 1987, for example. Others burst with severe deflationary consequences. That class of bubbles, as Carmen Reinhart and Kenneth Rogoff (2009) demonstrate,

18. I am defining risk aversion more broadly here than the standard economic definition, which states it in terms of utility over different outcomes. Risk aversion, as I use the term, encompasses all factors that govern individuals' willingness to engage in risky actions. Most notably, it encompasses not only their preferences toward risk, but also their perceptions of risk.

Risk aversion is the primary human trait that governs the pricing of income-earning assets. When people become uncertain or fearful, they disengage from perceived risk. When their uncertainty declines, they take on new commitments. Risk aversion, by definition, ranges from zero to full.

The extremes of zero and full risk aversion, of course, are outside all human experience. Zero risk aversion—that is, the absence of any aversion at all to engaging in risky actions—implies that an individual does not care about, or cannot discriminate among, objective states of risk to life and limb. Such individuals cannot (or do not choose to) recognize life-threatening events.

To acquire food, shelter, and the other necessary contributors to life requires action, that is, the taking of risks, either by an individual or by others on the individual's behalf. Eschewing all objective risk is not consistent with life. Thus full risk aversion, like zero risk aversion, is a hypothetical state that is never observed in practice.

Day-by-day existence occurs well within these outer boundaries of risk aversion and can be very approximately measured by credit risk spreads. Credit spreads that very approximately track changing risk aversion exhibit little to no long-term trend. Prime railroad bonds of the immediate post–Civil War years reflect spreads over U.S. Treasuries that are similar to the post–World War II experience.

19. Yields on long-term Treasuries, a proxy for riskless capitalization rates, are essentially trendless. Real yields in recent years are not far from the nominal Treasury bond yields of 1900, when long-term inflation expectations (under the gold standard) were effectively zero.

appears to be a function of the degree of leverage in the financial sector, particularly when the maturity of debt is less than the maturity of the assets it funds.

Had the share of financial assets funded by equity been significantly higher in September 2008, it seems unlikely that the deflation of asset prices would have fostered a default contagion much, if at all, beyond that of the dot-com boom. It is instructive in this regard that since the start of the crisis, no unaffiliated hedge fund has defaulted on its debt, despite very large losses that often forced fund liquidation.

II.D. Why Did the Boom Reach Such Heights?

Why did the 2007 bubble reach century-rare euphoria? The answer, I believe, lies with the dot-com bubble, which burst with very little footprint on global GDP and, in the United States, produced the mildest recession in the post–World War II period. The previous U.S. recession, in 1990–91, was the second most shallow. Coupled with the fact that the 1987 stock market crash left no visible impact on GDP, this experience led the Federal Reserve and many a sophisticated investor to believe that future contractions would also prove no worse than a typical postwar recession.

The need for large bank capital buffers appeared increasingly less pressing in this period of Great Moderation. As late as April 2007, the IMF noted that "global economic risks [have] *declined* since . . . September 2006. . . . The overall U.S. economy is holding up well . . . [and] the signs elsewhere are very encouraging" (emphasis in original).[20] The banking regulations adopted internationally under the Basel Accords did induce a modest increase in capital requirements leading up to the crisis. But the debates in Basel over the pending global capital accord that emerged as Basel II were largely over whether to keep bank capital requirements unchanged or to reduce them. Leverage accordingly ballooned.

It is in such circumstances that we depend on our highly sophisticated global system of financial risk management to contain market breakdowns. How could it have failed on so broad a scale? The paradigm that spawned several Nobel Prize winners in economics—Harry Markowitz, Robert Merton, and Myron Scholes (and Fischer Black, had he lived)—was so thoroughly embraced by academia, central banks, and regulators that by 2006 it had become the core of the global regulatory standards embodied in Basel II. Many quantitative investment firms whose number crunching sought to expose profitable market trading principles were successful so

20. IMF, *World Economic Outlook,* April 2007, p. xii.

long as risk aversion moved incrementally (which it did much of the time). But crunching data that covered only the last 2 or 3 decades did not yield a model that could anticipate a crisis.

Mathematical models that calibrate risk, however, are surely better guides to risk management than the "rule of thumb" judgments of a half century ago. To this day it is hard to find fault with the *conceptual* framework of our models, as far as they go. Black and Scholes' elegant option pricing proof is no less valid today than a decade ago. The risk management paradigm nonetheless harbored a fatal flaw.

In the growing state of high euphoria, risk managers, the Federal Reserve, and other regulators failed to fully comprehend the underlying size, length, and impact of the negative tail of the distribution of risk outcomes that was about to be revealed as the post-Lehman crisis played out. For decades, with little to no data, most analysts, in my experience, had conjectured a far more limited tail risk. This assumption, arguably, was the major source of the critical risk management system failures.

Only modestly less of a problem was the vast and, in some cases, virtually indecipherable complexity of the broad spectrum of financial products and markets that developed with the advent of sophisticated mathematical techniques to evaluate risk.[21] In despair, investment managers subcontracted an inordinately large part of their task to the "safe harbor" risk designations of the credit rating agencies. No further judgment was required of investment officers who believed they were effectively held harmless by the judgments of these government-sanctioned rating organizations. But despite their decades of experience, the analysts at the credit rating agencies proved no more adept at anticipating the onset of crisis than the investment community at large.

Even with the breakdown of our sophisticated risk management models and the failures of the credit rating agencies, the financial system would have held together had the third bulwark against crisis—our regulatory system—functioned effectively. But under crisis pressure, it too failed. Along with the vast majority of market participants, regulators failed to anticipate the onset of crisis.

The heavily praised U.K. Financial Services Authority was unable to anticipate, and thus to prevent, the bank run that threatened one of that country's largest commercial banks, Northern Rock. The venerated credit

21. I often maintained that because of this complexity, policymakers had to rely on an international "invisible hand" to bring equilibrium to such undecipherable markets. The high level of market liquidity appeared, erroneously, to confirm that the system was working.

rating agencies bestowed ratings that implied triple-A future smooth sailing for many a highly toxic derivative product. The Basel Committee on Banking Supervision, representing regulatory authorities from the world's major financial systems, promulgated a set of capital rules that failed to foresee the need that arose at the height of the crisis for much larger capital and liquidity buffers. The Federal Deposit Insurance Corporation had noted as recently as the summer of 2006 that "more than 99 percent of all insured institutions met or exceeded the requirements of the highest regulatory capital standards."[22] U.S. commercial and savings banks are extensively regulated, and even though for years our 10 to 15 largest banking institutions have had permanently assigned on-site examiners to oversee daily operations, many of these banks still were able to take on toxic assets that brought them to their knees.

III. Financial Intermediation

III.A. The Purpose of Finance

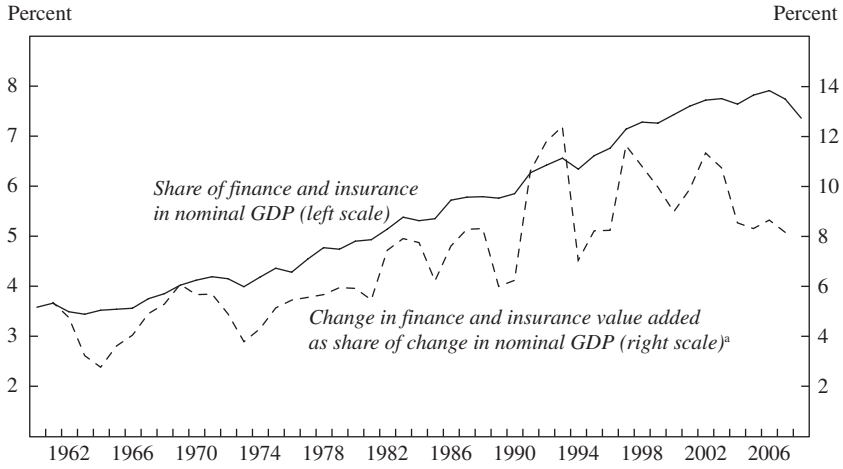
The ultimate goal of a financial system and its regulation in a market economy is to direct the nation's saving, plus any saving borrowed from abroad (the current account deficit), toward investments in plant, equipment, and human capital that offer the greatest increases in the nation's output per worker hour. Nonfinancial output per hour, on average, rises when obsolescent facilities (with low output per hour) are replaced with facilities that embody cutting-edge technologies (with high output per hour). This process improves average standards of living for a nation as a whole. In the United States, the evident success of finance in the decades before the crisis in directing scarce savings into real productive capital investments appears to explain the generous compensation that nonfinancial market participants had been willing to pay to the domestic producers of financial services.

The share of U.S. gross domestic product accruing as income to finance and insurance, according to the Bureau of Economic Analysis, rose fairly steadily from 2.3 percent in 1947 to 7.9 percent in 2006 (figure 6). Many other global financial centers exhibit similar trends.[23] Only a small part of the rise in the United States represented an increase in net foreign demand

22. *FDIC Quarterly Banking Profile,* 2nd Quarter 2006, p. 3.

23. Increased, but less pronouncedly so, financial shares are evident in the United Kingdom, the Netherlands, Japan, Korea, and Australia, among others. The world's most rapidly expanding (and increasingly market-oriented) economy, China, reports a rise in financial intermediaries' share of GDP from 1.6 percent in 1980 to 5.4 percent in 2008.

Figure 6. Share of the Financial Sector in GDP, 1960–2008



Source: Bureau of Economic Analysis.
a. Three-year moving averages.

for U.S. financial and insurance services.[24] The decline in the share to 7.4 percent in 2008 reflects write-offs of savings previously presumed to be productively employed.[25]

Given the historic breakdown of the last 2 years, did nonfinancial market participants over the decades misread the efficiency of finance and inappropriately compensate this small segment of our economy? The prevalence of so many financial product failures certainly suggests so, for the decade leading up to the crisis. Nonetheless, it is difficult to make the same judgment in the face of the fairly persistent rise of finance's share for the previous half century. Moreover, finance's share of *growth* in nominal GDP has been largely trendless since 1990, averaging about 10 percent (figure 6).

The proportion of nonfarm employment accounted for by finance and insurance since 1947 has risen far less than the share of gross income originating in that sector, implying a significant upgrading of the skills attracted to finance and their compensation. A recent study (Philippon and Reshef 2009) finds a markedly above-average rise in the salaries of those

24. The net foreign demand for U.S. financial services has grown significantly but has been largely offset by net imports of insurance services.

25. The share of national income originating in a somewhat broadened measure of finance was little changed in 2009 from 2008.

employed in finance since 1980, presumably reflecting the greater skills drawn to finance in recent years. By 2007 a quarter of all graduates of the venerable California Institute of Technology were entering finance.[26]

What are we to make of these extraordinarily persistent and stable uptrends? Are they wholly accidental? (After all, there is no evidence of such a trend in the prewar years.) It is not that the value of assets to be managed has been persistently rising relative to GDP.[27] The answer to this question matters a great deal.

In the context of financial reform, the critical issue that must be addressed is whether the growing share of financial services was happenstance, or evidence that a growing share of financial services was *required* to intermediate an ever more complex division of labor. I raise the issue because many recent policy recommendations would lower the share of financial services income in GDP. Would such policies affect the growth of U.S. nonfinancial productivity and our standards of living? More important, given the recent failures of risk management and regulation, would increased financial regulation at this time thwart or (through increased stability) enhance economic growth? We need a far deeper understanding of the role of financial intermediation in promoting growth to answer that question. How finance evolves in the postcrisis years should bring clarity to many of today's uncertainties.

III.B. Risky Financial Intermediation

As I noted earlier, the shape of the distribution of the extreme negative tail risk was unknown before the default of Lehman. Since tail risk, in principle at least, is open-ended,[28] there will always be *some* risk that bank capital cannot cover, and hence some, perhaps even many, banks will fail. But that need not become a systemic problem if equity capital and liquidity requirements are raised substantially and a significant part of an intermediary's debt takes the form of mandated contingent capital bonds (see section IV.F). Still, there will always be the possibility, however remote, of the private financial intermediary system faltering, requiring sovereign credit to keep vital intermediation functioning.

26. *The Economist,* "Number-Crunchers Crunched," February 13, 2010, p. 568.

27. Household net worth can be taken as a proxy for the net worth of the economy to be managed at a fee. The ratio of that net worth to disposable personal income was largely unchanged between 1952 and 1996. Since then it has been volatile, with recent quarters returning to the long-term average.

28. Tail risk would converge to zero only if risk aversion were to become absolute, an impossibility if life is to be sustained (see note 18).

Central bankers have long been aware of the potential for a breakdown in private financial markets. Indeed, in the United States as recently as 1991, in contemplation of the unthinkable and at the urging of the Federal Reserve Board of Governors, Section 13-3 of the Federal Reserve Act was reconsidered and amended by Congress. The section as revised grants virtually unlimited authority to the Board to lend in "unusual and exigent circumstances."

III.C. The Hundred-Year Flood

A decade ago, addressing that issue, I noted,

> There is a . . . difficult problem of risk management that central bankers confront every day, whether we explicitly acknowledge it or not: How much of the underlying risk in a financial system should be shouldered [solely] by banks and other financial institutions? . . . [Central banks] have all chosen implicitly, if not in a more overt fashion, to set our capital and other reserve standards for banks to guard against outcomes that exclude those once or twice in a century crises that threaten the stability of our domestic and international financial systems.
>
> I do not believe any central bank explicitly makes this calculation. But we have chosen capital standards that by any stretch of the imagination cannot protect against all potential adverse loss outcomes. There is implicit in this exercise the admission that, in certain episodes, problems at commercial banks and other financial institutions, when their risk-management systems prove inadequate, will be handled by central banks. At the same time, society on the whole should require that we set this bar very high. Hundred-year floods come only once every hundred years. Financial institutions should expect to look to the central bank only in extremely rare situations. (Greenspan 2000a)

At issue is whether the crisis that arrived a few years later is that "hundred-year flood." At best, once-in-a-century observations yield results that are scarcely robust. But recent evidence suggests that what happened in the wake of the Lehman collapse is likely the most severe global financial crisis ever. In the Great Depression, of course, the collapse in economic output and the rise in unemployment and destitution far exceeded the current and, in the view of most, prospective future state of the global economy. And of course, the widespread bank failures markedly reduced short-term credit availability. But short-term financial markets continued to function.

Financial crises are characterized by a progressive inability to float first long-term debt and eventually short-term and overnight debt as well. Long-term uncertainty and therefore risk are always greater than near-term risk, and hence risk spreads almost always increase with the maturity of the financial instrument in question.[29] The depth of a financial crisis is

29. Yields on riskless longer maturities can fall below short-term riskless rates if tight money persuades investors that future inflation will be less.

properly measured by the degree of collapse in the availability of short-term credit.

The evaporation of the global supply of short-term credits within hours or days of the Lehman failure is, I believe, without historical precedent. A run on money market mutual funds, heretofore perceived to be close to riskless, was under way within hours of the announcement of Lehman's default.[30] Within days, the withdrawal of trade credit set off a spiral of global economic contraction, and the Federal Reserve had to move quickly to support the failing commercial paper market. Even the almost sacrosanct, fully collateralized repurchase agreement market encountered severe and unprecedented difficulties.

One has to dig very deep into peacetime financial history to uncover similar episodes. The market for call money, the key short-term financing vehicle of a century ago, shut down at the peak of the 1907 panic, "when no call money was offered at all for one day and the [bid] rate rose from 1 to 125%" (Homer and Sylla 1991, p. 340). Even at the height of the 1929 stock market crisis, the call money market functioned, although annual interest rates did soar to 20 percent. In lesser financial crises, availability of funds in the long-term market disappeared, but overnight and other short-term markets continued to function.

The withdrawal of overnight money represents financial stringency at its maximum. Investors will be willing to lend overnight before they feel sufficiently protected by adequate capital to reach out for more distant, and hence riskier, maturities.

The evaporation in September 2008 of short-term credits was global and all encompassing. But it was the same process we had previously observed at a more micro level.[31]

IV. Regulatory Reform

IV.A. Principles of Reform

Given this apparently unprecedented period of turmoil, by what standard should proposals for reform of official supervision and regulation be judged? I know of no form of economic organization based on a division

30. Hugo Bänziger, "Money Market Funds Need New Global Standards," *Financial Times,* November 5, 2009. Bänziger was chief risk officer at Deutsche Bank at the time.

31. As the credit of New York City, for example, became suspect in the mid-1970s, the first failure of issuance was evident in long-term municipal bonds, followed by failures in progressively shorter maturities, until even overnight markets started to crumble. A similar progression led up to the Mexican financial crisis of 1994–95.

of labor, from unfettered laissez-faire to oppressive central planning, that has succeeded in achieving both maximum sustainable economic growth and permanent stability. Central planning certainly failed, and I strongly doubt that stability is achievable in capitalist economies, given that always-turbulent competitive markets are continuously being drawn toward, but never quite achieving, equilibrium (and that it is precisely this process that leads to economic growth).

People acting without forethought cannot be productive except by chance. Identification of effective innovation is, of necessity, a rational act. Hence, regulation, by inhibiting irrational behavior when it can be identified, can be stabilizing, as recent history has demonstrated. But there is an inevitable cost of regulation in terms of economic growth and standards of living when it imposes restraints beyond containing unproductive behavior.

Regulation by its nature imposes restraints on competitive markets. The elusive point of balance between growth and stability has always been a point of contention, especially when it comes to financial regulation.

Throughout the postwar years in the United States, with the exception of a limited number of bank bailouts (Continental Illinois in 1984, for example), private capital proved adequate to cover virtually all provisions for lending losses. As a consequence, there was never a definitive test of what then constituted conventional wisdom, namely, that an equity capital–to–assets ratio of 6 to 10 percent on average, the range that prevailed between 1946 and 2003, was adequate to support the U.S. banking system.

Risk managers' assumption of the size of the negative tail of the distribution of credit and interest rate risk was, as I noted earlier, of necessity conjectural, and for generations we never had to test those conjectures. Most of the shape of the distribution of perceived risk was thoroughly documented in the precrisis years, as "moderate" financial crises and euphorias traced out their relevant parts of the curve. But since modern financial data compilation began, we had never had a "hundred-year flood" that exposed the full intensity of negative tail risk.

Risk managers, of course, knew in earlier decades that an assumption of normality in the distribution of risk was unrealistic, but as a first approximation that greatly facilitated calculation, it prevailed. The mathematics implied by fat tails was also well understood, but our number crunching capabilities fell far short of making the required calculations to guide actions, except at prohibitive cost. That is no longer the case.

Clearly what we experienced in the weeks following the Lehman default is exactly the type of market seizure that tail risk conjecture was supposed to capture, and did not. Having experienced Lehman, risk managers will be far more cautious in evaluating future risk—at least for a while.

Many investment firms are constructing probability distributions of outcomes employing, as the negative tail, data based on the experience of the last 2 years. Using Monte Carlo simulations or other techniques, they have concluded, not unexpectedly, that a financial crisis as severe as the one that followed the Lehman default would have been predicted to occur far more often than indicated by models in which risk is distributed normally. Such evidence suggests the onset of a "hundred-year flood" somewhat more often than once in a century.

Indeed, the aftermath of the Lehman crisis traced out a startlingly larger negative tail than almost anybody had earlier imagined. At least partly responsible may have been the failure of risk managers to fully understand the impact of the emergence of shadow banking, a development that increased financial innovation but, as a result, also increased the level of risk. The added risk was not compensated by higher capital.

When risk premiums are low over a protracted period, as they were, for example, from 1993 to 1998 and from 2003 to 2007, investors' willingness to bid for all types of financial assets, especially the high-risk tranches of collateralized debt obligations, creates an illusion of permanent market liquidity that in the latest episode turned out to be intoxicating. It led several major investment banks to attempt to weather the financial storm with only a thin veneer of tangible capital.

The most pressing reform, in my judgment, in the aftermath of the crisis is to fix the level of regulatory risk-adjusted capital, liquidity, and collateral standards required by counterparties. Private market participants are now requiring economic capital and balance sheet liquidity well in excess of the yet-to-be-amended Basel II requirements. The shadow banks that survived the crisis are now having to meet significantly tighter market standards, with respect to capital, liquidity, and collateral, than existed before the crisis. These are major changes that need to be reflected in the new set of regulatory requirements and standards currently undergoing global review.

One major fallout of the crisis is a marked rise in the degree of moral hazard (see note 41), which requires that all financial intermediaries be subject to maximum leverage ratios. These ratios, as with all risk-adjusted capital adequacy measures, need to be based on more realistic risk adjustment factors applied to their assets and on the proportion of their liabilities

funded with overnight or other short-term debt. Precrisis regulatory capital requirements, although based on decades of experience, were clearly too lax: for example, they erroneously designated pools of self-amortizing home mortgages as among the safest of private instruments. And a surprisingly and unfortunately large proportion of investment portfolio decisions were, by law, accorded "safe harbor" status if they adhered to the credit risk judgments (or rather, misjudgments) of the credit rating agencies.

To ensure that financial intermediaries have adequate cash to meet ongoing commitments in the event of a shutdown in external funding, international bank liquidity regulation should match the tightening already evident in private risk management paradigms (Basel Committee on Banking Supervision 2009). Collateral has shown itself particularly subject to rapid recapture. Bear Stearns had nearly $20 billion in pledgeable liquid funds a week before it collapsed. Morgan Stanley lost more than a half trillion dollars of pledgeable collateral during the height of the crisis. In the United States, to lower the risk of a "run on the broker," the amount of customer assets (collateral) held by broker-dealers that cannot be commingled with their own assets needs to be increased. That would decrease the amount of funds that can "run." However, such action must be measured and coordinated with other global regulators to avoid regulatory arbitrage (see French and others forthcoming).

Unaffiliated hedge funds have weathered the crisis—as extreme a real-life stress test as one can construct—without taxpayer assistance or, as I noted earlier, default. Although hedge funds are only lightly regulated, much of their leveraged funding comes from more heavily regulated banks. Moreover, as Sebastian Mallaby (2010) writes, "Most hedge funds make money by driving prices *away* from extremes and toward their rational level." In so doing, they supply much-needed liquidity to financial markets when other competitors have withdrawn. Regulations that inhibit the ability of hedge funds to supply such services are counterproductive.

Capital, liquidity, and collateral, in my experience, address almost all of the financial regulatory structure shortcomings exposed by the onset of the crisis. In retrospect, there has to be a level of capital that would have prevented the failure of, for example, Bear Stearns and Lehman Brothers. (If not 10 percent, think 40 percent.) Moreover, generic capital has the regulatory advantage of not having to forecast which particular financial products are about to turn toxic. Certainly investors did not foresee the future of subprime securities or the myriad other broken products. Adequate capital eliminates the need for an unachievable specificity in regulatory fine tuning.

The jerry-built regulatory structure that has evolved over the decades in the United States has become much too complex. Policymakers failed to recognize, during the debates that led to legislation resulting in a badly needed opening up of financial competition (the Gramm-Leach-Bliley Act of 1999), that increased competition, especially through shadow banking, also increased negative tail risk. And increased negative tail risk necessitates higher capital requirements.

IV.B. Upward Revisions of Bank Economic Capital

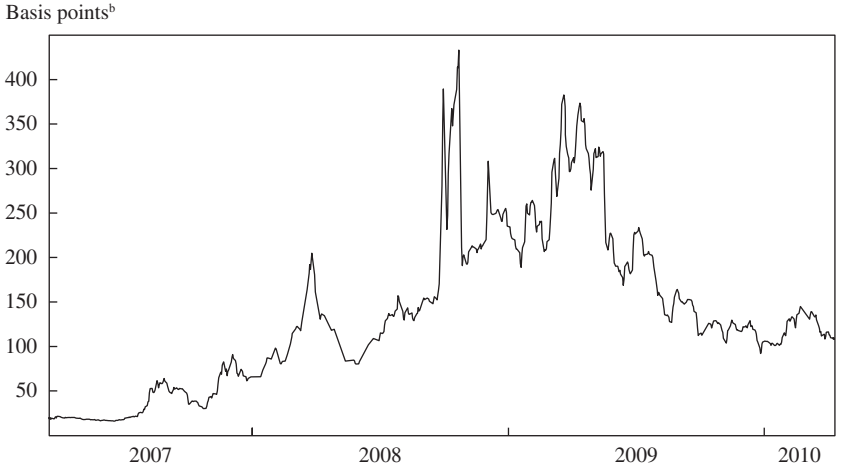
How much capital is currently being required of financial institutions by their counterparties will strongly influence the upcoming revisions in *regulatory* capital requirements. It is too soon to have definitive answers. But very rough approximations for U.S. commercial banks can be inferred from the response of bank credit default swaps (CDSs), a measure of bank insolvency risk, to postcrisis events.[32] Movements in the CDS market should also give us some direct insight into when the banking system is perceived to have overcome the market's fear of widespread insolvency—and beyond that, to when markets perceive that banks will feel sufficiently secure to return to the free lending of the precrisis years.

Starting late in 2008 and accelerating into the first quarter of 2009, the U.S. Treasury, through its Troubled Asset Relief Program (TARP), added $250 billion to bank equity, the equivalent of adding approximately 2 percentage points to the equity capital-to-assets ratio. Its impact was important and immediate.

As the financial crisis took hold and deepened, the unweighted average price of 5-year CDSs of six major U.S. banks—Bank of America, JP Morgan, Citigroup, Goldman Sachs, Wells Fargo, and Morgan Stanley—rose from 17 basis points in early 2007 (for 5-year contracts, the average annual price of insurance was 0.17 percent of the notional amount of the underlying swap instruments) to 170 basis points just before the Lehman default on September 15, 2008. In response to the Lehman default, the 5-year CDS average price rose to more than 400 basis points by October 8. On the *day* the TARP was announced (October 14), the price fell to approximately 200 basis points, or essentially by half (figure 7). That a 2-percentage-point addition to the banks' book equity capital-to-assets

32. The seller of a CDS insures the holder of a particular debt instrument against loss in the event of default. Prices of CDSs are thus the most sensitive measure of the probability of bank default.

Figure 7. Price of Five-Year Credit Default Swaps[a]



Source: Author's calculations; Bloomberg.

a. Unweighted average prices of CDSs issued by Bank of America, Citigroup, Goldman Sachs, JPMorgan, Wells Fargo, and Morgan Stanley.

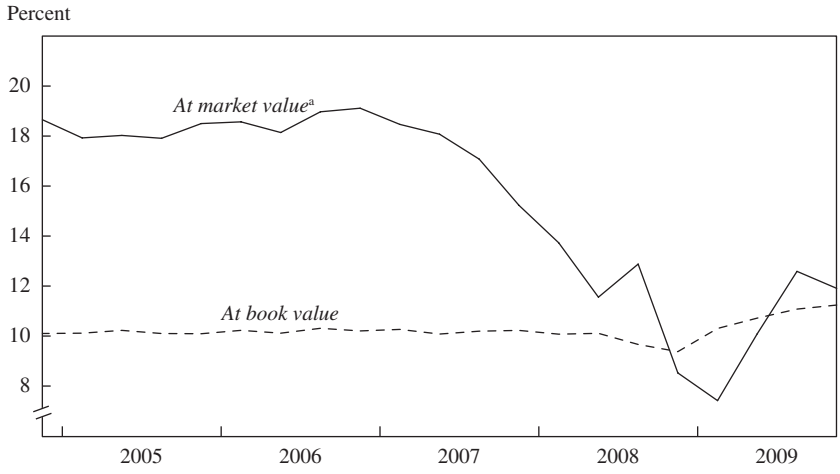
b. Hundredths of a percent of the notional value of the underlying swap contract.

ratio reversed roughly half the crisis surge in the price of 5-year CDSs implies an overall additional 4-percentage-point rise (from 10 percent in mid-2007 to 14 percent) in the equity capital cushion required by market participants to fund the liabilities of banks. That, of course, assumes linear extrapolation, an admittedly herculean assumption, and, of course, presumes that the probability of a TARP before the Lehman default was de minimis. The abruptness of the market reaction to the TARP announcement appears to confirm such a presumption, however.

Current book equity–to–assets ratios are still far from 14 percent. The average ratio for commercial banks (as reported by the Federal Deposit Insurance Corporation, FDIC) was 10.9 percent on March 31, 2010, compared with 10.1 percent in mid-2007. But unacknowledged loan losses were estimated by the IMF last October (they are now less) to be in the hundreds of billions of dollars. Trends in relevant liquidity are less readily measured but are assumed to parallel changes in capital.

That banks still have more equity capital to add is also indicated by the fact that the 5-year CDS price of March 31, 2010 (and since) remains over 100 basis points, still significantly elevated relative to the 17 basis points that prevailed in early 2007, when 10 percent capital was apparently

Figure 8. Equity-to-Assets Ratios at FDIC-Insured Commercial Banks, 2004–09



Source: Federal Deposit Insurance Corporation.
a. Averages constructed from Bloomberg data on the book and market equity value of 24 leading banks.

enough to virtually eliminate the threat of default and induce loan officers to lend freely.

There is little doubt that the TARP's cash injection markedly reduced the fear of bank default through early 2009. More difficult to judge is the impact on bank CDSs of the dramatic increase in bank equity at *market* value relative to bank assets at market value. That ratio rose 4.5 percentage points from the end of March 2009 to the end of December, from 7.4 percent to 11.9 percent (figure 8). There can be little doubt that this has materially increased the solvency of banks, although apparently less effectively, dollar for dollar, than the more permanent change in book-value equity.[33]

Much of the repayment of TARP investments to the U.S. Treasury was doubtless financed by new equity issuance, made possible by a more than one-half-trillion dollar increase in U.S. commercial bank equity at market value, and by borrowings made much easier (and cheaper) by the increased equity buffer engendered by gains in market-valued bank equity. The parceling of relative contributions of the TARP and of capital gains to bank solvency and willingness to lend may not be fully clear even in retrospect.

33. Between the end of March and the end of December 2009, the average CDS price fell from 369 to 104 basis points, while the ratio of the market value of equity to the market value of assets rose 450 basis points.

Table 2. CDS and LIBOR-OIS Spreads at Various Maturities, September 2009 and March 2010

Basis points

Maturity	*September 15, 2009*	*March 31, 2010*
CDS		
10 years	129	111
5 years	125	107
3 years	129	88
1 year	123	61
LIBOR-OIS		
3 months	12	11
1 month	7	8

Sources: British Bankers' Association, Bloomberg, Reuters, and Haver Analytics.

The TARP not only inserted capital but also induced market participants to infer that the U.S. Treasury would, at least for a while, stand behind the liabilities of the banking system. This may explain the divergence since mid-September 2009 between short-term (1- and 3-month) LIBOR-OIS spreads (an alternative to CDS spreads as a short-term measure of the likelihood of bank default) and 5- and 10-year CDS spreads. Short-term LIBOR-OIS spreads had returned to their precrisis level by the end of September 2009. Long-maturity CDS prices are only partway back (table 2). The 1-year LIBOR-OIS spread falls in between. Clearly, either markets are discounting some of the bank capital cushion at market value 5 and 10 years hence, owing to the volatility of stock prices, and/or they question the political willingness, or ability, of the U.S. government, after markets return to normal, to initiate another bank bailout.[34]

Given the foregoing set of fragile assumptions and conclusions (and they are all we have), I would judge that regulatory equity capital requirements in the end will be seen to have risen from the 10 percent precrisis level (in terms of book value) to 13 or 14 percent by 2012, and liquidity and collateral requirements will toughen commensurately.

IV.C. What Regulation Can Do

What, in my experience, supervision and examination *can* do as a backup to capital requirements and counterparty surveillance is promulgate

34. As fear of contagion from the European sovereign debt crisis mounted in the spring of 2010, CDS and LIBOR-OIS spreads rose markedly.

rules that are preventative and *do not require anticipating an uncertain future.* Supervision

—can audit and enforce capital and liquidity requirements[35]

—can require that financial institutions issue some debt that will become equity should equity capital become impaired (see section IV.F)

—can, and has, put limits or prohibitions on certain types of concentrated bank lending

—can prohibit complex affiliate and subsidiary structures whose sole purpose is tax avoidance or regulatory arbitrage

—can inhibit the reconsolidation of affiliates previously sold to investors, especially structured investment vehicles (SIVs)[36]

—can require "living wills" in which financial intermediaries indicate, on an ongoing basis, how they can be liquidated expeditiously with minimum impact on counterparties and markets.

IV.D. Some Lessons of Regulatory Capital History

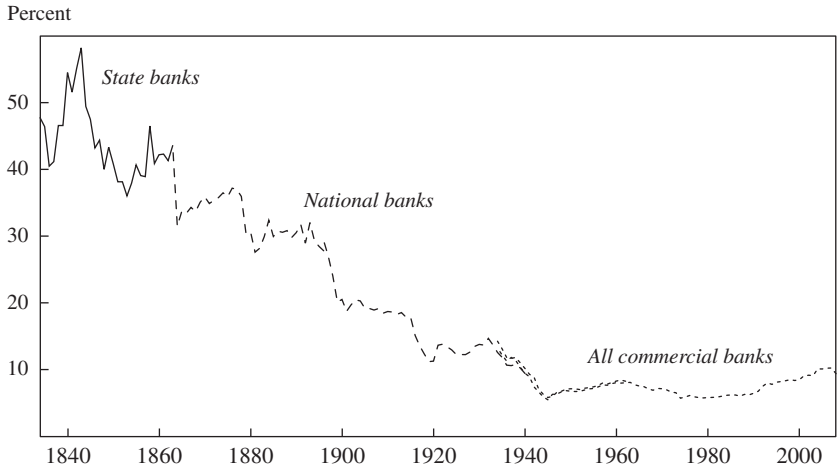
In the late 19th century, U.S. banks required equity capital of 30 percent of assets to attract the liabilities required to fund their assets. In the pre–Civil War period, that figure topped 50 percent (figure 9). Given the rudimentary nature of 19th-century payment systems and the poor geographical distribution of reserves in what was then an agricultural economy, competition for bank credit was largely local. It enabled national banks on average to obtain returns (net income) on their assets of well over 200 basis points in the late 1880s, and probably more than 300 basis points in the 1870s (compared with 70 basis points a century later).

Increasing efficiency of financial intermediation, owing to consolidation of reserves and improvements in payment systems, exerted competitive pressure on profit spreads to narrow and allowed capital-to-assets ratios to decline. In marked contrast, the annual average net income rate of return on *equity* was amazingly stable, rarely falling outside a range of 5 to 10 percent, measured annually, during the century from 1869 to 1966 (figure 10). That meant that net income as a percentage of assets and the degree of leverage were approximately inversely proportional during that century.

35. Increased capital requirements can go a long way toward containing large compensation packages. The recent higher profits will be needed to fulfill the capital requirements, especially if global competitors have similar capital requirements.

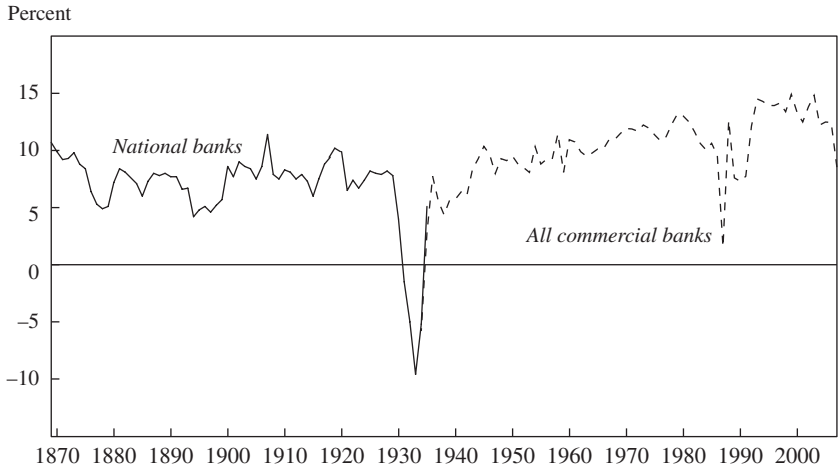
36. When, during the crisis, such assets appeared about to fail, sponsoring companies, fearful of reputation risk (a new insight?), reabsorbed legally detached affiliates at subsequent great loss.

Figure 9. Ratio of Equity Capital to Assets in the Banking Sector, 1834–2009



Source: Federal Deposit Insurance Corporation and Office of the Comptroller of the Currency.

Figure 10. Ratio of Net Income to Equity in the Banking Sector, 1869–2007



Source: Federal Deposit Insurance Corporation and Office of the Comptroller of the Currency.

Rates of return on assets and equity (despite the decline in leverage that resulted from rising Basel capital requirements) moved modestly higher during 1966–82 owing to a rapid expansion in noninterest income, for example from fiduciary activities, service charges and fees, and securitizations (and later from expansion into investment banking and brokerage). Noninterest income rose significantly between 1982 and 2006, increasing net income to nearly 15 percent of equity, as a consequence of a marked increase in the scope of bank powers. That increase in part reflected the emergence in April 1987 of court-sanctioned and Federal Reserve–regulated "Section 20" investment banking affiliates of bank holding companies.[37] The transfer of such business is clearly visible in the acceleration of gross income originating in commercial banking relative to that in investment banking starting in 2000 (Bureau of Economic Analysis).[38]

I tentatively conclude that the historical relative stability of average net income–to–equity ratios dating back to the post–Civil War years reflects an underlying ex ante market-determined rate of return on intermediation.

In summary, the crisis will leave in its wake a significantly higher capital-to-assets ratio requirement, both economic and regulatory, that must be reached if intermediation is to be restored to the point where banks and other financial institutions are confident they have a sufficiently secure capital cushion to lend freely.

IV.E. Limits to Regulatory Capital Requirements

If we accept as a benchmark the remarkable stability of the ratio of bank net income to equity capital (ranging between 5 and 15 percent) that has prevailed, with rare exceptions, since the end of the Civil War (figure 10), we can infer the highest average ratio of capital to assets that a banking system can tolerate before a significant number of banks are required to raise their margin, or shrink their size, or both. I assume a 5 percent annual

37. This development meant that the repeal, under the Gramm-Leach-Bliley Act, of the 1933 Glass-Steagall Act, which had separated commercial and investment banking, changed very little. From the enactment of Gramm-Leach-Bliley in 1999 to the Federal Reserve's acceptance of Goldman Sachs and Morgan Stanley as financial services holding companies at the height of the crisis, no applications to employ the greater powers were forthcoming. That forbearance apparently reflected a desire to stay clear of the Federal Reserve's regulatory embrace.

38. Rates of return crashed during the first half of 2009, with declines matched (on an annual basis) only by those in the depression years 1932–34. Both cases reflected a rare sharp breakout from the historical range, resulting mostly from large write-offs on previously extended loans.

average rate of return (the lower limit of the range) as a proxy for the full distribution of the thousands of banks that would make up the average. Accordingly, for this exercise it is employed as the ex ante competitively required average minimum return on intermediation. I assume as a first approximation that all variables are independent. If so, the *highest* ratio of capital to assets that the U.S. banking system can tolerate and still supply the nonfinancial sector with adequate financial service capacity can be inferred from the following identity:

$$\frac{\pi}{C} = \frac{\pi}{A} \times \frac{A}{C},$$

where π is net income, C is equity capital, and A is total assets. If $\pi/C = 0.05$, then $\frac{C}{A} = 20 \times \frac{\pi}{A}$.

It can be shown that $\pi/A = (r_r - r_p - k)w + n - e - \alpha$, where r_r is the rate of interest received from earning assets, r_p is the interest rate paid on earning assets, k is the ratio of losses to earning assets, w is the ratio of earning assets to total assets, n is the ratio of noninterest income to assets, e is the ratio of noninterest expense to total assets, and α is the ratio of taxes and minor other adjustments to total assets. As can be seen from table 3, virtually all of the rise in π/A and π/C for U.S. banks as a group since 1982 is due to the marked rise in noninterest income.

In the years immediately before the onset of the crisis, π/A averaged 0.012, and therefore the inferred maximum average regulatory capital, C/A, as a first approximation, was 0.24. A rate higher than 0.24, all else equal,[39] would put the average rate of return on equity below the critical 5 percent level. If π/A were to revert back to its average for 1950–75 (0.0074), then $C/A = 0.15$, marginally above the 12 to 14 percent presumed market-determined capital requirement that would induce banks to lend freely.

These calculations, as I noted, assume a static model in which all variables are independent. But clearly the required rate of return on equity cannot be independent of the capital-to-assets ratio. Increased capital

39. I do not deny that all else is not equal, and hence such conclusions are more illustrative than explanatory. A dynamic model is beyond the scope of this paper. Net interest income has enough of a history to effectively model, but noninterest income arguably does not.

Table 3. Accounting for Net Income in the U.S. Banking System

Level or change from previous period	*Net income divided by total assets* π/A	*Interest rate spread × share of earning assets in total assets* $(r_r - r_p) \times w$	*Loan-loss provisions and allocated transfer risk divided by earning assets × share of earning assets in total assets* $k \times w$	*Noninterest income divided by total assets* n	*Noninterest expense divided by total assets* e	*Taxes plus minor items, net, divided by total assets* α
Period average						
1962–66	0.766	2.580	0.079	0.566	1.965	0.335
1978–82	0.728	3.035	0.265	0.774	2.546	0.269
1992–96	1.092	3.673	0.426	1.949	3.617	0.488
2002–06	1.276	3.048	0.399	2.296	3.106	0.563
Change						
From 1962–66 to 1978–82	–0.038	0.455	0.186	0.207	0.581	–0.067
From 1978–82 to 1992–96	0.363	0.638	0.161	1.176	1.071	0.219
From 1992–96 to 2002–06	0.184	–0.624	–0.027	0.347	–0.511	0.075

Source: Author's calculations based on Federal Deposit Insurance Corporation data.

reduces the risk of the balance sheet and hence will attract equity investors despite a lower rate of return. This implies that owing to the recent rise in π/A, the actual regulatory capital ceiling can thus readily exceed the static ceiling of $C/A = 0.24$. In any event, increased capital requirements will surely reduce the marginal lending that occurred in recent decades owing to the failure to fully fund tail risk. Much of that marginal lending was in effect being subsidized by taxpayers. That subsidy became fully funded in 2008 by sovereign credit. Removing the subsidy through higher capital requirements will, of course, shrink financial intermediary balance sheets. Much of this lending was evidently nonproductive, and its loss is not apt to be a problem for our complex economy's required level of intermediation.

IV.F. Too Big to Fail

Beyond significantly increased capital requirements is the necessity of addressing the problem of some financial firms being "too big to fail" or, more appropriately, "too interconnected to be liquidated quickly." The productive employment of the nation's scarce saving is threatened when financial firms at the edge of failure are supported with taxpayer funds and designated as systemically important institutions. I agree with Gary Stern, the former president of the Federal Reserve Bank of Minneapolis, who has long held that "creditors will continue to underprice the risk-taking of these financial institutions, overfund them, and fail to provide effective market discipline. Facing prices that are too low, systemically important firms will take on too much risk" (Stern 2009, p. 56). These firms absorb scarce savings that need to be invested in cutting-edge technologies, if output per hour and standards of living are to continue to rise.

After wallowing in the backwaters of economics for years, "too big to fail" has arisen as a major, visible threat to economic growth. It finally became an urgent problem when Fannie Mae and Freddie Mac were placed into conservatorship on September 7, 2008. Before then, U.S. policymakers (with fingers crossed) could point to the fact that Fannie and Freddie, by statute, were not backed by the "full faith and credit of the U.S. government." Market participants however, did not believe the denial, and they consistently afforded Fannie and Freddie a special credit subsidy (Passmore, Sherlund, and Burgess 2005). On September 7, 2008, market participants were finally vindicated.

Fannie Mae and Freddie Mac need to be split up into smaller companies, none of them "too big to fail," and then reconstructed into stand-

alone securitizers. Their future solvency (and the threat of contagion) requires that these GSEs be prohibited from accumulating large portfolios of assets that add no useful backing to the process of securitization or the mortgage markets more generally. Those portfolios' sole purpose is to profit from the subsidy that market participants grant to these GSEs (Greenspan 2004b).

One highly disturbing consequence of the too-big-to-fail problem that has emerged since the September 2008 federal takeover of Fannie Mae and Freddie Mac is that market players will now believe that *every* significant financial institution, should the occasion arise, is subject to being bailed out with taxpayer funds. It is going to be very difficult for legislators to persuade future investors otherwise.

Businesses that are subject to being bailed out have competitive market and cost-of-capital advantages, but not necessarily efficiency advantages, over firms not thought to be systemically important. For years the Federal Reserve was concerned about the ever-growing size of our largest financial institutions. Federal Reserve research had been unable to find economies of scale in banking beyond a modest size (Berger and Humphrey 1994, p. 7; see also Berger 1994). A decade ago, citing such evidence, I noted that "megabanks being formed by growth and consolidation are increasingly complex entities that create the potential for unusually large systemic risks in the national and international economy should they fail" (Greenspan 1999). Regrettably, we did little to address the problem.

How to deal with systemically threatening institutions is among the major regulatory problems for which there are no good solutions. Early resolution of bank problems under the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA) appeared to have worked with smaller banks during periods of general prosperity. But the notion that risks can be identified in a sufficiently timely manner to enable the liquidation of a large failing bank with minimum loss proved untenable during this crisis, and I suspect will prove untenable in future crises as well.[40]

The solution that, in my judgment, has at least a reasonable chance of reversing the extraordinarily large "moral hazard" that has arisen over the

40. The FDIC has experienced large losses in the value of assets taken over in resolution during the last 2 years.

past year and more[41] is to require banks and possibly all financial intermediaries to issue contingent capital bonds, that is, debt that is automatically converted to equity when equity capital falls below a certain threshold. Such debt will, of course, be more costly on issuance than simple debentures.

However, should contingent capital bonds prove insufficient, we should allow large institutions to fail and, if assessed by regulators as too interconnected to liquidate quickly, be taken into a special bankruptcy facility, whereupon the regulator would be granted access to taxpayer funds for "debtor-in-possession financing" of the failed institution. Its creditors (when equity is wholly wiped out) would be subject to statutorily defined principles of discounts from par ("haircuts"), and the institution would then be required to split up into separate units, none of which should be of a size that is too big to fail. The whole process would be administered by a panel of judges expert in finance.

I assume that some of the newly created firms would survive, and others fail. If, after a fixed short period of time, no viable exit from the bank-

41. Moral hazard, in an economic context, arises when an institution is not debited with the full costs of its actions and therefore will tend, in part at least, to act contrary to how it would act were it pressured solely by unfettered competition, where the externalities of potential bailout costs are fully internalized by competitors. The institution accordingly requires other parties to suffer some of the costs of its actions.

An interesting speculation is whether the crisis that emerged in August 2007 from the extraordinary leverage (as much as 20 to 30 times tangible capital) taken on by U.S. investment banks would have occurred had these firms remained the partnerships that they were up to a quarter century ago. The 1970 ruling that allowed broker-dealers to incorporate and gain permanent capital seemed sensible at the time. Nonetheless, as partnerships, Lehman Brothers and Bear Stearns almost surely would not have departed from their historically low leverage. Before incorporation, fearful of the joint and several liability to which general partnerships are subject, those entities shied away from virtually any risk they could avoid. Their core underwriting of new issues rarely exposed them for more than a few days.

To be sure, the senior officers of Bear Stearns and Lehman Brothers lost hundreds of millions of dollars from the collapse of their stocks. But none, to my knowledge, has filed for personal bankruptcy, and their remaining wealth allows them to maintain much of their previous standard of living.

Replicating the incentive structure of partnerships should be a goal whenever feasible in future reform. That goal will doubtless not be always met given that the corporate structure is seen as required to raise capital on a scale perceived as necessary in today's global market. To eliminate moral hazard, it should not be necessary to follow Hugh McCulloch, our first Comptroller of the Currency in 1863, who went somewhat over the edge in proposing that the National Bank Act "be so amended that the failure of a national bank be declared prima facie fraudulent, and that the officers and directors, under whose administration such insolvency shall occur, be made personally liable for the debts of the bank, and be punished criminally, unless it shall appear, upon investigation, that its affairs were honestly administered." Under such a regime, moral hazard surely would not exist.

ruptcy appears available, the financial intermediary should be liquidated as expeditiously as feasible.

IV.G. Regulations Embodying a Forecast Fail with Regularity

The crisis has demonstrated that neither bank regulators nor anyone else can consistently and accurately forecast whether, for example, subprime mortgages will turn toxic, or to what degree, or whether a particular tranche of a collateralized debt obligation will default, or even whether the financial system as a whole will seize up. A large fraction of such difficult forecasts will invariably be proved wrong. Regulators can readily identify underpriced risk and the existence of bubbles, but most important, they cannot, except by chance, effectively time the onset of crisis.[42] This should not come as a surprise.

A financial crisis is defined as an abrupt and sharp decline in the price of income-producing assets, usually induced by a dramatic spike in the discount rate on expected income flows as market participants swing from euphoria to fear. Implicit in any sharp price change is that it is unanticipated by the mass of market participants, for were it otherwise, the price imbalances would have been arbitraged away.

Indeed, for years leading up to August 2007, it was widely expected that the precipitating event of the "next" crisis would be a sharp fall in the dollar, as the U.S. current account deficit, starting in 2002, had increased dramatically. The dollar accordingly came under heavy selling pressure. The rise in the euro-dollar exchange rate from around 1.10 in the spring of 2003 to 1.30 at the end of 2004 appears to have *gradually* arbitraged away the presumed dollar trigger of the "next" crisis. The U.S. current account deficit did not play a prominent direct role in the timing of the 2007 crisis, although because of that, it may in the next.

In the years ahead, forecasters will readily identify risks that are underpriced—or at least priced at less than their historical average. But in instance after instance, as I noted earlier, risk has remained underpriced for years. Forecasters as a group will almost certainly miss the onset of the next financial crisis, as they have so often in the past, and I presume any newly designated "systemic regulator" will also.

Many analysts argue that forecasting is not required. A systemic regulator, they hold, could effectively fine-tune capital and liquidity require-

42. There has been confusion on the issue, to which I may have been a party. With rare exceptions it *has* proved impossible to identify the point at which a bubble will burst, but its emergence and development *are* visible in credit spreads.

ments to match the stage of the business cycle. Properly calibrated, such requirements presumably could be effective in assuaging imbalances. But cycles are not uniform. In real time, where we are in the cycle is a forecast, and cycles vary. For example, the low of the unemployment rate at cyclical peaks (as identified by the National Bureau of Economic Research) since 1948 has ranged between 2.6 and 7.2 percent. Would we have judged a turn in the business cycle when, for example, the unemployment rate rose to 5.8 percent in April 1995, up from 5.4 percent in March? In the event, the unemployment rate soon reversed itself and continued to fall for 5 more years.

It is best to fix regulatory parameters and let monetary policy carry the discretionary load. The Federal Reserve will tighten if it observes rising euphoria that signals mounting inflationary pressures (as it did in February 1994 and June 2004) or if risk premiums fall inordinately.

Moreover, discretionary regulatory rules would raise uncertainties that could undesirably curb investment. Thus, in the current environment of complexity, I see no ready alternative to significantly increasing—and fixing—regulatory capital requirements and liquidity and beefing up individual banks' counterparty risk surveillance.

The Federal Reserve has been concerned for years about the ability of regulatory supervisors and examiners to foresee emerging problems that have eluded internal bank auditing systems and independent auditors. I remarked in 2000 before the American Bankers Association, "In recent years rapidly changing technology has begun to render obsolete much of the bank examination regime established in earlier decades. Bank regulators are perforce being pressed to depend increasingly on greater and more sophisticated private market discipline, the still most effective form of regulation. Indeed, these developments reinforce the truth of a key lesson from our banking history—that private counterparty supervision remains the first line of regulatory defense" (Greenspan 2000b). Regrettably, that first line of defense failed.

A century ago, examiners could appraise individual loans and judge their soundness.[43] But in today's global lending environment, how does a U.S. bank examiner judge the credit quality of, say, a loan to a Russian bank, and hence of the loan portfolio of that bank? That in turn would

43. In 1903, O. Henry (W. S. Porter), who had more than a passing relationship with banking shenanigans, wrote in "A Call Loan" about a fictional bank examiner from the Office of the Comptroller of the Currency who was obsessed with the collateral backing a $10,000 loan. Such detailed scrutiny is exceptionally rare in today's larger banks.

require vetting the Russian bank's counterparties and those counterparties' counterparties, all to judge the soundness of a single financial transaction. In short, a bank examiner cannot, and neither can a credit rating agency. How deep into the myriad layers of examination is enough for certification?

The complexity of our financial system in operation spawns, in any given week, many alleged pending crises that, in the event, never happen, and innumerable allegations of financial misconduct. To examine each such possibility at the level of detail necessary to reach meaningful conclusions would require an examination force many multiples larger than those now in place in any of our banking regulatory agencies. Arguably, at such levels of examination, sound bank lending and its necessary risk taking would be impeded.

The Federal Reserve and other regulators were, and are, therefore required to guess which of the assertions of pending problems or allegations of misconduct should be subject to full scrutiny by a regulatory workforce with necessarily limited examination capacity. But this dilemma means that in the aftermath of an actual crisis, we will find highly competent examiners failing to have spotted a Bernie Madoff. Federal Reserve supervision and evaluation is as good as it gets, even considering the failures of past years. Banks still have little choice but to rely upon counterparty surveillance as their first line of crisis defense.[44]

V. The Role of Monetary Policy

V.A. Monetary Policy and Home Price Bubbles

The global home price bubble of the last decade was a consequence of lower interest rates, but it was *long-term* interest rates that galvanized home asset prices, not the overnight rates of central banks, as has become the seeming conventional wisdom. In the United States, the bubble was driven by the decline in interest rates on fixed-rate long-term mortgage loans,[45] relative to their mid-2000 peak, 6 months before the FOMC began easing the federal funds rate in January 2001.

44. Having served on JP Morgan's board for a decade just before my joining the Federal Reserve, I had an extended insight into the effectiveness of that company's counterparty surveillance of Citicorp, Bank of America, Wells Fargo, and others, relative to the regulatory surveillance by Federal Reserve banks.

45. Their average maturity is more than 26 years (Federal Housing Finance Agency).

Between 2002 and 2005, the monthly fixed-rate mortgage rate closely tracked changes in U.S. home prices 11 months earlier (as measured by the 20-city S&P/Case-Shiller home price index), with an adjusted R^2 on the regression of 0.500 and a *t*-statistic of −6.93. Thus long-term mortgage rates were a far better indicator of home prices than the federal funds rate: a regression of home prices on the latter exhibits an adjusted R^2 of 0.205 and a *t*-statistic of −3.62 with only an 8-month lead.[46] Regressing home prices on *both* the fixed-rate mortgage (with an 11-month lead) and the federal funds rate (with an 8-month lead) yields a highly significant *t*-statistic for the mortgage rate of −5.20, but an insignificant *t*-statistic for the federal funds rate of −0.51.

This should not come as a surprise. After all, the prices of long-lived assets have always been determined by discounting the flow of income (or imputed services) using interest rates on assets of comparable maturity. No one, to my knowledge, employs overnight interest rates—such as the federal funds rate—to determine the capitalization rate of real estate, whether it be the cash flows of an office building or the imputed rent of a single-family residence.

It is understandable why, before 2002, the federal funds rate would have been perceived as a leading indicator of many statistics that in fact are driven by longer-term interest rates. The correlation between the federal funds rate and the rate on fixed-rate mortgage loans from 1983 to 2002, for example, had been a tight 0.86.[47] Accordingly, during those years, regressions with home prices as the dependent variable would have seemingly worked equally well with either long-term rates or overnight rates as the explanatory variable.

46. Both regressions, however, especially that using the funds rate, exhibit significant serial correlation, suggesting that the *t*-statistics are likely too high.

47. As a consequence, the Federal Reserve assumed that the term premium (the difference between long- and short-term rates) was a relatively stable, independent variable. The failure in 2004 and 2005 of the 325-basis-point rise in the funds rate to carry the yield on the 10-year Treasury note along with it (as historically it almost invariably had) was deemed a "conundrum." That episode has dramatically changed the long-held view that U.S. long-term interest rates were significantly influenced, if not largely determined, by monetary policy.

The emergence of globally arbitraged long-term rates has largely delinked U.S. long-term rates from Federal Reserve policy. It has accordingly changed the "conundrum" from why the 10-year Treasury note yield unexpectedly failed to respond to changes in the funds rate in 2004, to why the interest rate term structure was so stable through the latter part of the 20th century. Any notion that the Federal Reserve had of that stability being a fundamental characteristic of U.S. finance was dashed with the emergence of globally arbitraged long-term rates.

But the fixed-rate mortgage clearly delinked from the federal funds rate in the early part of this century. The correlation between them fell to an insignificant 0.10 during 2002–05, the period when the bubble was most intense, and as a consequence, the funds rate exhibited little, if any, influence on home prices.

The funds rate was lowered from 6½ percent in early 2001 to 1¾ percent in late 2001, and then eventually to 1 percent in mid-2003, a rate that held for a year. The Federal Reserve viewed the lowering to 1 percent as an act of insurance against the falling rate of inflation in 2003, which had characteristics similar to the Japanese deflation of the 1990s. We thought the probability of deflation small, but the consequences, should it occur, dangerous. On the other hand, we recognized that a funds rate held too low for too long might encourage *product* price inflation. I thought at the time that the rate decrease nonetheless reflected an appropriate balancing of risks. I still do.

To my knowledge, that lowering of the federal funds rate nearly a decade ago was not considered a key factor in the housing bubble. Indeed, as late as January 2006, Milton Friedman, historically the Federal Reserve's severest critic, evaluating monetary policy from 1987 to 2005, wrote, "There is no other period of comparable length in which the Federal Reserve System has performed so well. It is more than a difference of degree; it approaches a difference of kind."[48]

It thus came as somewhat of a surprise when, in August 2007, Stanford University's John Taylor (with whom I rarely disagree) argued that Federal Reserve policy in the aftermath of the dot-com bubble was the principal cause of the emergence of the U.S. housing bubble. According to Taylor (2007), had the funds rate followed his eponymous rule, housing starts would have been significantly lower and the U.S. economy would have avoided "much of the housing boom" and price bubble. His conclusion, often copied and repeated, seems, I fear, to have become close to conventional wisdom.[49]

As evidence, Taylor notes first the "significant" inverse correlation, with a lag, from mid-1959 to mid-2007 between the federal funds rate and

48. Milton Friedman, "The Greenspan Story: 'He Has Set a Standard,' " *Wall Street Journal,* January 31, 2006.

49. For example, a recent survey by the *Wall Street Journal* (Jon Hilsenrath, "Bernanke Challenged on Rates' Role in Bust," January 14, 2010) found that 78 percent of Wall Street and business economists surveyed and 48 percent of academic economists surveyed thought, "Excessively easy Fed policy in the first half of the decade helped cause a bubble in house prices."

housing starts and argues that according to his rule (a useful first approximation to a central bank's monetary policy stance), the Federal Reserve had set an inappropriately low funds rate during 2002–05.[50] As a consequence, he claims, "housing starts jumped to a 25-year high. . . . The surge in housing demand led to a surge in housing price inflation. [The] jump in housing price inflation then accelerated the demand for housing in an upward spiral" (Taylor 2007).

Taylor postulates housing starts as the primary driver of home prices. The evidence, however, suggests that it is not starts that drive prices and initiate the "upward spiral," but the other way around (figure 11). Home price changes, with a 6-month lead, have significant explanatory power for single-family starts from mid-1976 to 2009: the adjusted R^2 is 0.36, and the *t*-statistic is 15.0. American home builders, in my experience, respond to home price changes, not the federal funds rate, to determine how many "homes for sale" they start. And the home price change, as I noted earlier, is a function of lagged long-term mortgage rates.

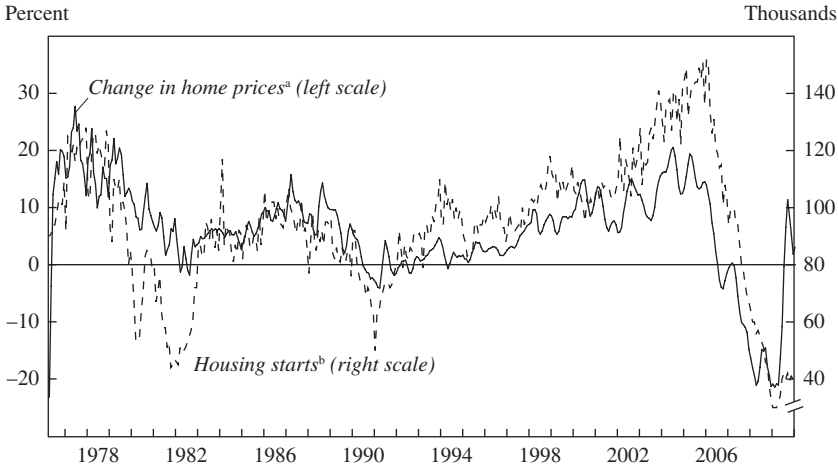
Housing starts, in any event, should be extraneous to Taylor's explanation of the bubble. It is employed because the Taylor rule by itself is structured to indicate a proper federal funds rate to balance the trade-off between inflation and unemployment. There are no asset price inputs, especially home prices, called for in the Taylor rule. Home prices cannot be substituted willy-nilly for the consumer price index (CPI) or the core personal consumption expenditures (PCE) price index in the Taylor paradigm. The CPI could stand as a proxy for home prices if the correlation between the two were very high. But it is not. The correlation between home prices and consumer prices, and between asset prices in general and product prices, is small to negligible, and on occasion negative. The Taylor rule clearly cannot be applied to asset prices, especially when benign product price inflation is almost surely a necessary condition for an income-producing-asset price bubble.[51]

The correct interpretation of a Taylor rule as applied to the period 2002–05 that stipulates that the federal funds rate is too low is that *product*

50. The Taylor rule indicated, according to a chart in Taylor (2007), that the funds rate should have been set at an average of 3.7 percent during 2002–05, compared with an actual average rate of 1.8 percent. Taylor's calculations employ the consumer price index as the inflation variable. Employing the core personal consumption expenditures price index, the Federal Reserve's preferred measure, narrows the gap significantly.

51. Moreover, the usual culprits behind either asset or product price inflation were missing. Growth in the M2 measure of the money stock, for example, was well behaved during 2002–05.

Figure 11. Home Prices and Housing Starts, 1976–2009



Source: Standard & Poor's, LoanPerformance, and Bureau of the Census.

a. Three-month moving average of seasonally adjusted monthly data. Before December 1999, LoanPerformance Single-Family Combined Home Price Index; from December 1999 onward, S&P/Case-Shiller Composite 20-City Index.

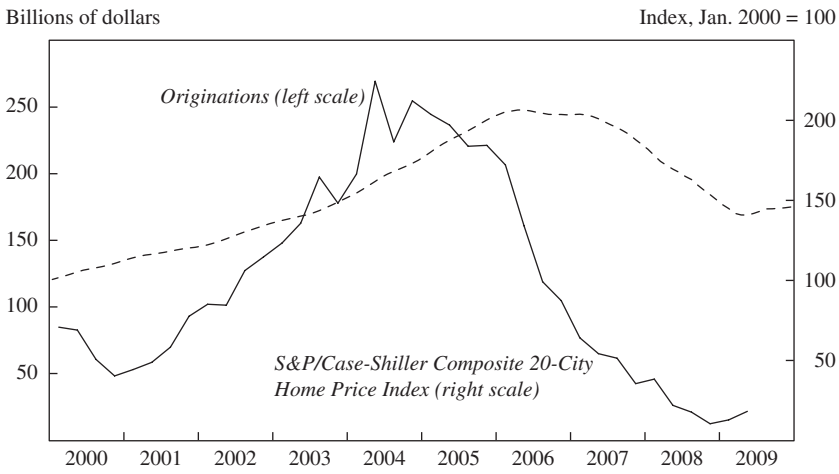
b. Starts of single-family homes, seasonally adjusted monthly data.

price inflation (the core implicit PCE deflator in the Federal Reserve's case) is threatening, and rate hikes to meet it are indicated. But inflation did not threaten. Indeed, core PCE averaged a modest annual inflation rate of only 1.9 percent during that period. Thus not only was the Taylor rule inappropriate for assessing the causes of asset price increases; it also gave a false signal for policy to stabilize the core PCE price.

The believers in Federal Reserve "easy money" policy as the root of the housing bubble correctly note that a low federal funds rate (at only 1 percent between mid-2003 and mid-2004) lowered interest rates for ARMs. That, in turn, they claim, increased demand for homes financed by ARMs and hence was an important contributor to the emergence of the bubble.

But in retrospect, it appears that the decision to buy a home most likely preceded the decision of how to finance the purchase. I suspect (but cannot definitively prove) that during that period of euphoria, a large majority of homebuyers who ended up financing with ARMs would have instead funded their purchases with fixed-rate mortgages had ARMs not been available. How else can one explain the peaking of originations of ARMs 2 years *before* the peak in home prices (figure 12)? Market demand obviously did not need ARM financing to elevate home prices during the last 2 years of the expanding bubble.

Figure 12. Home Prices and Originations of Adjustable-Rate Mortgages, 2000–09[a]



Source: Mortgage Bankers Association and Standard & Poor's.
a. Both series are quarterly data, seasonally adjusted.

Taylor (2009), confronted with evidence that the housing bubble was global, alludes to a seemingly tight relationship in a number of European countries between the degree of deviation from the Taylor rule and the size of the bubble. But a recent study by Federal Reserve staff (Dokko and others 2009), using a broader sample of countries, notes that deviations from the Taylor rule do not seem to be correlated with changes in home prices. They conclude (p. 31) that the relationship is "statistically insignificant (and relatively weak in economic terms as well)."

Moreover, Taylor does not buy the global saving-investment explanation of the decline in real long-term interest rates (which he foreshortens into the "saving glut") as the trigger of the global housing bubble. He succinctly states,

> Some argue that the low interest rates in 2002–4 were caused by global factors beyond the control of the monetary authorities. If so, then the interest-rate decisions by the monetary authorities were not the major factor causing the boom. This explanation—appealing at first glance because long-term interest rates remained low for a while after the short-term federal funds rate began increasing—focuses on global saving. It argues that there was an excess of world saving—a global saving glut—that pushed interest rates down in the United States and other countries. The main problem with this explanation is that there is no actual evidence of a global saving glut. On the contrary . . . the global saving rate—world saving as a fraction of world GDP—was low in the 2002–4 period, especially when compared with the 1970s and 1980s. (Taylor 2009, p. 6)

Here Taylor is employing ex post data to refute analysis based on ex ante saving and investment intentions (see section II.A above), an argument most economists should find puzzling.

V.B. Could the Breakdown Have Been Prevented?

Could the breakdown that so devastated global financial markets have been prevented? Given inappropriately low financial intermediary capital (that is, excessive leverage) and two previous decades of virtually unrelenting prosperity, low inflation, and low long-term interest rates, I very much doubt it. Those economic conditions are the necessary, and likely the sufficient, conditions for the emergence of a bubble in income-producing assets. To be sure, central bank monetary tightening has the capacity to break the back of any prospective cash flow that supports bubbly asset prices, but almost surely at the cost of a severe contraction of economic output, with indeterminate consequences. The downside of that trade-off is open-ended.[52]

But why not tighten incrementally? There are no examples, to my knowledge, of a successful incremental defusing of a bubble that left prosperity intact. Successful incremental tightening by central banks to gradually defuse a bubble requires a short-term feedback response.[53] But policy affects an economy with long and variable lags of as much as 1 to 2 years.[54] How does the FOMC, for example, know *in real time* if its incremental tightening is affecting the economy at a pace the policy requires? How much in advance will it have to tighten to defuse the bubble without disabling the economy? But more relevant, unless incremental tightening significantly raises risk aversion (and long-term interest rates) or disables the

52. Tight regulations on mortgage lending—for example, down payment requirements of 30 percent or more, the removal of the mortgage interest tax deduction, or elimination of home mortgage nonrecourse provisions—would surely severely dampen enthusiasm for homeownership. But they would also limit homeownership to the affluent, unless ownership by low- and moderate-income households were fully subsidized by government. Since January 2008 the subprime mortgage origination market has virtually disappeared. How will HUD's affordable housing goals (see note 10) be achieved in the future?

53. Some econometric models imply such capability for asset prices in general and home prices in particular. They achieve this by assuming a stable term structure, which, of necessity, yields a tight relationship between the federal funds rate and long-term rates. The latter is then employed to capitalize a flow of income (imputed housing services in the case of homes).

54. See, for example, Alan S. Blinder, "The Case for Optimism on the Economy," *Wall Street Journal,* December 16, 2009.

economy enough to undercut the cash flow that supports the relevant asset prices, I see little prospect of success.

The Federal Reserve's one attempt at incremental tightening failed. In early 1994 we embarked on a 300-basis-point tightening to confront what we perceived at the time as growing inflationary pressures. It was a policy that could have been just as easily read by the market as an incremental tightening to defuse the then-incipient dot-com bubble.

We not only failed to defuse the nascent stock market bubble that was evident in late 1993, but arguably enhanced it. The ability of the economy to withstand a severe monetary tightening in 1994 inadvertently demonstrated that the emerging boom was stronger than markets had anticipated and, as a consequence, raised the equilibrium level of the Dow Jones Industrial Average.[55] This suggested that a tightening far greater than the 1994 episode or the tightening in 2000 would have been required to quash the bubble. Certainly a funds rate far higher than the 6½ percent that was reached in mid-2000 would have been required.

At some rate, monetary policy can crush any bubble. If 6½ percent is not enough, try 20 percent, or 50 percent for that matter. But the state of prosperity will be an inevitable victim.[56] In 2005 we at the Federal Reserve did harbor concerns about the possible resolution of the housing bubble euphoria that gripped the nation. In 2005 I noted, "History has not dealt kindly with the aftermath of protracted periods of low risk premiums" (Greenspan 2005, p. 7).

However, we at the Federal Reserve never had a sufficiently strong conviction about the risks that could lie ahead. As I noted earlier, we had been lulled into a state of complacency by the only modestly negative economic aftermaths of the stock market crash of 1987 and the dot-com bust. Given that history, we believed that any decline in home prices would be gradual. Destabilizing debt problems were not perceived to arise under those conditions.

For guidance, we looked to the policy response to the unprecedented one-day stock-bubble bust of October 19, 1987, and the 2000 bear market. Contrary to prior experience, large injections of Federal Reserve liquidity

55. For details see Greenspan (2004a).

56. Such actions would obviously provoke an extreme political response. Although the decisions of the FOMC are not subject to legal reversal, the range of monetary policy choices has been politically constrained to what constitutes conventional wisdom in academia. As recent evidence reaffirms, the Federal Reserve's degree of policy independence is fixed by statute, and it can be altered or eliminated by statute.

apparently did help stabilize the economy—previously such crashes had led to economic retrenchment.

Unless there is a societal choice to abandon dynamic markets and leverage for some form of central planning, I fear that preventing bubbles will in the end turn out to be infeasible. Assuaging their aftermath seems the best we can hope for. Policies, both private and public, should focus on ameliorating the extent of deprivation and hardship caused by deflationary crises. But if an effective way, other than substantial increases in capital, to defuse leveraged bubbles without a major impact on economic growth were discovered, it would be a major step forward in organizing our market economies.

VI. In Summary

In this paper I have endeavored to trace the powerful economic forces that emerged in the aftermath of the Cold War and led to a dramatic decline and convergence of global real long-term interest rates. That in turn engendered, first, a dramatic global home price bubble heavily leveraged by debt, and second, a delinking of monetary policy from long-term interest rates.[57]

The global bubble was exacerbated by the widespread packaging of U.S. subprime and alt-A mortgages into securities, which found willing buyers at home (especially the GSEs) and abroad, many encouraged by grossly inflated credit ratings. More than a decade of virtually unrivaled global prosperity, low inflation, and low long-term interest rates reduced global risk aversion to historically unsustainable levels.

The bubble started to unravel in the summer of 2007. But unlike in the "debt-lite" deflation that followed the earlier dot-com boom, heavy leveraging set off serial defaults, culminating in what is likely to be viewed as the most virulent financial crisis ever. The major failure of both private risk management (including credit rating agencies) and official regulation was to significantly misjudge the size of the tail risks that were later exposed in the aftermath of the Lehman default. Had capital and liquidity provisions to absorb losses been significantly higher going into the crisis, contagious defaults surely would have been far less.

This paper has argued accordingly that the primary imperative going forward has to be increased regulatory capital, liquidity, and collateral

57. Whether the latter will continue with a less arbitrageable international bond market remains to be seen.

requirements for banks and shadow banks. I have also noted a number of less important reform initiatives that may be useful.

But the notion of an effective "systemic regulator" as part of a regulatory reform package is ill advised. The chronic sad state of economic forecasting should give governments pause on that issue. Standard models, except when heavily adjusted by ad hoc judgments, could not anticipate the current crisis, let alone its depth. Indeed, models rarely anticipate recessions, unless, again, the recession is artificially forced into the model structure.

In closing, let me reiterate that the fundamental lesson of this crisis is that, given the complexity of the division of labor required of modern global economies, we need highly innovative financial systems to ensure the proper functioning of those economies. But although, fortunately, most financial innovation is successful, much is not. And it is not possible in advance to discern the future success of each innovation. Only adequate capital and collateral can resolve this dilemma. If capital is adequate, then, by definition, no financial institution will default and serial contagion will be thwarted. Determining the proper level of risk-adjusted capital should be the central focus of reform going forward.

We can legislate prohibitions on the kinds of securitized assets that aggravated the current crisis. But markets for newly originated alt-A and adjustable-rate subprime mortgages, synthetic collateralized debt obligations, and many previously highly popular structured investment vehicles no longer exist. And private investors have shown no inclination to revive them. The next crisis will no doubt exhibit a plethora of innovative new assets, some of which will have unintended toxic characteristics that no one can forecast in advance. But if capital and collateral are adequate, losses will be restricted to those equity shareholders who seek abnormal returns but in the process expose themselves to abnormal losses. Taxpayers should not be at risk.

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Comments and Discussion

COMMENT BY

N. GREGORY MANKIW This is a great paper. It presents one of the best comprehensive narratives about what went wrong over the past several years that I have read. If you want to assign your students only one paper to read about the recent financial crisis, this would be a good choice. There are some pieces of the analysis about which I am skeptical. But before I get to that, let me emphasize several important points of agreement.

Greenspan refers to recent events in the housing market as a "classic euphoric bubble." He is certainly right that asset markets can depart from apparent fundamentals in ways that are often hard to understand. This has happened before, and it will happen again. When the bubble bursts, the aftershocks are never pleasant.

Greenspan then points out that the political process, rather than reducing the risks associated with the bubble, actually contributed to them. In a footnote, he points out that in October 2000, in the waning days of the Clinton administration, the Department of Housing and Urban Development finalized rules that expanded the affordable housing goals of the government-sponsored enterprises (GSEs) Fannie Mae and Freddie Mac. As a result, the GSEs increased their holdings of subprime mortgages substantially. Although neither Greenspan nor I would suggest that the crisis was primarily the result of misguided housing policies, we both believe that these policies served to make a bad situation worse. This fact is important to keep in mind—not to assess blame; there is more than enough of that to go around. Rather, in judging how much policy can accomplish going forward, one should be mindful of how imperfect the political process is.

When considering what future regulation can do to reduce the likelihood of future crises, Greenspan emphasizes that whatever rules are promulgated

cannot be premised on policymakers' ability to anticipate an uncertain future. In my view this is particularly wise. Some think the main cause of the recent crisis is that policymakers failed to anticipate the bursting of the housing bubble. If only we had central bankers with greater prescience, the argument goes, all this could have been avoided. In my view—and, I believe, Greenspan's as well—this is wishful thinking in the extreme. It indeed would be nice if somehow the individuals guiding the national economy had superhuman powers to see into the future. In reality, our economic leaders are mortals who share the same biases and flaws in perception as market participants.

What, then, can be done to make the financial system more crash-proof? Greenspan offers several good suggestions. First and most obvious, capital requirements should be raised. This is truer now than it has ever been. By bailing out almost every major financial institution that needed it, as well as a few that did not, the federal government raised the expectation of future bailouts, thereby turning the entire financial system, in effect, into a group of GSEs. Going forward, creditors to these institutions will view them as safe, and so they will lend to them too freely. The institutions, in turn, will be tempted to respond to their low cost of debt by leveraging to excess. Higher capital requirements are needed to counteract this newly expanded moral hazard.

Second, I like Greenspan's idea of "living wills," in which financial intermediaries are required to offer their own plans to wind themselves down in the event they fail. The advantage of this idea is that when future failures occur, as they surely will, policymakers will have a game plan in hand. How well these financial living wills will work, however, is hard to say. Like real wills, they may well be contested by "next of kin"—the counterparties to the institution's transactions. For living wills to work, they would need to be made public—say, by putting them on a centralized webpage—to discourage the counterparties from complaining after the fact that they thought they had more legal rights in the event of liquidation than they do.

Third, and perhaps most important, I like the idea of requiring financial firms to issue contingent debt that will turn into equity when some regulator deems that the firm has insufficient capital. Essentially, this debt would become a form of preplanned recapitalization in the event of a future financial crisis. But most important, the recapitalization would be done with private rather than public money. Because the financial firm would pay the cost of these contingent funds, rather than enjoying taxpayer subsidies, it would have an incentive today to lower its risk profile, for instance by

reducing its leverage. The less risky the firm, the less likely it is that the contingency would be triggered, and the lower the interest rate the firm would pay on this contingent debt.

This brings me to the one conclusion of the paper with which I disagree—or, at least, I was not sufficiently persuaded. The issue concerns the importance of leverage to the viability of a financial intermediary. Greenspan proposes raising capital requirements and reducing leverage, but he suggests that there are limits to this. If leverage is reduced too much, he argues, financial intermediaries will be not be sufficiently profitable to remain viable. He offers some back-of-the-envelope calculations that purport to show how much leverage the financial system needs to stay afloat.

When I read this part of the paper, my first thought was, What about the Modigliani-Miller theorem? Recall that this famous theorem says that a firm's value as a business enterprise is independent of how it is financed. The debt-equity ratio determines how the risky cash flow from operations is divided among creditors and owners, but it does not affect whether the firm is fundamentally viable as a going concern. It seems to me that, as least as a first approximation, the logic of this theorem should apply to financial intermediaries as well as to other types of business. If not, why not?

I think it is clear where, from the Modigliani-Miller perspective, Greenspan's calculations go awry. He assumes that the rate of return on equity must be at least 5 percent. But as he notes, this number is actually endogenous to the degree of leverage. If a bank is less leveraged, its equity will be safer, and the required rate of return should fall.

Indeed, one can imagine a bank with almost no leverage at all. Suppose banks were required to hold 100 percent reserves against demand deposits, and that all bank loans had to be financed 100 percent with bank capital. A bank would then, in essence, be a marriage of a super-safe money market mutual fund with an unleveraged finance company. (Such a system would be similar to what is sometimes called "narrow banking.") It seems to me that a banking system operating under such strict regulations could well perform the crucial economic function of financial intermediation. No leverage would be required.

Such a system would, however, forgo the "maturity transformation" function of the current financial system, in which many banks and other intermediaries borrow short and lend long. The issue I am wrestling with is whether maturity transformation is a crucial feature of a successful financial system. The resulting maturity mismatch seems to be a central element of banking panics and financial crises. The open question is what value it

has and whether the benefits of today's highly leveraged financial system exceed the all-too-obvious costs.

To put the point most broadly: The Modigliani-Miller theorem says leverage and capital structure are irrelevant, yet many bankers would surely claim they are central to the process of financial intermediation. A compelling question on the research agenda is to figure out who is right, and why.

COMMENT BY

JEREMY C. STEIN It is a pleasure to comment on this important and wide-ranging paper by Alan Greenspan. In light of the breadth of ground that it covers, I will have to focus my comments on just a couple of the issues that struck me as particularly interesting. The first of these concerns the central role of capital and liquidity requirements in any attempt to reform financial markets. As the paper states, "The most pressing reform, in my judgment, in the aftermath of the crisis is to fix the level of regulatory risk-adjusted capital, liquidity, and collateral standards required by counterparties." I agree with this view. Moreover, Chairman Greenspan makes a highly welcome contribution by taking this observation to the logical next step: he poses, and attempts to answer, the quantitative question of just how high capital requirements should be raised. This is a point on which most policymakers have thus far been conspicuously silent.

The paper argues for a regulatory minimum ratio of book equity to assets in the neighborhood of 14 percent. The argument has two parts. First, a rough calculation suggests that a 14 percent ratio would provide the banking sector with a buffer adequate to see it through a crisis equal in magnitude to that of the last few years. And second, another back-of-the-envelope exercise yields the conclusion that a 14 percent regulatory minimum would not be overly burdensome, in the specific sense that it would not prevent banks from earning a return on equity in line with historical averages.

In the same spirit of simple calibration, I would like to offer another approach to the second piece of the puzzle: the costs associated with raising capital requirements by several percentage points. My analysis is nothing more than an application of the standard weighted average cost of capital (WACC) machinery that is routinely taught to MBA students everywhere, which augments the Modigliani-Miller (1958) paradigm to take account of corporate income taxes. Suppose that equity capital requirements are raised very substantially—say, by 10 percentage points. Moreover, suppose that at the margin, this additional equity displaces long-term debt in the capital

structure of the affected banks. According to Modigliani-Miller, the only net effect of this change on banks' WACC (and hence on the rate they charge for corporate or consumer loans, for example) comes from the lost tax deductions on the long-term debt that is eliminated. Thus, if the displaced debt yielded, say, 7 percent, then given a 35 percent corporate tax rate, a 10-percentage-point reduction in the debt tax shield would raise the WACC by $0.10 \times 0.07 \times 0.35 = 0.00245$, or about 25 basis points. Again, this is the impact of a very large increase in the equity capital ratio, equivalent to going from a low initial ratio of 4 percent all the way up to the level suggested by Greenspan of 14 percent.

Of course, this calculation comes with a number of caveats. First, and perhaps most important, it should be thought of as capturing the long-run steady-state costs of having to *hold* more equity on the balance sheet, while disregarding the transitional flow costs associated with *raising* the required new equity. Given the adverse selection problems associated with new equity issues (Myers and Majluf 1984), these flow costs may be significant. This implies that if higher capital requirements are phased in too abruptly—so that banks have to get there through large external equity issues, rather than by gradually accumulating retained earnings—the transitional impact on their lending behavior may be much higher than my 25-basis-point figure suggests.

Another caveat is that even in a long-run steady state, taxes may not be the only relevant violation of the idealized Modigliani-Miller conditions. To take one example, Gary Gorton and Andrew Metrick (2010) and Stein (2010) argue that banks like to issue collateralized short-term debt because this debt commands a "money-like" convenience premium based on its relative safety and the transactions services that safe claims provide. If one takes a crude upper bound on this convenience premium to be 1 percent, and if capital requirements have the effect of crowding out such short-term debt at the margin, as opposed to long-term debt, this would add another $0.10 \times 0.01 = 10$ basis points to the overall effect,[1] for a total of 35 instead of 25. This logic suggests that other sensible modifications are also likely to have only a relatively small effect.

All of this would therefore seem to reinforce—albeit with a quite different methodology—the broad conclusions in Greenspan's paper, namely, that although there are undoubtedly costs associated with significant increases in bank capital requirements, a crude estimate of these costs does not

1. Krishnamurthy and Vissing-Jorgensen (2010) estimate the convenience premium associated with Treasury securities to be on the order of 70 basis points, which suggests that my 100-basis-point number is probably a conservative upper bound.

suggest that they are prohibitive. Said differently, both his analysis and mine would appear to give significant comfort to those who worry that plausibly higher capital requirements will make bank loans much more expensive.

And yet there would seem to be an obvious tension here. Banks manifestly care a great deal about optimizing their capital structures, and they show a persistent tendency to gravitate toward high leverage. In contrast, most nonfinancial firms, many of which operate with dramatically lower leverage, seldom appear to be nearly as strongly drawn toward any fixed target capital structure. So although the Modigliani-Miller-plus-taxes paradigm may be adequate for capturing the relatively small benefits of debt for nonfinancial firms, one wonders, in light of their very different behavior, whether the same paradigm does not leave out something of first-order importance when it comes to financial firms. Put simply: if higher capital ratios have only a small impact on the WACC for financial firms, why do they—unlike their nonfinancial counterparts—resist them so forcefully?

My own attempt at reconciling this tension goes as follows. Perhaps the substitution of equity for debt finance does in fact have the same small effects on the WACC for financial and nonfinancial firms—say, 25 basis points for a 10-percentage-point change in the equity ratio. But what is different about financial firms are the *competitive implications* of a small cost-of-capital disadvantage. An auto manufacturer or a software firm is unlikely to be driven out of business over a 25-basis-point cost-of-capital difference; so many other factors—the quality of its product, the loyalty of its customer base, and so on—are so much more important that it can fail to fully optimize on the cost-of-capital dimension and still survive. In contrast, for a financial firm, cheap capital is the single dominant input, and it simply cannot afford to cede a 25-basis-point edge to its competitors. In this sense, high leverage is for financial firms like what a performance-enhancing drug is for elite sprinters: even if the drug is harmful to health and cuts only a few hundredths of a second from their times, with all else so closely matched, they may not feel they can afford not to take it.

On the one hand, the drug analogy makes much stricter capital regulation seem like a no-brainer: if it can stop a systemically unhealthy form of competition with only a minimal impact on performance (in this case, on the cost of loans to corporations and households), then it would seem highly desirable from a social perspective. The hitch, however, is that, much like with drug testing, the same competitive forces create a powerful motive for evading the regulation. One important channel for this evasion is migration of credit creation from the regulated banking sector to the less regulated

shadow banking sector. For example, instead of keeping a consumer loan on its balance sheet, subject to the more stringent capital rules, a bank can bundle the loan with other, similar loans into a security, which winds up, say, in the portfolio of a hedge fund, which in turn finances its purchase of the security largely with overnight repos and only a very thin slice of capital.

Although such migration may leave the banks themselves safer, it is much less clear that it leaves the financial system in better shape should a crisis occur. One of the most dramatic features of the subprime crisis was the complete collapse of the market for asset-backed securities—and not just those related to subprime mortgages, but also those based on auto loans, credit card receivables, student loans, and other assets. This market collapse, which was arrested only by the Federal Reserve's intervention with the Term Asset-Backed Securities Loan Facility (TALF), played an important role in deepening the credit crunch.

The bottom line is that I do not worry too much about the effects of higher capital requirements on the cost of loans to households and firms. Based on the sorts of calculations sketched above, my best estimate is that these effects will be relatively muted. At the same time, I worry a great deal about the effects on *how and by whom* credit is provided, and the potential implications of these changes for overall systemic stability.

To be clear, I do not at all mean to suggest that capital requirements for banks should not be significantly higher. Indeed, if forced to pick a number for the required capital ratio, I might well come out somewhere in the same range as Greenspan. However, the danger of competition leading to evasion of the capital requirement suggests that the focus should not be just on banks, or even just on all bank-like institutions. Rather, an effort must be made to impose similar capital standards *across a given asset class,* no matter who winds up holding the asset. This will not be an easy task, but one tool that might be helpful is broad-based regulation of "haircuts" (that is, minimum margin requirements) on asset-backed securities that trade in the shadow banking market. Returning to the previous example, this regulation might stipulate that whoever holds a tranche of a consumer loan securitization, be it a hedge fund, a pension fund, or anybody else, would be required to post a minimum haircut against that tranche. The value of the haircut would depend on the seniority of the tranche, the underlying collateral, and so forth. If these haircut requirements are well structured, they could go a long way toward achieving harmonization across organizational forms, in that there would be no obvious advantage based on avoidance of regulation to moving the consumer loans off the balance sheets of banks and into the shadow banking sector.

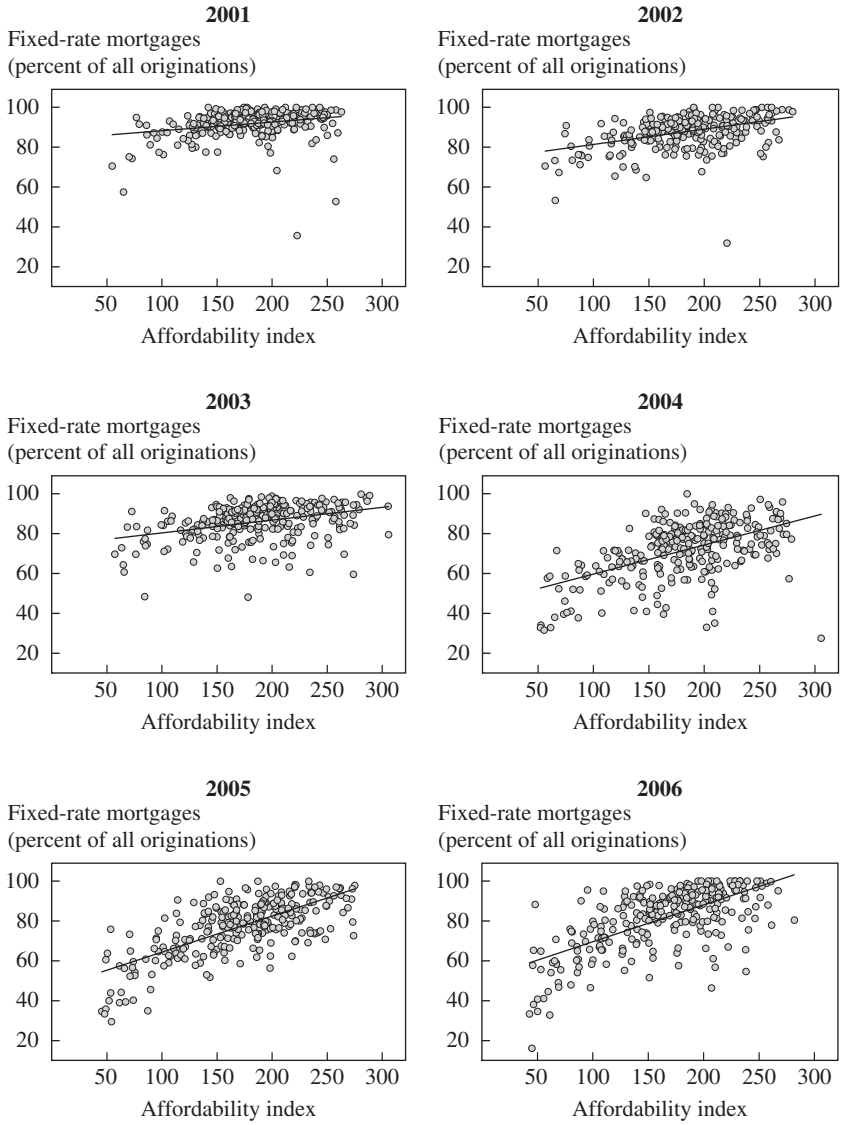
My reading of Greenspan's paper is that he is fundamentally sympathetic to this approach, and indeed that he has something very much along these lines in mind when he refers to the need to "fix the level of . . . collateral standards required by counterparties." If so, I hope that other policymakers will pay careful attention to his advice.

On a different note, I am inclined to be more skeptical of Greenspan's analysis when he downplays the role of low short-term interest rates in the initial years of the housing boom. He writes, "The global home price bubble . . . was a consequence of lower interest rates, but it was *long-term* interest rates that galvanized home asset prices, not the overnight rates of central banks, as has become the seeming conventional wisdom" (emphasis in original). My own suspicion is that short-term rates did play an important independent role, by reducing the required monthly payments for borrowers taking out adjustable-rate mortgages (ARMs), whose rates are tied to short-term market rates. This hypothesis presumes that some of these borrowers were either myopic or liquidity constrained, so that their initial monthly payment—as opposed to the expected payments over the life of the loan—was decisive in their choice. Although this presumption may not accurately characterize the behavior of the majority of borrowers in normal real estate markets, perhaps it rings more true as a description of the recent subprime boom.

In any case, although I do not have conclusive evidence for my hypothesis, I can offer one suggestive set of plots. Figure 1 plots, for each year from 2001 through 2006, the share of fixed-rate mortgages in total mortgages initiated in each of 269 metropolitan statistical areas (MSAs) against an affordability index for that MSA. The affordability index is from Moody's Economy.com and is based on the median family income in an MSA relative to the monthly mortgage payment on a median-priced home in that MSA (assuming a conventional fixed-rate mortgage loan). Higher values of the index correspond to greater affordability, that is, to higher ratios of incomes to home prices.

The figure conveys two key messages. First, throughout the period, ARM use is more prevalent in more expensive cities, where liquidity constraints are presumably more likely to be binding on homebuyers. Second, this relationship becomes strikingly more pronounced between 2002 and 2004, when the federal funds rate was bottoming out and home prices began to rise dramatically. This latter effect is consistent with the key mechanism underlying my hypothesis, namely, that the short-term rate works through its ability to reduce the monthly payments for income-constrained borrowers who finance their homes with ARMs.

Figure 1. Share of Fixed-Rate Mortgages and Housing Affordability in 269 MSAs, 2001–06



Source: Benjamin Iverson, Harvard Business School, and James Vickery, Federal Reserve Bank of New York, using data from Moody's Economy.com and the Monthly Interest Rate Survey from the Federal Housing Finance Agency.

a. Each observation is for a single MSA. The affordability index is based on the ratio of median family income in an MSA to the monthly payment on a conventional fixed-rate mortgage for a median-priced home in that MSA. Higher values of the index indicate greater affordability (that is, a higher ratio of median income to mortgage payment). Lines are fitted regression lines.

Again, this evidence is only suggestive, and more work would be required to support the story I have in mind with any real degree of confidence. Nevertheless, at a minimum, I believe that the role of short-term rates in the recent housing bubble remains an important open question.

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GENERAL DISCUSSION Several panelists expressed thanks to Chairman Greenspan for his service to the nation and for his candor in stating that the events of the last few years had led him to revise some long-held views.

Gregory Mankiw agreed with Jeremy Stein that in the presence of taxes there is a preference for debt over equity, to which banks may well respond more than other firms. If that is the case, then the policy prescription is clear: reform the tax code to eliminate the preference for debt.

Alan Blinder pointed to what seemed an incipient consensus on there being two types of bubble, although this may oversimplify what might really be a continuum. Bubbles of the first type, which includes the tech stock bubble of the late 1990s, are based on equity rather than leverage and credit, whereas those of the second, which include the recent crisis, are based on excessive leverage. The Greenspan-Bernanke mop-up-after view of how to deal with crises continues to make sense for the first type but not for the second. One reason is that the Federal Reserve has informational advantages in the credit system, especially the banking part. If the Federal Reserve were designated an explicit systemic risk regulator over the entire financial system, that informational advantage would become even larger.

Blinder agreed with Greenspan that more equity capital in the financial structure of financial institutions has to be part of the solution, but he was unsure whether it is the whole solution. There is potentially an intermediate course of action between forced bankruptcy, as in the case of Lehman Brothers, and bailout, as in the case of AIG. The government can step in and grab hold of the reins, fire management, wipe out the shareholders, impose some losses on creditors, and then take the failed firm into either receivership or conservatorship. Authority to undertake such resolutions will be an important part of any reform—not because it will prevent bubbles, but because it will mitigate the fallout and the cost to taxpayers when they happen. Related to this is the need to require more collateral behind purchases of over-the-counter derivatives—the capital markets analogue to increasing bank capital. One could go further and more or less force derivatives transactions onto organized exchanges, by imposing a higher capital requirement for derivatives not traded on exchanges. Reform should also include doing something about the go-for-broke incentives that were rampant in financial markets in the run-up to the crisis.

Benjamin Friedman observed that strengthening capital requirements is also about accounting reform. Often what matters is not just the specific percentage by which assets must be backed by equity, but also the specification of the asset total by which that percentage gets multiplied. For example, the chief problem at Citibank was the $100 billion in assets that were off the balance sheet, and therefore against which the bank held zero capital. The comparable off-balance-sheet amount at Lehman Brothers was $50 billion. In each case the needed reform is not choosing a new percentage but requiring that capital be held against a much more inclusive specification of the firm's assets.

Friedman also thought the Modigliani-Miller perspective, which had been suggested by both discussants, was interesting but led to a troubling conclusion. The standard Modigliani-Miller theorem assumes not only no taxes, but also no bankruptcy. If the banking system as a whole is operating at one level of leverage, then any one bank that is forced to make do with less leverage is at a competitive disadvantage. If the banking system requires some minimum amount of leverage to do business, this implies some probability of any bank (or even all of them) failing, and this in turn requires either a public sector subsidy or the possibility of a taxpayer bailout. If that is so, it means there cannot be a banking sector unless the banks collectively have a leverage ratio high enough to put the taxpayer at risk.

Finally, Friedman posed a question for Greenspan on the choice between regulation by public institutions and regulation by creditors. Before the crisis, Greenspan had argued forcefully and articulately that the latter was superior. The paper, however, was as sharply critical of one as of the other. Friedman therefore wondered whether the experience of the crisis had changed Greenspan's thinking on the relative advantages of the two.

Olivier Blanchard followed up on Mankiw's remarks regarding maturity transformation. In the aggregate, most savers probably have a longer horizon than the firms to which they lend. Much of this saving is for retirement or other long-term purposes, whereas much physical capital has a life of about 10 years. Thus, at the macro level, the transformation of short-term saving into long-term investment does not seem that important, yet many institutions are involved in precisely that process.

Martin Baily laid out two views prevalent among noneconomists of what caused the crisis: one is that it was all about greedy bankers, whose actions produced a market failure of the worst kind. The other is that it was a government failure, either of the regulators or of housing policy. For those who think the culprit was federal policy, the answer is to change the policy—to get the government out of the way and let the market work. For those who think the problem was market failure, the answer is to strengthen regulation. But in Baily's view the crisis was caused by both market failure and government failure, and therefore to some extent both things have to be done—some mix of less government in some areas and more government in others is needed.

Baily agreed that bubbles cannot be forecast precisely, but that does not mean that nothing can or should be done when one sees a bubble forming. If you know you have high cholesterol, you may not know whether or when you will have a heart attack, but it is still a good idea to take anti-cholesterol medication. When policymakers—both financial regulators and monetary authorities—observe a highly leveraged increase in asset prices, they should do something, even though they risk being wrong in their diagnosis. It is worth taking out the insurance policy of at least leaning against that particular wind. It would also be a good idea for the Federal Reserve to have another tool that it presently lacks, namely, the ability to adjust margin requirements or capital requirements of all kinds—for example, to set minimum down payments for mortgages in the event of an incipient mortgage bubble.

Baily agreed, to some degree, that a large moral hazard had been created. There were good reasons to protect debtors in the heat of the crisis, but doing so also created a danger: investors might believe that the regula-

tors will not regulate the next time either. On the other hand, the moral hazard problem can be overstated. The managers of financial institutions have certainly taken a hit: almost all the institutions that got into trouble have replaced their managers. Shareholders have taken a big hit as well. The problem is mainly on the debtors' side, and it needs to be dealt with through the living wills and other resolution mechanisms that Greenspan mentioned, to make sure that the debtors cannot walk away unscathed.

Christopher Carroll called the Panel's attention to the fact that Robert Shiller, in a December 1996 speech at the Federal Reserve, had warned of a bubble emerging in the stock market, and that in January 2004, speaking again at the Federal Reserve, Shiller had warned of a bubble emerging in the housing market. Perhaps when Robert Shiller enters the precincts of the Federal Reserve Board, he takes on supernatural powers that give him intuition on this subject that others lack. But if one or at least a few respected economists have strong intuitions that a bubble is in the process of forming, that does seem an appropriate time for regulators to think about becoming more vigilant.

Christopher Sims cited the paper's observation that the private sector did not seem to price systemic risk very well leading up to the crisis. This suggests the presence of an externality: just because private agents do not take account of the risks they impose on the system does not mean that systemic risk does not exist. That the markets did not seem to react to this risk in advance raises the question of whether regulators could do better. There is some chance that the right kind of regulators could do better, through aggressive information collection or examination of accounting practices, for example. Then the question becomes how to avoid regulatory capture. In the years leading up to the crisis, it had become politically difficult to suggest tighter regulation. One argument for assigning more responsibility for systemic regulation to the Federal Reserve rather than some other agency is that the Federal Reserve has a dedicated revenue source and its governors serve 14-year terms. These things go a long way toward making regulators independent and allowing them to avoid capture.

George von Furstenberg interpreted the paper's message to private financial institutions as "Go ahead and spill it—we will mop it up." Yet this policy, he argued, has already led to enormous underpricing of risk and subsequent socialization of enormous losses. This was indeed the opposite of central planning—it was central bungling. In other words, what produces a deviation from market models is to let markets be perceived as failing in an egregious way. Therefore, it is important to take precautions and buffer the system against the destructive effects of bubbles. If bubbles

are not preventable, then much greater precautions are necessary. Some of these have absurdly kicked in after the fact: now the Federal Housing Administration and the GSEs have increased their lending standards; now firms like AIG are subject to special margin requirements. There are many things that can be done to reduce the vulnerability of the system to bubbles, if bubbles there must be. If you know that hailstorms exist but cannot predict them, you do not have to stand outdoors bareheaded. There are ways to reduce your exposure. Certainly the only course is not just to mop up afterward—a strategy that in this case has been anything but market directed, and has been very incomplete and extremely costly to the taxpayer.

Richard Cooper agreed with Greenspan that banks, at a minimum, should be subject to higher capital requirements, and perhaps other financial institutions should as well. He wondered why that general point is not even more broadly applicable—why not, for example, impose minimum down payment requirements on homebuyers? The Federal Reserve had full authority to require the institutions it regulated to impose such requirements; in the spirit of Baily's anti-cholesterol metaphor, imposing such requirements in 2003 and 2004 might have prevented the heart attack, given what was known at the time.

Cooper also agreed with Friedman on the need for accounting reform, and specifically for bringing structured investment vehicles and the like onto banks' consolidated balance sheets. He was at least as interested, however, in the principles governing the valuation of assets and liabilities, particularly when regular markets do not exist (for venture capital, for example) or when they have frozen, as happened in late 2008. In this country, accounting rules are left to an entirely private body called the National Accounting Standards Board, which operates under the principle that all information that can conceivably be brought onto the financial statements should be. Transparency and bringing things onto the balance sheet are two different things, however. Cooper wondered whether the process for setting accounting standards in general ought to be reviewed, or whether a set of regulatory accounting standards ought to be established that would be used for setting capital requirements, rather than relying on mark-to-market rules, particularly when the market valuations have to be artificially simulated or taken from a few distress transactions.

Robert Hall noted that Martin Baily had prescribed anti-bubble medication as if a best-selling medication of that type already existed. But the paper's argument was that the interest rate controlled by the central bank is not an effective anti-bubble medication, at least with respect to real

estate. Prospective investors capitalizing the value stream from a piece of real estate look far into the future, yet the central bank's influence is limited to a relatively short horizon. Hall pointed out that many countries that did not have ARMs—and the great majority do not—also had huge housing bubbles. The evidence points to low long-term interest rates as what matter when valuing housing, and therefore suggests that it was low global long-term rates, not short-term rates, that caused what became a worldwide bubble.

Hall went on to note that the other anti-bubble medication, suggested by Richard Cooper, involves introducing frictions into financial markets by regulating down payments or margins. There is nothing intrinsically wrong or dangerous about making risky loans, provided that the institutions holding the loans are not huge, highly leveraged, and systemically important. Getting a much more robust financial system is the solution to this problem, not anti-bubble medication. The economy rode through the equity bubble that popped in 2000 without any financial crisis. It should be able to ride through a real estate bubble just as well.

Justin Wolfers noted that the paper was largely silent on the shadow banking system and hoped for more discussion of that topic in the final draft.