

The Crisis

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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 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 now under way.

The central theme of this paper is that in the years leading up to the current 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.

In sections II through V, this paper reviews the causes of the crisis. In sections VI to VIII, the nature of financial intermediation is probed; in sections IX to XV, a set of reforms that I hope address the shortcomings of the existing regulatory structure; in sections XVI and XVII, the role of monetary policy in the current crisis is examined; and section XVIII, the conclusion.

II. 1. The Arbitraged Global Bond Market and the Housing Crisis

It was the global proliferation of securitized, toxic U.S. subprime mortgages that was the immediate trigger of the current crisis. But the roots of the crisis reach back, as best I can judge, to the aftermath of the Cold War.

The fall of the Berlin Wall¹ 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 that was 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 economic export-oriented model of the so-called Asian Tigers: fairly well educated low-cost workforces joined with developed-world technology, protected by an increasing rule of law, unleashed explosive economic growth.² The 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 of workers became subject to domestic competitive forces, especially in the former Soviet Union. As a consequence, between 2000 and 2007, the real GDP growth of the developing world was more than double that of the developed world.

The consequence was a pronounced fall from 2000 to 2005 in both global real long-term interest rates⁴ and nominal long-term rates (exhibit 1) which indicated that global saving intentions, of necessity, had chronically exceeded global intentions to invest. In the developing world, consumption restrained by culture and inadequate consumer finance could not keep up with the surge of income and, as a consequence, the

¹ For a more detailed explanation, see A. Greenspan, *The Age of Turbulence: Adventures in a New World*, 2007. Chapter 20.

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

³ IMF World Economic Outlook 2007, Chapter 5, p. 162.

⁴ Desroches, Brigitte and Michael Francis. "World Real Interest Rates: A Global Savings and Investment Perspective." Bank of Canada. Working Paper. March, 2007.

savings rate of the developing world soared from 24% of nominal GDP in 1999 to 34% by 2007, far outstripping its investment rate.

Yet the *ex post* global saving – investment rate in 2007, overall, was 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. That weakened global investment was the major determinant in the decline of global real long-term interest rates was also the conclusion of the March 2007 Bank of Canada study.⁵ Of course, whether it was a glut of excess intended saving or a shortfall of investment intentions, the conclusion is the same: lower real long-term interest rates.

Inflation and long-term rates in all developed economies and major developing economies by 2006 had converged to single digits, I believe for the first time ever. The path of the convergence is evident in the unweighted variance of interest rates on ten-year sovereign debt of 15 countries that declined markedly from 2000 to 2005 (exhibit 2).⁶ Equity and real-estate capitalization rates were inevitably arbitrated lower by the fall in global long-term real interest rates. Asset prices, particularly house prices, accordingly moved dramatically higher.

The Economist's surveys document the remarkable convergence of nearly 20 individual nations' house price rises during the past decade.⁷ Japan, Germany, and Switzerland (for differing reasons) being the only important exceptions. U.S. price gains, at their peak, were no more than the global peak average.⁸ In short, geo-political events

⁵ Ibid.

⁶ The variances of the logs of the 15 long term interest rates exhibit similar trends.

⁷ For example, *The Economist*, September 13, 2007.

⁸ World Economic Outlook, April 2008.

ultimately led to a fall in long-term mortgage interest rates that in turn led, with a lag, to the unsustainable boom in house prices globally.

II. 2 Securitization of Subprimes: the Crisis Story Unfolds

Subprime mortgages in the United States for years had been a small appendage to the broader U.S. home mortgage market, comprising only 7% of total originations as recently as 2002. Most such loans were fixed-rate mortgages, and only a modest amount had been securitized. With the price of homes having risen at a quickening pace since 1997 (exhibit 3), such 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 home mortgages into securities (exhibit 4). The firms clearly had found receptive buyers. Both domestic and foreign investors, largely European,⁹ were drawn to the above average yield on these securities and a foreclosure rate on the underlying mortgages that had been in decline for two years.

Another factor contributing to the surge in demand was the heavy purchases of subprime securities by Fannie Mae and Freddie Mac, the major U.S. Government Sponsored Enterprises (GSE). Pressed by the Department of Housing and Urban Development¹⁰ and the Congress to expand “affordable housing commitments,” they chose to meet them by investing heavily in subprime securities. The firms accounted for an estimated 40% of all subprime mortgage securities (almost all adjustable rate), newly

⁹ 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 writedowns relative to residential mortgage loans. Global Financial Stability Report, IMF, October 2009, p.10.

¹⁰ In October 2000, the U.S. Department of Housing and Urban Development (HUD) finalized a rule “significantly increasing the GSEs’ affordable housing goals” for each year 2001 to 2004. In November 2004, the annual housing goals for 2005 and beyond were raised still further. (Office of Policy Development and Research, Issue Brief No. V and others).

purchased, and retained on investors' balance sheets during 2003 and 2004 (exhibit 5).¹¹ That was an estimated five times their share of newly purchased and retained in 2002, implying that a significant proportion of the increased demand for subprime mortgage backed securities during the years 2003-2004 was effectively politically mandated, and hence driven by highly inelastic demand.

By the first quarter of 2007, virtually all subprime originations were being securitized, (compared with only half in 2000,)¹² and subprime mortgage securities outstanding totaled more than \$900 billion, a rise of more than six-fold since 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 subprime mortgage securities into what appeared to be a vast and receptive global market. As loan underwriting standards rapidly deteriorated,¹³ subprime mortgage originations swelled by 2005 and 2006 to a bubbly 20% of all U.S. home mortgage originations, almost triple their share in 2002.

¹¹ FHFA Annual Report to Congress 2008, (Revised) Historical Data Tables 5b Part 2 and 14b Part 2. (Originally published May 18, 2009, updated to include a significant reclassification effective September 3, 2009.) Prior to revision, I estimated the share at only 25%. Data newly reclassified by Fannie Mae accounts for almost all the revision.

¹² *The 2009 Mortgage Market Statistical Annual*. Inside Mortgage Finance Publications, Inc., 2009.

¹³ We at the Federal Reserve were aware as early as 2000 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.

II. 3. 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 covenants¹⁴ were eased as a classic euphoric global bubble took hold. By 2007, yield spreads in the overall debt markets had narrowed to a point where there was little room for further underpricing of risk. Our broadest measure of credit risk, the spread of yields on CCC, or lower, bonds (against 10-year U.S. Treasury bonds) fell to a probable record low in the spring of 2007, though only marginally so (exhibit 6). 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 raised the spectre of “irrational exuberance” in 1996¹⁵ only to watch the dot-com boom, after a one-day stumble, continue to inflate for four 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 that “. . . our 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 formalized by Citigroup’s Charles Prince’s now famous remark in 2007, just prior to the onset of the crisis, that “When the music stops, in terms of liquidity,

¹⁴ These 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.

¹⁵ Remarks at the Francis Boyer Lecture of The American Enterprise Institute for Public Policy Research, December 5, 1996

¹⁶ Failing to anticipate the length and depth of emerging bubbles should not have come as a surprise. Though we like to pretend otherwise, policymakers, and indeed forecasters in general, are doing exceptionally well if we can get projections essentially right 70% of the time. But that means we get it wrong 30% of the time. In 18½ years at the Fed, I certainly had my share of the latter.

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 risked being able to anticipate the onset of crisis in time to retrench. They were mistaken. They believed the then seemingly insatiable demand for their array of exotic financial products would enable them to sell large parts of their portfolios without loss. 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 falling capitalization rates that decline measurably below their long term

¹⁷ *Financial Times*, July 9, 2007.

¹⁸ Note that I am defining risk aversion more broadly than the narrow economic definition 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 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 can thus range from zero to full.

The extremes of zero and full risk aversion, of course, are outside all human experience. Zero risk aversion – that is, no aversion at all to engaging in risky actions – implies an individual not caring about – or not being able to discriminate among – objective states of risk to life and limb. Such individuals cannot (or do not choose to) recognize life-threatening events.

To achieve the food, shelter, and the other necessary contributors to living requires action, that is, the taking of risks, by either 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 we never observe in practice.

Day by day existence occurs well within the 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 (see, for example, exhibit 7). The AAA railroad bonds of the immediate post-Civil War years reflect spreads over U.S. treasuries that are similar to our post-World War II experience.

trendless averages.¹⁹ Falling capitalization rates propel one or more asset prices to unsustainable levels. All bubbles burst when risk aversion reaches its irreducible minimum, i.e. credit spreads approaching zero, though analysts' ability to time the onset of deflation has proved illusive.

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 Reinhart and Rogoff data demonstrate,²⁰ appears to be a function of the degree of debt leverage in the financial sector, particularly when the maturity of debt is less than the maturity of the assets it funds.

I very much doubt that in September 2008, had financial assets been funded predominately by equity instead of debt, that the deflation of asset prices would have fostered a default contagion much beyond that of the dotcom boom. It is instructive in this regard that no hedge fund has defaulted on debt throughout the current crisis, despite very large losses that often forced fund liquidation.

II. 4. 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 that burst with very little footprint on global GDP, and in the U.S., the mildest recession in the post-World War II period. And indeed the previous U.S. recession (1990-1991) was the second most shallow. Coupled with the fact that the

¹⁹ Long term Treasury real yields, 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 standards) were effectively zero.

²⁰ Reinhart, Carmen M. and Kenneth S. Rogoff, This Time is Different: Eight Centuries of Financial Folly, Princeton University Press, 2009.

1987 stock market crash left no visible impact on GDP, it led the Federal Reserve and many a sophisticated investor to believe that future contractions would also prove no worse than a typical post-war recession.

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. . . [T]he overall U.S. economy is holding up well . . . [and] the signs elsewhere are very encouraging.”²¹ Basel regulations did induce a modest increase in capital requirements leading up to the crisis. But the debates in Basel over the pending global capital accord, which emerged as Basel II, were largely between stable bank-capital requirements and less bank capital. 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 Nobel Prize winners in economics²² was so thoroughly embraced by academia, central banks, and regulators that by 2006 it became the core of global regulatory standards (Basel II). Many quantitative firms whose number crunching sought to expose profitable market trading principles were successful so 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 prior to the current crisis did not yield a model that could anticipate a crisis.

Mathematical models that define risk, however, are surely superior guides to risk management than the “rule of thumb” judgments of a half century ago. To this day it is

²¹ IMF World Economic Outlook, April 2007, p.xii.

²² Harry Markowitz, Robert Merton, Myron Scholes, and Fisher Black, had he lived.

hard to find fault with the *conceptual* framework of our models as far as they go. Fisher Black and Myron 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 is arguably the major source of the critical risk management system failures.

Only modestly less of a problem was the vast, and in some cases, the virtual indecipherable complexity of a broad spectrum of financial products and markets that developed with the advent of sophisticated mathematical techniques to evaluate risk.²³ In despair, an inordinately large part of investment management subcontracted 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 government sanctioned rating organizations.

But despite their decades of experience, the analysts of 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, the financial system arguably would have held together had the second bulwark against

²³ I often argued that because of the complexity, we had to rely on an international “invisible hand” to bring equilibrium to such undecipherable markets. The high level of market liquidity (erroneously) appeared to confirm that the system was working.

crisis—our regulatory system—functioned effectively. But, under crisis pressure, it too failed.

U.S. commercial and savings banks are extensively regulated, and even though for years our largest 10 to 15 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. The heavily praised U.K. Financial Services Authority was unable to anticipate, and prevent, the bank run that threatened Northern Rock. The venerated credit rating agencies bestowed ratings that implied Aaa 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.

III. 1. The Purpose of Finance

The ultimate goal of financial structure and regulation in a market economy is to direct a nation's saving, plus any saving borrowed from abroad (the current account deficit), towards investments in plant, equipment and human capital that offer the greatest increases in a nation's output per 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) overall standards of living for a nation as a whole. The evident success of finance for decades prior to the onset of this crisis in directing our scarce savings into real

productive capital investments appears to explain the extent nonfinancial market participants had been compensating U.S. financial services.

The share of U.S. gross domestic income accruing to finance and insurance, according to the Bureau of Economic Analysis, had risen fairly steadily from 2.3% in 1947 to 7.9% in 2006 (exhibit 8). Only a small part of the rise was the result of an increase in net foreign demand for U.S. financial and insurance services.²⁴ The decline in the share to 7.4% in 2008 reflects write-offs of previously presumed productively employed saving.

Given the historic breakdown of the last 2 years, did non-financial 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 period 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 *six* decades.²⁵ Moreover the share of *growth* in finance to the *growth* in nominal GDP has been largely trendless since 1990, averaging about 10% (exhibit 9).²⁶ The proportion of nonfarm employment accounted for by finance and insurance since 1947, has risen far less than gross income originating, implying a significant upgrading of skills and compensation attracted to finance. A recent study²⁷ indicates a pronounced above average rise in the salaries of those employed in finance, presumably

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

²⁵ How productively a nation's saving has been invested in fixed assets often cannot be known for years.

²⁶ A continuation of that rate of marginal growth implies that the *average share* that had been rising for six decades should soon flatten out, even if no regulatory reform is forthcoming.

²⁷ Philippon, Thomas and Ariell Reshef, "Wages and Human Capital in the U.S. Financial Industry: 1909-2006," NBER Working Paper, December 2008.

reflecting the greater skills drawn to finance in recent years. By 2007, a quarter of all graduates of the venerable California Institute of Technology entered finance.²⁸

What are we to make of this extraordinarily persistent stable uptrend? Is it wholly accidental? (After all, there is no evidence of such a trend in the pre-war years). It is not that the value of assets to be managed has been persistently rising relative to GDP.²⁹ The answer to this question matters a great deal.

In the context of financial reform, the critical question that must be addressed is whether a 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?³⁰

I raise the issue because many recent policy recommendations would lower the shares of financial income in GDP. Would such policies affect growth of U.S. nonfinancial productivity and our standards of living? The more important issue given the recent failure of risk management and regulation is whether increased financial regulation at this time thwarts or enhances (through increased stability) economic growth. We need a far deeper understanding of the role of financial intermediation in economic growth to answer that question.

²⁸ *The Economist*. February 13, 2010.

²⁹ Household net worth is a proxy for the net worth of the economy to be managed at a fee. The ratio of 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.

³⁰ Increased, but less pronounced, financial shares are evident in the U.K., Canada, Germany, and Japan, among others. The most rapidly expanding, and increasingly market-oriented economy, China, reports a rise in financial intermediary shares of GDP from 1.6% in 1980 to 5.4% in 2008.

III. 2. Risky Financial Intermediation

A financial intermediary cannot profitably operate without risk. Holding only short-term riskless government paper insures against credit loss, but the interest income spread will always be negative. Hence, that portfolio, with rare exceptions,³¹ cannot be funded with private credit, except at a loss. Financial intermediaries therefore have no choice but to operate with leverage and accept the risk that entails.

But how much risk is required to obtain a competitive rate of return on capital devoted to financial intermediation? It is evident that the average amount of leverage (the inverse of the equity capital to asset ratio) that banks have been able to take on and remain profitable rose dramatically during the 19th century from less than two prior to the Civil War to ten or more after World War II, apparently because payment systems improved as American banking shifted from largely agricultural loans to commercial loans and competition broadened.

But averages convey little relevant information regarding the distribution of risk. Until the evidence of the impact of Lehman, the shape of the distribution of the extreme negative tail risk was unknown. Since tail risk, in principle at least, is open-ended,³² there will always be *some* risk that can not be covered by bank capital, and hence some, 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 would be a mandated contingent capital bonds (see page 3). Still,

³¹ It is conceivable that in rare instances value added from diversification—an intermediary's primary function—can offset credit loss.

³² Tail risk would converge to zero only if risk aversion were to become absolute, an impossibility if life is to be sustained (see footnote 18).

there will be the possibility, however remote, that the private financial intermediary system falters, requiring sovereign credit to keep vital intermediation functioning.

Central bankers have long been aware of the potential of a breakdown in private financial markets. Indeed in the U.S., 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 considered, and amended, by the Congress. The section grants virtually unlimited authority to the Board to lend in “unusual and exigent circumstances.”

III. 3. 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 chosen implicitly, if not in a more overt fashion, to set 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.”³³

At issue is whether the current crisis is that “hundred year flood.” At best, once in a century observations can 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 rise in unemployment and destitution far exceeded the current, and to most, the 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. Future uncertainty and therefore risk is always greater than near term risk, and hence risk spreads always increases with the maturity of a financial instrument.³⁴ The depth of financial crisis is 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 underway within hours of the Lehman announcement of default.³⁵ The Federal Reserve had to move quickly to support the failing commercial paper market. Unsupported, trade credit withdrawal set off a spiral of global economic collapse within days. Even the almost sacrosanct fully

³³ Greenspan, Alan. *Technology and Financial Services*. Before the Journal of Financial Services Research and the American Enterprise Institute Conference, April 14, 2000.

³⁴ Yields on riskless longer maturities can fall below short-term riskless rates if tight money persuades investors that future inflation will be less.

³⁵ Hugo Bänziger, chief risk officer at Deutsche Bank. *Financial Times*, November 5, 2009.

collateralized repurchase agreement market encountered severe unprecedented difficulties.

We need to dig very deep into peacetime financial history to uncover similar episodes. The call money market, that era's key short term financing vehicle, 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%."³⁶ Even at the height of the 1929 stock market crisis, the call money market functioned, though rates did soar to 20%. 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 is financial stringency at its maximum. Investors are 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, but only at a more micro level.³⁷

IV. 1. Principles of Reform

Given this virtually unprecedented period of turmoil, by what standard should reform of official supervision and regulation be judged? I know of no form of economic organization based on a division of labor, from unfettered laissez-faire to oppressive central planning, that has succeeded in achieving both maximum sustainable economic

³⁶ Sidney Homer and Richard Sylla. A History of Interest Rates 3rd Ed. Rutgers University Press, 1991.

³⁷ As the credits 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.

growth and permanent stability. Central planning certainly failed and I strongly doubt that stability is achievable in capitalist economies, given the always turbulent competitive markets continuously being drawn towards, but never quite achieving, equilibrium (that is the process leading to economic growth).

People acting without forethought can not be productive except by happenstance. Identification of effective innovation is, of necessity, a rational act. Hence, inhibiting irrational behavior when it can be identified, through regulation, as recent history has demonstrated, could be stabilizing. 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 post-war years, with the exception of a limited number of bailouts of U.S. banks,³⁸ 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, that an equity capital-to-asset ratio of 6% to 10%, the range that existed between the years 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, as I noted earlier, was, 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 pre-crisis years as "moderate"

³⁸ Continental Illinois in 1984 for example.

financial crises and euphorias traced out their relevant part of the curve. But since modern financial data compilation began, we never had a “hundred year flood” that exposed the full intensity of the negative tail.

The aftermath of the Lehman crisis traced out a startlingly larger negative tail than most anybody had earlier imagined. I assume, with hope more than knowledge, that that was indeed the extreme of possible *financial* crisis that could be experienced in a market economy.

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 were 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 experiences of the last two years. Employing Monte-Carlo simulations, or other techniques, they concluded, not unexpectedly, that the probability of a financial crisis as severe as the current one would have been predicted to occur far more often than indicated by models with risk distributed normally. Such evidence suggests the onset of a “hundred year flood” more often than once in a century.

The most pressing reform that needs fixing in the aftermath of the crisis, in my judgment, is the level of regulatory risk adjusted capital. Regrettably, the evident potential for gaming of this system calls for an additional constraint in the form of a minimal *tangible* capital requirement. Pre-crisis regulatory capital requirements based on decades of experience designated pools of self-amortizing home mortgages among the safest of private instruments. And a surprisingly, and unfortunately, large proportion of investment portfolio decisions were essentially subcontracted to the (mis-)judgments of credit rating agencies.

That regime is now moot. Capital and liquidity requirements mandated for individual lenders are now apparently adjusting to the upward revised market judgment that the negative tail of risk distribution was underestimated. Private markets accordingly now, as I noted earlier, are requiring economic capital and balance sheet liquidity well in excess of, soon to be amended, Basel II.

Capital and liquidity, in my experience, address almost all of the financial regulatory structure shortcomings exposed by the onset of crisis. In retrospect, there has to be a level of capital that would have prevented the failure, for example, of Bear Stearns and Lehman Brothers. (If not 10%, think 40%.) Moreover, 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.

Our current jerry-built regulatory structure that has evolved over the decades 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) that increased competition also necessarily increased the negative tail risk, necessitating higher capital requirements.

IV. 2. Upward Revisions of Economic Capital

How much capital is currently being required by counterparties will strongly influence the upcoming revisions in *regulatory* capital requirements.

It is too soon to have definitive answers. But very rough approximations can be inferred from the response of bank credit default swaps (CDS) to post-crisis events.³⁹ Its movements should also give us some insight into when the banking system will return to the free lending of the pre-crisis 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 approximately two 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 spread of 5-year credit default swaps of six major U.S. banks⁴⁰ rose from 17 basis points in early 2007, and to 170 basis points just prior to the Lehman default on September 15, 2008. In response to the Lehman default, the 5-year CDS rose to more than 400 basis points by October 10. On the *day* TARP was announced (October 14), the five-year CDS fell to approximately 200 basis points, essentially by half (exhibit 10). The implication of a two percentage point addition to bank book equity capital to asset ratio, reversing roughly half

³⁹ This is the most sensitive measure of the probability of bank default where, for example, the seller of protection insures the holder of a particular debt instrument in the event of default.

⁴⁰ Bank of America, JP Morgan, Citigroup, Goldman Sachs, Wells Fargo, and Morgan Stanley.

the crisis surge in 5 year CDS, implies an overall additional four percentage point rise (from 10% in mid-2007 to 14%) 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, the presumption that the probability of a TARP prior to Lehman was *de minimis*. The abruptness of the market reaction to the TARP announcement appears to confirm such a presumption.

Current book equity ratios to assets are still far from 14%. The equity to asset ratio for commercial banks was (as reported by the FDIC) 11.1% on September 30, 2009 compared with 10.1% in mid-2007. However, removing the more than \$500 billion addition to commercial bank assets in the form of passive holdings of Federal Reserve balances (an asset) would raise the equity to asset ratio to 11.7. But unacknowledged loan losses were estimated by the IMF last October in the hundreds of billions of dollars as well. Trends in relevant liquidity is less readily measured, but is assumed to parallel changes in capital.

That banks still have more equity capital to add is also indicated by the 5-year CDS of December 31, 2009 (and since) priced at near 100bp, still significantly elevated relative to the 17bp level that prevailed in early 2007 when 10% capital was apparently enough to virtually eliminate the threat of default and induce loan officers to lend freely.

There is little doubt that the TARP cash injection markedly reduced the fear of bank default through early 2009. What is more difficult to judge, is the impact on bank CDS of the dramatic increase in bank equity at *market* value relative to bank assets at *market* value. That ratio rose 5 percentage points from the end of March 2009 to the end

of September (7.4% to 12.6%)⁴¹ (exhibit 11). There can be little doubt that this has materially increased the solvency of banks, though apparently only half as effectively, dollar for dollar in protecting solvency as the more permanent book value equity change.⁴²

Much of the repayment of TARP investments to the U.S. Treasury were doubtless financed by new equity issuance made possible by \$650 billion increase in U.S. commercial bank equity at market value, and 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 TARP and capital gains, on bank solvency and willingness to lend, may not be fully clear even in retrospect.

TARP not only inserted capital, but 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 September, 2009 between short term (1 and 3 month) Libor/OIS⁴³ and 5 and 10 year CDS. Short term Libor/OIS spreads had returned to their pre-crisis level; by the end of September, 2009. Long maturity CDS are only part way back.⁴⁴ One year Libor/OIS falls in between. (Exhibit 12). Clearly markets either are discounting some of the bank capital cushion at market value five and

⁴¹ The fourth quarter ratio apparently changed little. The S&P 1500 capitalized market value at the end of fourth quarter was only 2.3% higher than on September 30.

⁴² Between the end of March, 2009 and the end of September, CDS fell from 370 to 125 basis points as the ratio of the market value of equity to the market value of assets rose more than 500 basis points between those dates.

⁴³ A short-term measure of the likelihood of bank default (an alternative to the CDS measure).

⁴⁴ CDS: basis points September 15, 2009 January 14, 2010

10 year	129	110
5 year	125	99
3 year	129	83
1 year	123	66
Libor/OIS: basis points		
3 month	12	12
1 month	7	11

ten 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.

Given the forgoing set of fragile assumptions and conclusions (it's all we have) I would judge that regulatory equity capital requirements in the end will be seen to have risen from the 10% pre-crisis (in terms of book value) to 13% or 14% by 2012, and liquidity requirements to toughen commensurately.

Market participants have also increased required margin and collateral requirements for transactions with nonbank financial intermediaries. In dealing with nonbanks that come in all varieties under the label of "shadow banking," it is probably best to regulate financial products rather than institutions.

IV. 3. What Regulation *Can* Do

What, in my experience, supervision and examination *can* do as back-up to capital requirements and counterparty surveillance is promulgate rules that are preventative and *do not require anticipating an uncertain future*. Supervision:

- can audit and enforce collateral and capital requirements.⁴⁵
- can require the issuance of some debt of financial institutions that will become equity, should equity capital become impaired (see page 33.)
- can, and has, put limits or prohibitions on certain types of concentrated bank lending.

⁴⁵ Increased capital requirements can go a long way to contain large compensation packages. The recent higher profits will be needed to fulfill the capital requirements, especially if global bank competitors have similar capital requirements.

- can prohibit a complex affiliate and subsidiary structure whose sole purpose is tax avoidance or regulatory arbitrage.
- can inhibit the reconsolidation of affiliates previously sold to investors, especially structured investment vehicles (SIVs). When such assets appeared about to fail, sponsoring companies, fearful of reputation risk (a new insight?), reabsorbed legally detached affiliates at subsequent great loss.
- can require “living wills” that mandate a financial intermediary to indicate on an ongoing basis how it can be liquidated expeditiously with minimum impact on counterparties and markets.

IV. 4. Regulatory Capital History

In the late 19th century, U.S. banks required equity capital of 30% of assets to attract the liabilities required to fund their assets. In the pre-Civil War period, that figure topped 50% (exhibit 13). Given the rudimentary nature of 19th century payment systems, and geographically poorly placed distribution of reserves in a then agricultural economy, competition for bank credit was largely local. It enabled national banks on average to obtain net income to asset returns of well over 200 basis points in the late 1880s and probably more than 300 basis points in the 1870s (this compares with 70 basis points a century later.)

Increasing efficiency of financial intermediation owing to consolidation of reserves and improving payment systems, competitively pressed spreads to narrow and allowed capital to asset ratios to decline. In marked contrast, the annual average net income rate of return on *equity* was amazingly stable, rarely falling out of a 5% to 10%

range measured annually during the century 1869 to 1966 (exhibit 14). That meant that net income as a percentage of assets and the degree of leverage were largely proportional, and offsetting, during that century.

The rates of return on assets, and equity (despite the decline in leverage,⁴⁶) moved modestly higher during the years 1966-1982 owing to a rapid expansion in non-interest income, such as fiduciary activities, service charges and fees, net securitization income, (and later investment banking, and brokerage). Noninterest income rose significantly between 1982 and 2006 (increasing net income to equity to a near 15%) as a consequence of a marked increase in the scope of bank powers.

That in part reflected the emergence in April, 1987 of court sanctioned, and Federal Reserve regulated, “Section 20” investment banking affiliates of bank holding companies.⁴⁷ The transfer of such business is clearly visible in the acceleration of bank gross income originating relative to that of investment banks starting in 2000 (exhibit 15).⁴⁸

I assume the historic relative stability of the 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 current crisis will leave in its wake a significantly higher capital to asset ratio requirement, both economic and regulatory, that must be reached if

⁴⁶ The result of rising Basel Committee capital requirements.

⁴⁷ That meant the repeal of the 1933 Glass Steagal Act in 1999 that had separated commercial and investment banking, when it came in the form of Gramm-Leach-Bliley Act, changed very little. From its enactment in 1999 to the Federal Reserve’s acceptance of Goldman-Sachs and JP Morgan as financial services holding companies at the height of the crisis, no applications to employ the greater powers were forthcoming. That forbearance was apparently a desire to stay clear of the Federal Reserve’s regulatory embrace.

⁴⁸ Rates of return crashed during the first half of 2009, with declines matched (on an annual basis) only by those in the years 1932-1934. Both cases reflected a rare sharp breakout from the historic range, resulting mostly from large write offs on previously extended loans.

intermediation is to be restored to the point where banks and other intermediaries are confident they have a sufficiently secure capital cushion to lend freely.

IV. 5. Limits to Regulatory Capital Requirements

When determining the levels of adequate regulatory capital, it is important to recognize that that decision is not independent of the scope of regulated bank activity. There are limits to the level of regulatory capital. A bank, or any financial intermediary, requires significant leverage to be competitive. Without adequate leverage, markets do not provide a rate of return on financial assets high enough to attract capital to that activity.⁴⁹ Yet at too great a degree of leverage, bank solvency is at risk.

To find the regulatory balance we need to seek the highest average ratio of capital to assets a banking system can tolerate before a significant number of banks are required to raise their margin and/or shrink their size.⁵⁰

That question is solvable if we accept as a benchmark the remarkable stability of net income to equity capital (5% to 15%) that has prevailed with rare exceptions since the end of the Civil War (exhibit 14). I assume that a 5% annual 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. If so, the *highest* ratio of capital to assets the U.S. banking system can tolerate and still supply the

⁴⁹ Compared with nonfinancial activities that require substantial highly illiquid fixed assets, a financial intermediary can be created and liquidated (given legal sanction) in short order. Its return on assets is therefore far less than what an average industrial corporation requires. Finance accordingly requires much greater leverage (and risk) to yield a competitive return on equity.

⁵⁰ Though the quality of loans they seek must improve as a consequence, at some point such shrinkage might impair the levels of economic activity that depend on a significant financial sector to facilitate real investment.

nonfinancial sector with adequate financial service capacity can be inferred from the identity:

$\pi/C = (\pi/A)*(A/C)$ where π is net income, C is equity capital, and A is total assets.

If $\pi/C = .05$, then $C/A = 20*(\pi/A)$.

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 non-interest expense to total assets and α is the ratio of taxes and minor other adjustments to total assets.

As can be seen from exhibit 16 all of the rise in π/A and π/C since 1980 owe to the marked rise in non-interest income.

In the years immediately prior to the onset of crisis π/A averaged 0.012 and therefore the inferred maximum average regulatory capital, C/A , was 0.24. A rate higher than 0.24, all else equal,⁵¹ would put the average rate of return on equity below the critical 5% level. If π/A were to revert back to the average of the first quarter century of the post-war period (0.0075) then $\pi/A = 0.0075$ and $C/A = 0.15$, marginally above the 12% to 14% presumed market determined capital requirements, that would induce banks to lend freely.

While such calculations derive from a static model and are necessarily imprecise, they emphasize the regulatory tradeoffs between capital requirements and scope of permissive banking activities. They suggest that a targeted regulatory capital requirement of 13% to 14% of assets leaves considerable leeway for regulators to raise capital

⁵¹ I do not deny 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 history to effectively model. But non-interest income arguably does not.

requirements *provided* that in the process, the scope of activities of banking is not unduly restricted.

In summary, there is an upper limit to the amount of equity capital a financial firm could be required to hold without pressing its rate of return on equity below what history suggests is the average minimum competitive 5%. Because financial intermediation requires significant leverage to be profitable, risks, sometimes large risks, are inherent to this indispensable process. And on very rare occasions, it will break down and may require the temporary substitution of sovereign credit for private capital.

IV. 6. Too Big to Fail

Beyond significantly increased capital requirements is the necessity of addressing the problems of some financial firms being “too big to fail” (TBTF) or more appropriately “too interconnected to be liquidated quickly.” The productive employment of the nation’s scarce saving is being threatened by financial firms at the edge of failure, supported with taxpayer funds, designated as systemically important institutions. I agree with Gary Stern, the former President of the Federal Reserve Bank of Minneapolis, who has long held the position 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.”⁵² These firms absorb scarce savings that needs to be invested in cutting edge technologies, if output per hour and standards of living are to continue to rise.

⁵² Statement before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, Washington, DC, May 6, 2009.

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. Prior to that date, 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 consistently afforded Fannie and Freddie a special credit subsidy. On September 7, 2008, market participants were finally vindicated.⁵³

One highly disturbing consequence of the TBTF-bailout problem that has emerged since the September 2008 federal takeover of Fannie Mae and Freddie Mac is that market players are going to believe that *every* significant financial institution, should the occasion arise, would be subject to being bailed out with taxpayer funds. Businesses that are bailed out have competitive market and cost-of-capital advantages, but not efficiency advantages, over firms not thought to be systemically important.

For years the Federal Reserve had been concerned about the ever larger size of our financial institutions. Federal Reserve research had been unable to find economies of scale in banking beyond a modest-sized institution. A decade ago, citing such evidence,⁵⁴ 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

⁵³ Fannie Mae and Freddie Mac need to be split up into individual companies, none “too big to fail”, then reconstructed into securitizers adding a valuable service to modern finance. Their future solvency can be assured if they are prohibited from accumulating large portfolios of assets that add no useful backing to the process of securitization or the mortgage markets more generally.

⁵⁴ Allen N. Berger and David B. Humphrey. *Bank Scale Economies, Mergers, Concentration, and Efficiency: The U.S. Experience*. The Wharton School: University of Pennsylvania, Page 7, July 1994.

and international economy should they fail.”⁵⁵ Regrettably, we did little to address the problem.

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, has proved untenable during this crisis and I suspect in future crises as well.⁵⁶

The solution, in my judgment, that has at least a reasonable chance of reversing the extraordinarily large “moral hazard”⁵⁷ that has arisen over the past year is to require banks and possibly all financial intermediaries to hold contingent capital bonds, that is, debt which is automatically converted to equity when equity capital falls below a certain

⁵⁵ Greenspan, Alan. The Evolution of Bank Supervision. Before the American Bankers Association, Phoenix, AZ. October 11, 1999.

⁵⁶ FDIC experienced large losses in the value of assets taken over in resolution during the last two years.

⁵⁷ 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 were 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 the American investment banks almost surely would not have occurred had these firms remained the partnerships they were up to a quarter century ago. The ruling (in 1970) that allowed broker-dealers to incorporate and gain permanent capital seemed sensible at the time. Nonetheless, as partnerships, Lehman Brothers and Bear Stearns, would not have departed from their historic low leverage. Prior to incorporation, those entities fearful of the joint and several liability of general partnerships 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 filed for personal bankruptcy and their remaining wealth allowed them to maintain much of their previous standards of living. Replicating the incentive structure of partnerships should be a goal whenever feasible in future reform. To eliminate moral hazard, it should not be necessary to follow Hugh McCulloch, our first Comptroller of the Currency in 1863, somewhat over the edge, proposed 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.

threshold. Such debt will, of course, be more costly on issuance than simple debentures, but its existence could materially reduce moral hazard.

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. That would grant the regulator access to taxpayer funds for “debtor-in-possession financing.” A new statute would create a panel of judges, who are expert in finance. The statute would require creditors (when equity is wholly wiped out) to be subject to statutorily defined principles of discounts from par (“haircuts”) before the financial intermediary was restructured. The firm would then be required to split up into separate units, none of which should be of a size that is too big to fail.

I assume that some of the newly created firms would survive, and others fail. If, after a fixed period of time (one month?), no viable exit from bankruptcy appears available, the financial intermediary should be liquidated as expeditiously as feasible.

IV. 7. Regulations Embodying a Forecast Fail with Regularity

The current 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 if 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 importantly they

cannot, except by happenstance, effectively time the onset of crisis.⁵⁸ 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 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 arbitrated away.

Indeed for years leading up to August 2007, it was widely expected that the precipitating event of the “next” crisis would have been a sharp fall in the U.S. dollar as our current account deficit, starting in 2002, increased dramatically. The dollar accordingly came under heavy selling pressure. The rise in the euro-dollar exchange rate from, say, 1.10 in the spring of 2003 to 1.30 at the end of 2004 appears to have *gradually* arbitrated 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, though because of that it may in the next crisis.

In the years ahead, forecasters will readily identify risk that is underpriced—or at least identify risks priced at less than their historic 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. In the current environment of complexity, I see no ready alternative to significantly

⁵⁸ 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 is visible in credit spreads.

increasing regulatory capital requirements and liquidity and beefing up individual banks' counterparty risk surveillance.

The Federal Reserve had been concerned for years about the ability of regulatory supervisors and examiners to foresee emerging problems that 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.”⁵⁹ Regrettably, that first line of defense failed.

A century ago, examiners could appraise individual loans and judge their soundness.⁶⁰ 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 the loan portfolio of that bank. That in turn would 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

⁵⁹ Alan Greenspan, before the American Bankers Association, September 18, 2000.

⁶⁰ In 1903, O. Henry (W.S. Porter) who had more than a passing relationship with banking shenanigans wrote in “A Call Loan” about a bank examiner from the Office of the Comptroller of the Currency who was obsessed with the collateral backing for a \$10,000 loan: such detailed scrutiny is exceptionally rare in today's larger banks.

of financial misconduct. To examine each such possibility in 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, 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, of necessity, a work force with 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 Madoff. Federal Reserve supervision and evaluation is as good as it gets even considering the failures of past years. Yet the banks still have little choice but to rely upon counterparty surveillance as their first line of crisis defense.⁶¹

V. 1. Monetary Policy and House Price Bubbles

The global house 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. In the United States, the house price bubble was driven by the low level of the 30 year fixed rate mortgage that declined from its mid-2000 peak, six months prior to the FOMC easing of the federal funds rate in January, 2001.

⁶¹ Having served on JP Morgan's board for a decade just prior to my joining the Federal Reserve, I had an extended insight into the relative effectiveness of their counterparty surveillance of Citicorp, Bank of America, Wells Fargo, and others, compared to regulatory surveillance by Federal Reserve banks.

Between 2002 and 2005, monthly home mortgage 30 year rates led monthly U.S. home price change (as measured by the 20 city Case-Shiller home price index) by 11 months with an R^2 (adjusted) of 0.511 and a t-statistic of -6.93; a far better indicator of home prices than the fed-funds rate that exhibited an R^2 (adjusted) of 0.216 and a t-statistic of -3.62 with only an eight month lead.⁶² Regressing both mortgage rates (with an 11-month lead) and the federal funds rate (with an 8-month lead) on home prices yields a highly significant t-statistic for mortgages of -5.20, but an insignificant t-statistic for the federal funds rate of -.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) by interest rates of the same maturities as the life of the asset. No one, to my knowledge, employs overnight interest rates—such as the fed-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 the fed funds rate prior to 2002 would be perceived as a leading indicator of many statistics that in fact are driven by longer-term interest rates. The correlation coefficient in the U.S. between the fed funds rate and the 30-year mortgage rate from 1963 to 2002, for example, had been a tight 0.83.⁶³ Accordingly,

⁶² Both regressions, especially the funds rate, however exhibit significant serial correlation suggesting that t-statistics are likely too high.

⁶³ As a consequence, the Federal Reserve assumed that the term premium was a relatively stable, independent variable. The failure in 2004 and 2005 of the 400 basis point rise in the funds rate to carry the yield on the ten-year Treasury note along with it (as it historically almost invariably did), was deemed a “conundrum.” It 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 arbitrated long term rates has largely delinked U.S. long term rates from Fed 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 Fed had of that stability being a

during those years, regressions with home prices as the dependent variable would have seemingly worked equally as well with either long term rates or overnight rates as the explanatory variable.

But the 30-year mortgage rate had clearly delinked from the fed funds rate in the early part of this decade. The correlation between the funds rate and the 30-year mortgage rate fell to an insignificant .17 during the years 2002 to 2005, 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% in early 2001 to 1¾% in late 2001, and then eventually to 1% in mid-2003, a rate that held for a year. The Federal Reserve viewed the 1% rate as an act of insurance against the falling rate of inflation in 2003 that had characteristics similar to the Japanese deflation of the 1990's. The Fed thought the probability of deflation small, but the consequences, should it occur, dangerous. But 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, in evaluating the period of 1987 to 2005, wrote, "There is no other period of comparable length in which

fundamental characteristic of U.S. finance was dashed with the emergence of globally arbitrated long term rates.

the Federal Reserve System has performed so well. It is more than a difference of degree; it approaches a difference of kind.”⁶⁴

It thus came as somewhat of a surprise that in August 2007, Stanford University’s John Taylor (with whom I rarely disagree) argued that Fed policy in the aftermath of the dot-com bubble was the principle cause of the emergence of the U.S. housing bubble.⁶⁵

According to Taylor, 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, I fear, appears to have become close to conventional wisdom.⁶⁶

As evidence Taylor notes first the “significant” inverse correlation, with a lag, from mid-1959 to mid-2007 between the federal funds rate and 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 the years 2002 to 2005.⁶⁷ As a consequence, “housing starts jumped to a 25-year high... The surge in housing *demand* led to a surge in housing price inflation (*italics mine*). [The] jump in housing price inflation then accelerated the demand for housing in an upward spiral.”

Taylor inappropriately equates starts (an increase in supply) with demand, the primary driver of home prices. The evidence suggests that it is not starts that drive prices and initiate the “upward spiral,” but the other way around (exhibit 17). Home price

⁶⁴ *Wall Street Journal*, January 31, 2006.

⁶⁵ Taylor, John B. “Housing and Monetary Policy,” Kansas City Federal Reserve Bank Economic Symposium. Jackson Hole, WY. August 2007.

⁶⁶ For example, in a recent survey by the *Wall Street Journal* (1/14/10) found that 77% of Wall Street and business economists and 48% of academic economists thought “Excessively easy Fed policy in the first half of the decade helped cause a bubble in house prices.”

⁶⁷ The Taylor Rule indicated, according to a Taylor chart, that the funds rate should have been set at an average of 3.8% during the period 2002 to 2005 compared with an actual funds rate that averaged 1.8%. Taylor’s calculations employ the CPI as the inflation variable. Employing the core PCE price, the Federal Reserve’s preferred measure, narrows the gap significantly.

change, with a 6-month lead, has significant explanatory power for single-family starts from 1976 to 2009 (R^2 (adjusted) of .36, t-statistic of 15.0). American home builders, in my experience, respond to price change to determine how many “homes for sale” they start, not the federal funds rate. And 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 CPI or core PCE price in the Taylor paradigm. CPI could stand as a proxy for home prices if the correlation between home prices and CPI 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 or, 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.⁶⁸

The correct interpretation of a Taylor Rule as applied to the period 2002 to 2005 that stipulated that the federal funds rate is too low is that *product* 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 inflation rate of only 2.0% during the years 2002 to 2005. Thus not only was the Taylor

⁶⁸ Moreover, the usual culprits of either asset or product price inflation were missing. M2 growth, for example, was well behaved during the years 2002 to 2005.

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 of Fed “easy money” policy as the root of the housing bubble correctly note that a low fed fund rate (at only 1% between mid-2003 and mid-2004) lowered interest rates for adjustable rate mortgages (ARM). That in turn, they claim, increased demand for homes financed by ARMs and hence were an important contributor to the emergence of the bubble.

But, in retrospect, it appears that the decision to buy homes preceded the decision of how to finance the purchase. I suspect (but cannot definitively prove) that a large majority of home buyers financing with ARMs, were ARMs not being offered, (during that period of euphoria) would have instead funded their purchases with 30-year fixed rate mortgages. How else can one explain the peaking of originations of ARMs two years *prior* to the peak in home prices (exhibit 18). Market demand obviously did not need ARM financing to elevate home prices during the last two years of the expanding bubble.

Taylor, confronted with evidence that the housing bubble is 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 bubbles.⁶⁹ But a recent study by Federal Reserve staff, using a broader sample of countries, notes that deviations from the Taylor rule do not seem to be correlated with changes in house prices. They conclude that the

⁶⁹ Taylor, John B. Getting Off Track. Stanford, California: Hoover Institution Press, 2009.

relationship is “statistically insignificant (and relatively weak in economic terms as well).”⁷⁰

Moreover, John Taylor does not buy the global saving-investment explanation of the decline in real long term interest rates as the trigger of the global housing bubble that he foreshortens into the “saving glut.” 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.”⁷¹ Taylor is employing *ex post* data to refute analysis based on *ex ante* saving and investment intentions (see page 5), an argument most economists should find puzzling.

V. 2. Could the Breakdown Have Been Prevented?

Could the breakdown that so devastated global financial markets have been prevented? Given inappropriately low financial intermediary capital (i.e. excessive leverage) and two decades of virtual unrelenting prosperity, low inflation, and low long-

⁷⁰ Dokko, Jane, et.al., “Monetary Policy and the Housing Bubble,” Finance and Economics Discussion Series, Federal Reserve Board, Washington, DC, December 22, 2009.

⁷¹ Taylor, John B, op. cit.

term interest rates, I very much doubt it. Those economic conditions are the necessary, and likely the sufficient, conditions for the emergence of an income-producing asset bubble. To be sure, central banks have 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 tradeoff is open-ended.⁷²

But why not incremental tightening? There are no examples, to my knowledge, of a successful incremental defusing of a bubble that left prosperity in tact. Successful incremental tightening by central banks to gradually defuse a bubble requires a short-term feedback response.⁷³

But, policy impacts an economy with long and variable lags of as much as one to two years.⁷⁴ How does the FOMC for example know in *real time* if its incremental ever-greater tightening is impacting 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 relevantly, unless incremental Fed tightening significantly raises risk aversion (and long-term interest rates) or disables the economy enough to undercut the cash flow that supports the relevant asset prices, I see little prospect of success.

⁷² Tight regulations on mortgage lending, for example, down payment requirements of 30% or more, the removal of the mortgage interest tax deduction, and eliminating home mortgage non-recourse provisions would surely severely dampen enthusiasm for homeownership. But that would delimit home ownership to the affluent, unless low and moderate income ownership were fully subsidized by government. Since January 2008, the subprime origination market has virtually disappeared. How will HUD's affordable housing goals (see footnote 10) be achieved in the future?

⁷³ 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 services in the case of homes).

⁷⁴ See, for example, Alan Blinder, *Wall Street Journal*, December 15, 2009.

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 already underway.

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.⁷⁵ This suggested that a tightening far greater than the 1994 episode and the tightening in 2000 would have been required to quash the bubble. Certainly a funds rate far higher than the 6½% that was reached in mid-2000 would have been required.

At some rate, monetary policy can crush any bubble. If not 6½%, try 20%, or 50% for that matter. Any bubble can be crushed, but the state of prosperity will be an inevitable victim.⁷⁶ In 2005 we at the Fed 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."⁷⁷

⁷⁵ For details see remarks by Alan Greenspan at the annual meeting of the American Economic Association in January 3, 2004.

⁷⁶ Such actions would obviously provoke an extreme political response. While the decisions of the FOMC are not subject to legal reversal, the range of monetary policy choices is politically restrained 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.

⁷⁷ Alan Greenspan at a Jackson Hole Symposium, August 26, 2005.

However we 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 boom. Given history, we believed that any declines in home prices would be gradual. Destabilizing debt problems were not perceived to arise under those conditions.

For guidance, we looked to policy in response to the unprecedented one-day stock-bubble bust of October 19, 1987 and 2000 bear market. Contrary to any prior experience,⁷⁸ large injections of Federal Reserve liquidity apparently did help stabilize the economy.

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 to defuse leveraged bubbles without a major impact on economic growth is discovered, it would be a major step forward in organizing our market economies.

VI. In Summary

In this paper, I endeavor to trace the powerful economic forces that emerged in the aftermath of the Cold War that led to a dramatic decline and convergence of global real long-term interest rates. That in turn engendered (1) a dramatic global home price

⁷⁸ Previously, such crashes led to economic retrenchment.

bubble heavily leveraged by debt and (2) a delinking of monetary policy from long-term rates.⁷⁹

The global bubble was exacerbated by the heavy securitization of American subprime and Alt-A mortgages that found willing buyers at home 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 the debt-lite deflation of the earlier dotcom 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 and official regulation was to significantly misjudge the size of tail risks that were 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 argues accordingly that the primary imperative going forward has to be (1) increased regulatory capital and liquidity requirements on banks and (2) significant increases in collateral requirements for globally traded financial products, irrespective of the financial institutions making the trades. I also note on page 27 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 current sad state of economic forecasting should give governments pause on the issue. Standard models, other than those that are heavily add-

⁷⁹ Whether the latter will continue with a less arbitrageable international bond market remains to be seen.

factored, could not anticipate the current crisis, let alone its depth. Indeed, models rarely anticipate recessions, unless again, the recession is add-factored into the model structure.

Exhibit 1

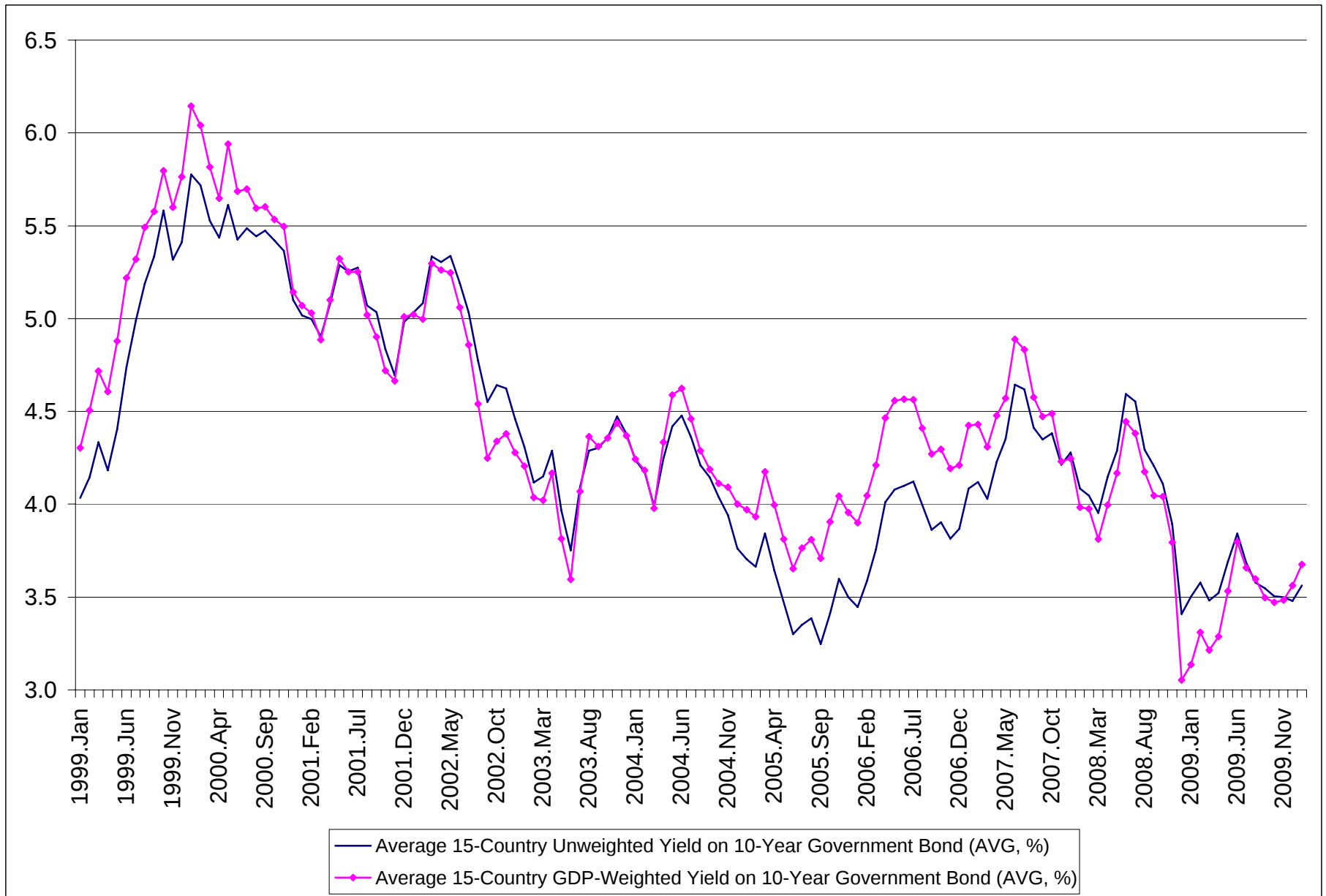


Exhibit 2

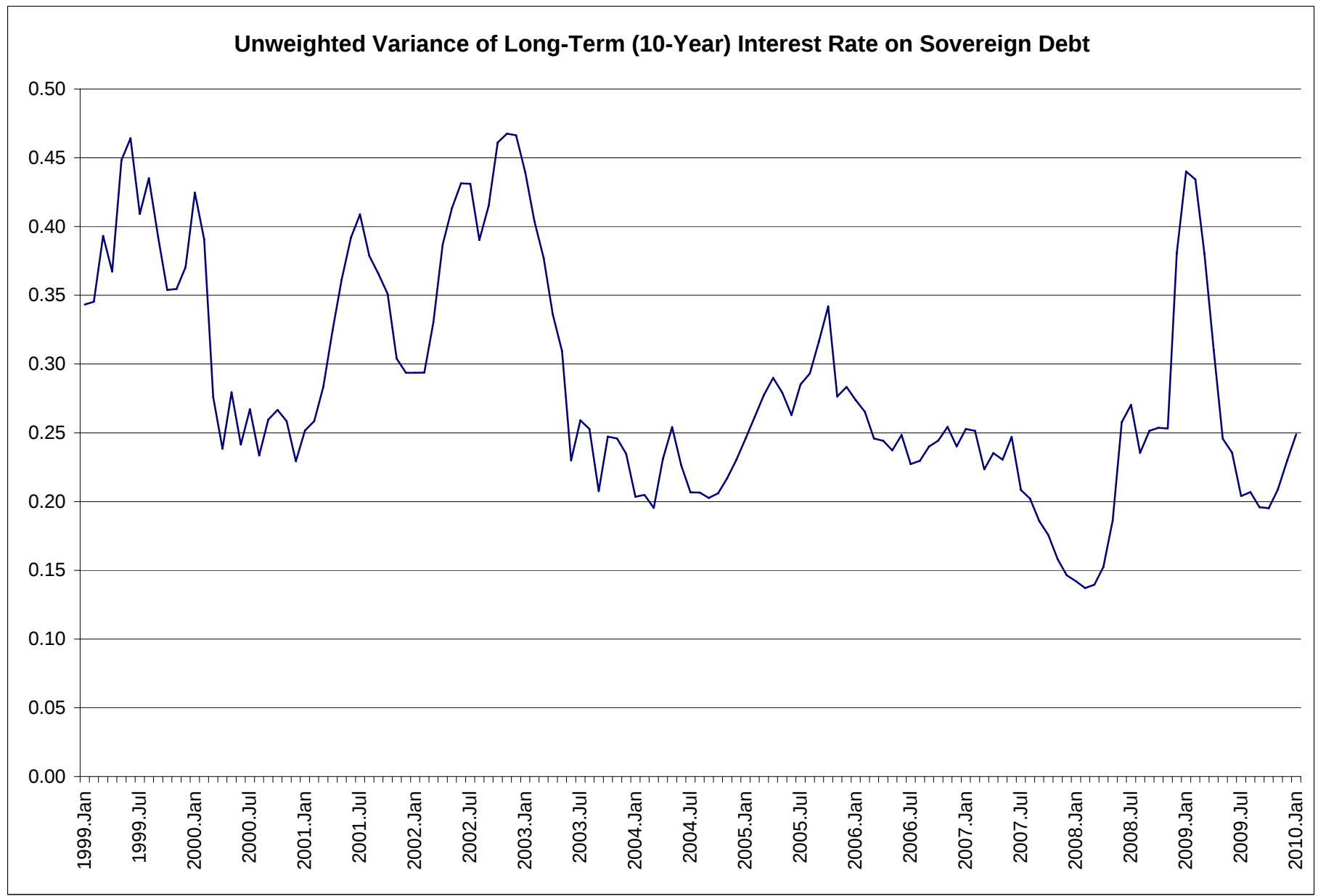


Exhibit 3

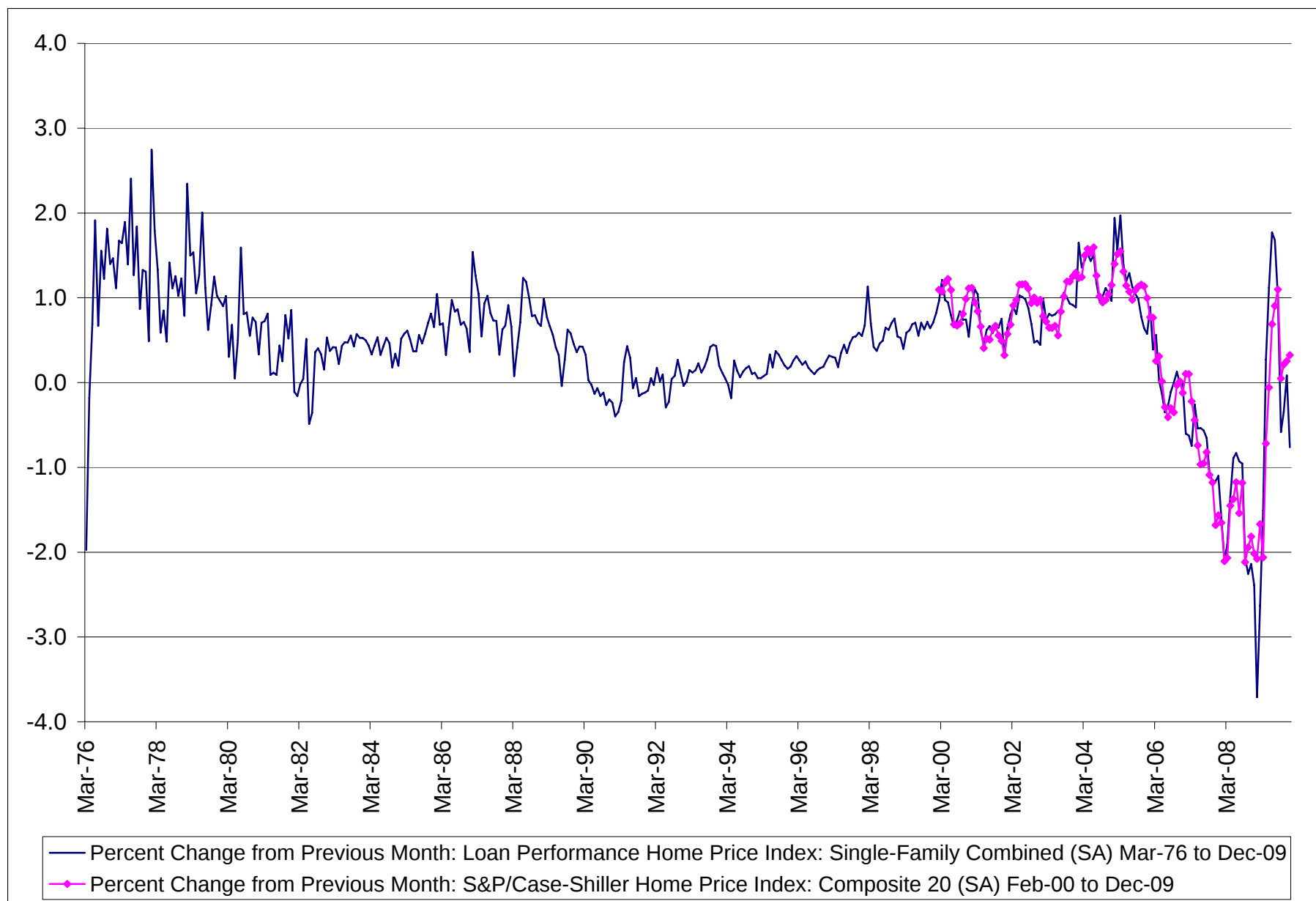


Exhibit 4

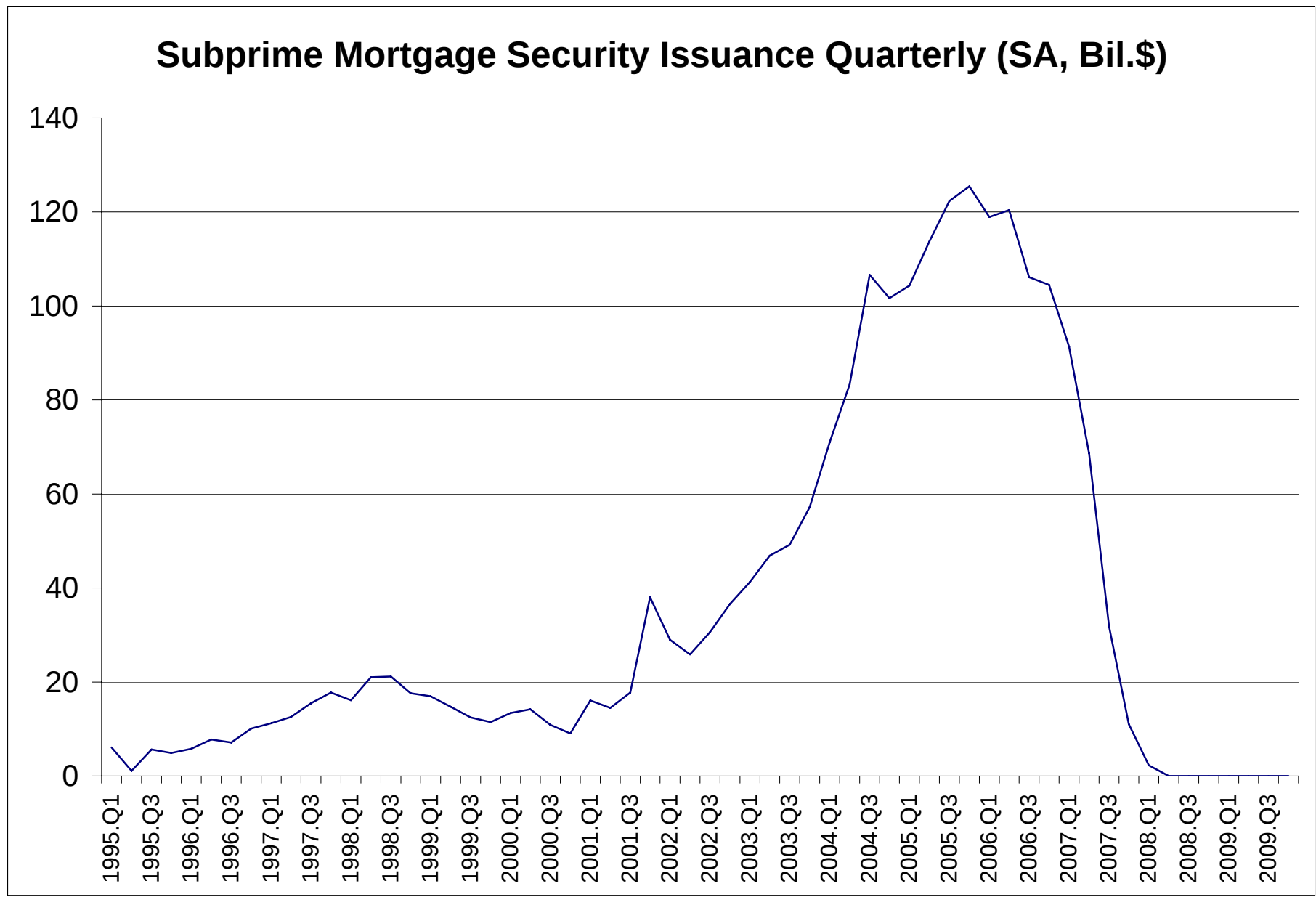


Exhibit 5

	A	B=ΔA	C	D=C/A*100	E=ΔC	F=E/B*100
			Fannie Mae & Freddie Mac Subprime Single-Family Mortgage Related Securities			
	Total Subprime MBS Outstanding (Bil.\$)	Change in Total Subprime MBS Outstanding (Bil.\$)	Retained in Portfolio (Bil.\$)	As a percent of Total Subprime MBS Outstanding	Change from end of previous year (Bil.\$)	Change as a percent of Change in Total Subprime MBS Outstanding
2000	108.1					
2001	147.0	38.9	19.0	13.0		
2002	222.2	75.2	24.7	11.1	5.7	7.6
2003	324.9	102.7	66.9	20.6	42.1	41.0
2004	539.9	215.0	150.6	27.9	83.8	39.0
2005	763.6	223.7	179.2	23.5	28.6	12.8
2006	924.7	161.1	169.0	18.3	-10.2	-6.3
2007	770.9	-153.8	133.4	17.3	-35.6	23.1
2008	585.7	-185.2	99.4	17.0	-34.0	18.3

Source: FHFA Annual Report to Congress, 2008 (revised), Loan Performance

Some data partially estimated by author. All Fannie Mae data for 2002 to 2008 are actual. 2001 required separating a published total that combined Subprime and Alt-A. Outstandings at the end of 2002 were (almost all ARMs) the guide. All Freddie Mac data for 2006-2008 are actual. Earlier data combined Subprime and Alt-A. I worked back from the split available for 2006. Other data on the split between fixed-rate and ARMs (predominately Subprime) governed the earlier separation.

Exhibit 6

Yield Spread: CCC & Lower Rated Securities less 10-Year Treasury Note (% p.a.)

Daily: Aug. 4, 1988 to Mar. 5, 2010

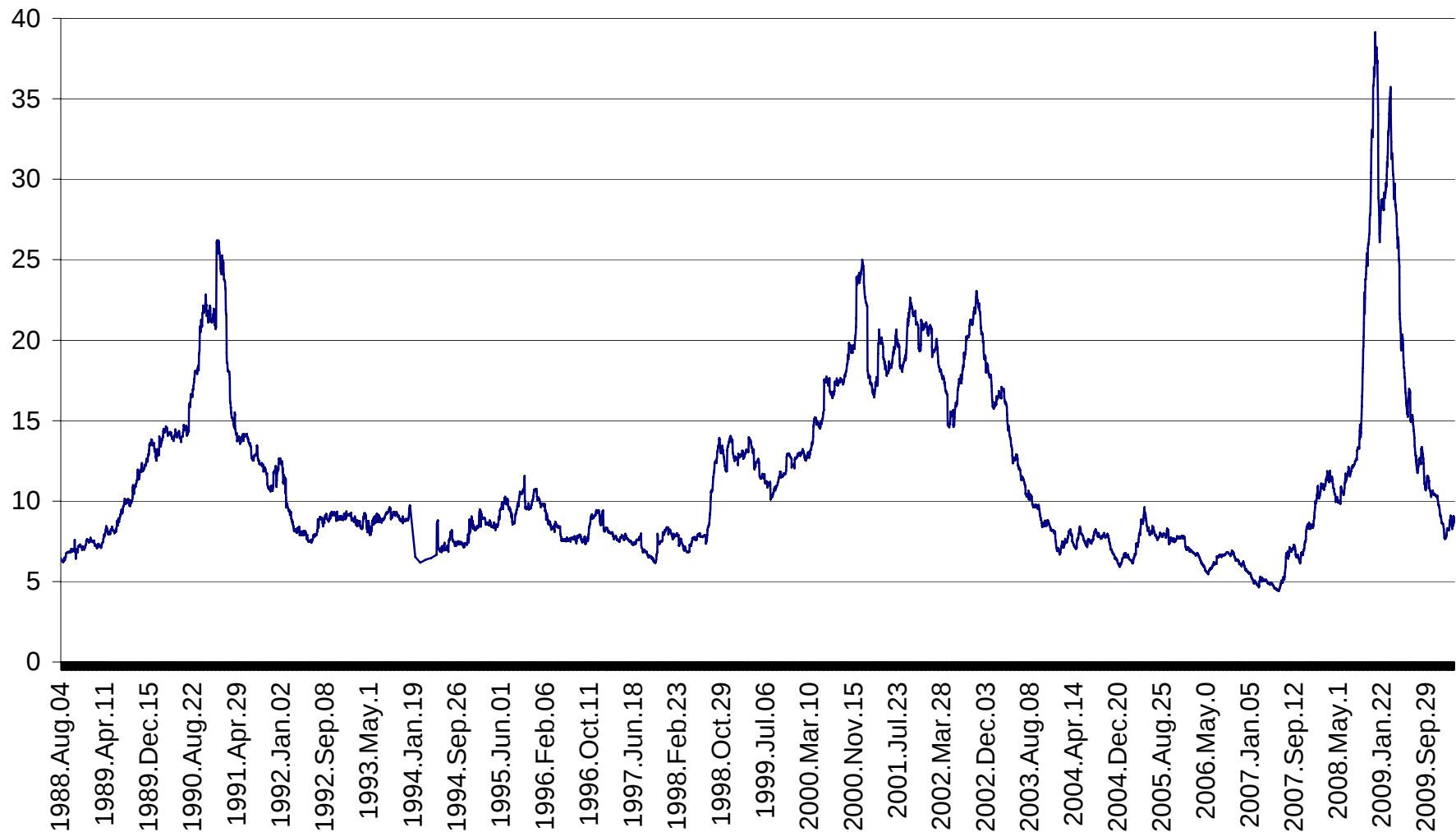


Exhibit 7

Yield Spread: BAA Corporate Bond less 10-Year Treasury Note

Jan. 1919 to Feb. 2010

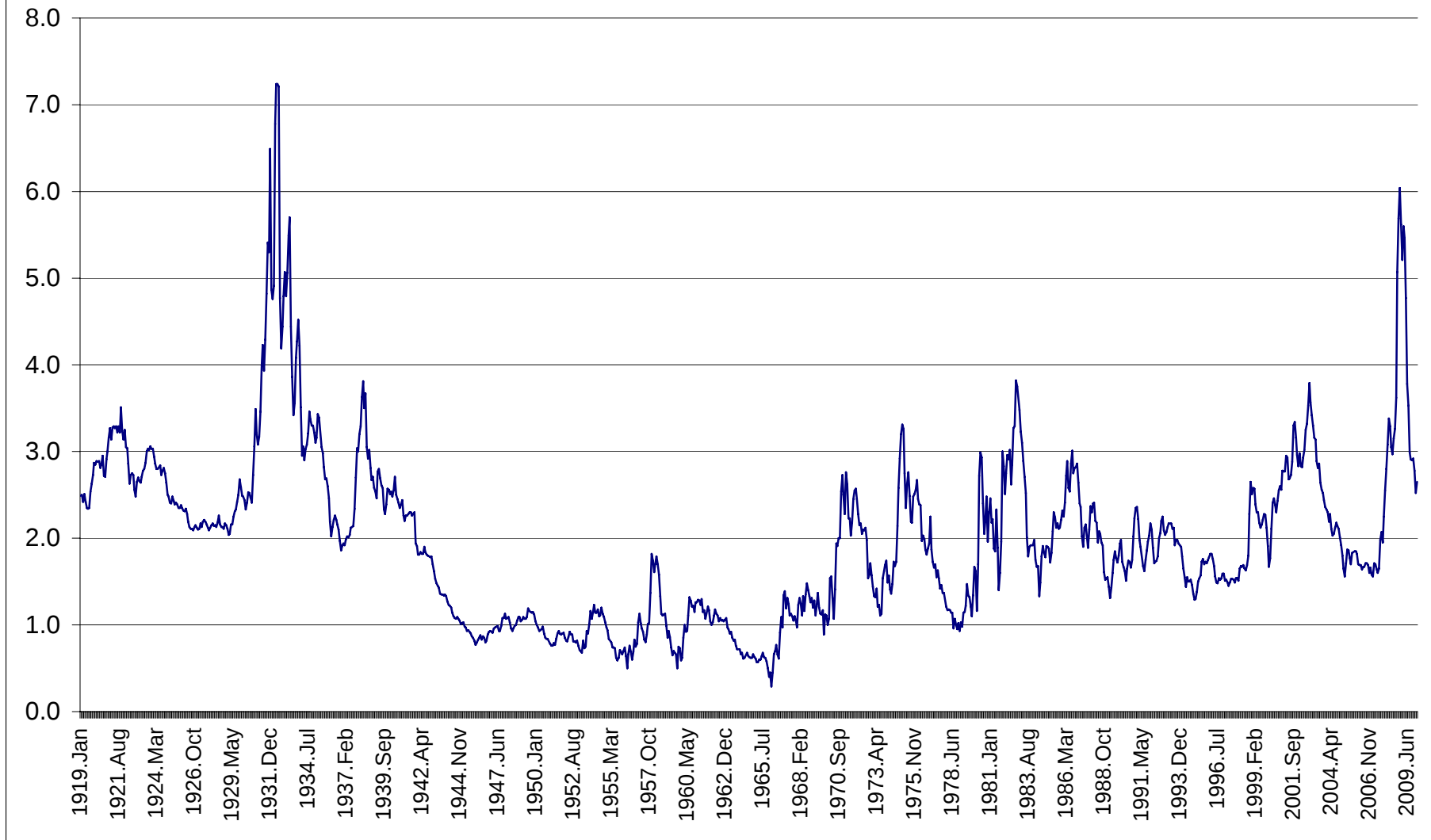


Exhibit 8

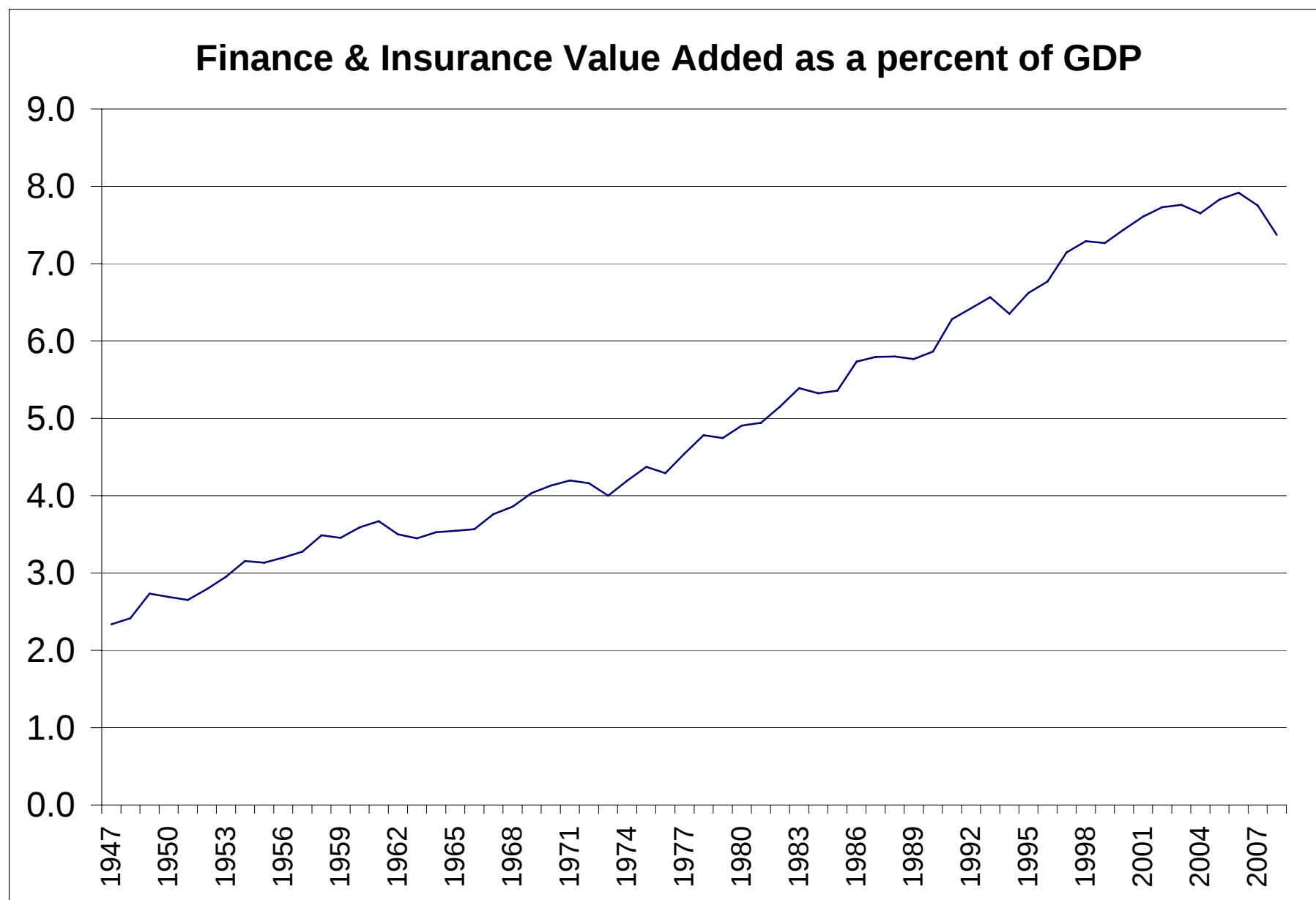


Exhibit 9

Finance & Insurance: Change in Value Added as a share of Change in GDP; 1960-2007

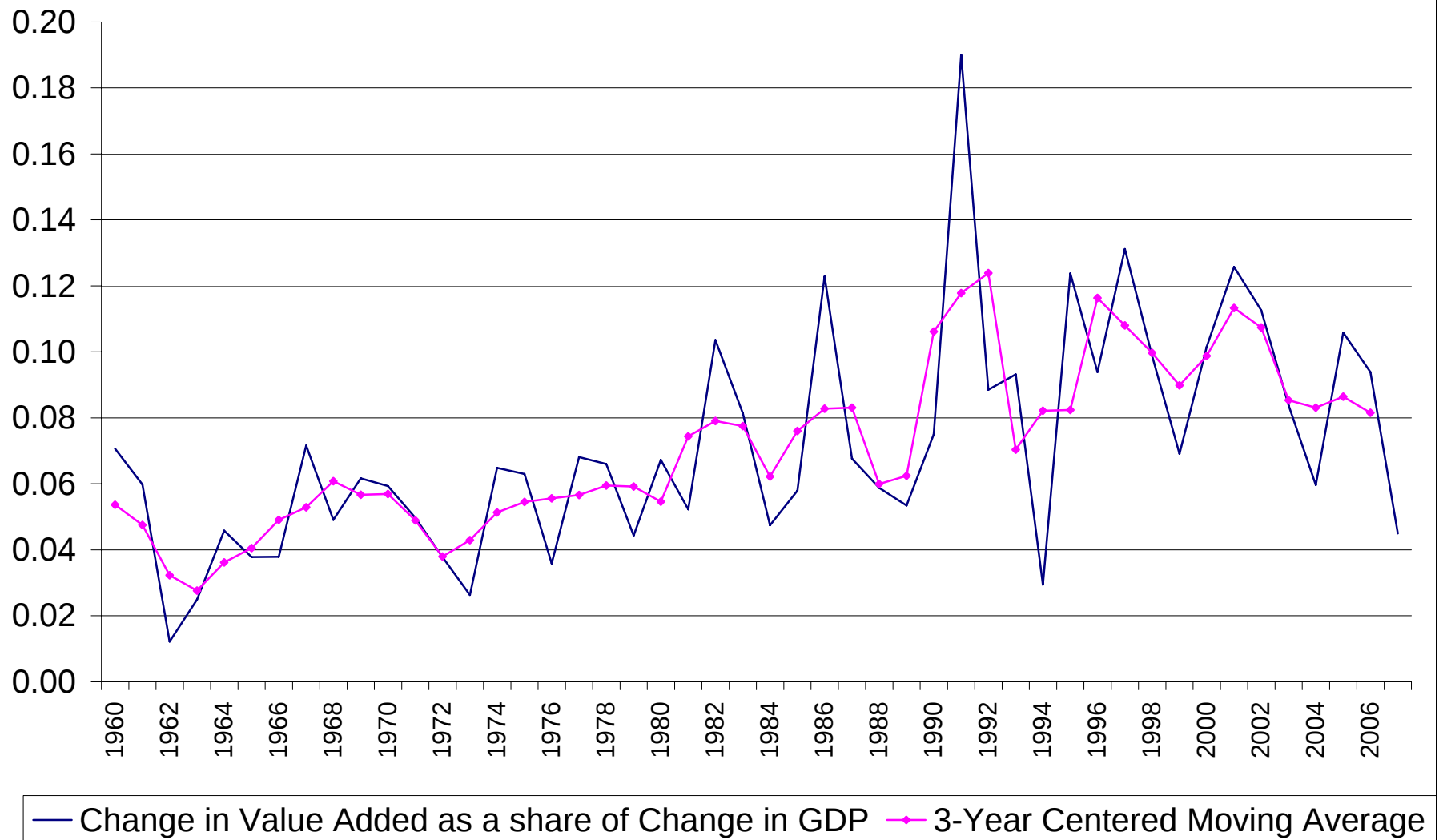


Exhibit 10

5-Year CDS: Average of Bank of America, JPMorgan, Citigroup, Goldman Sachs, Wells Fargo, and Morgan Stanley

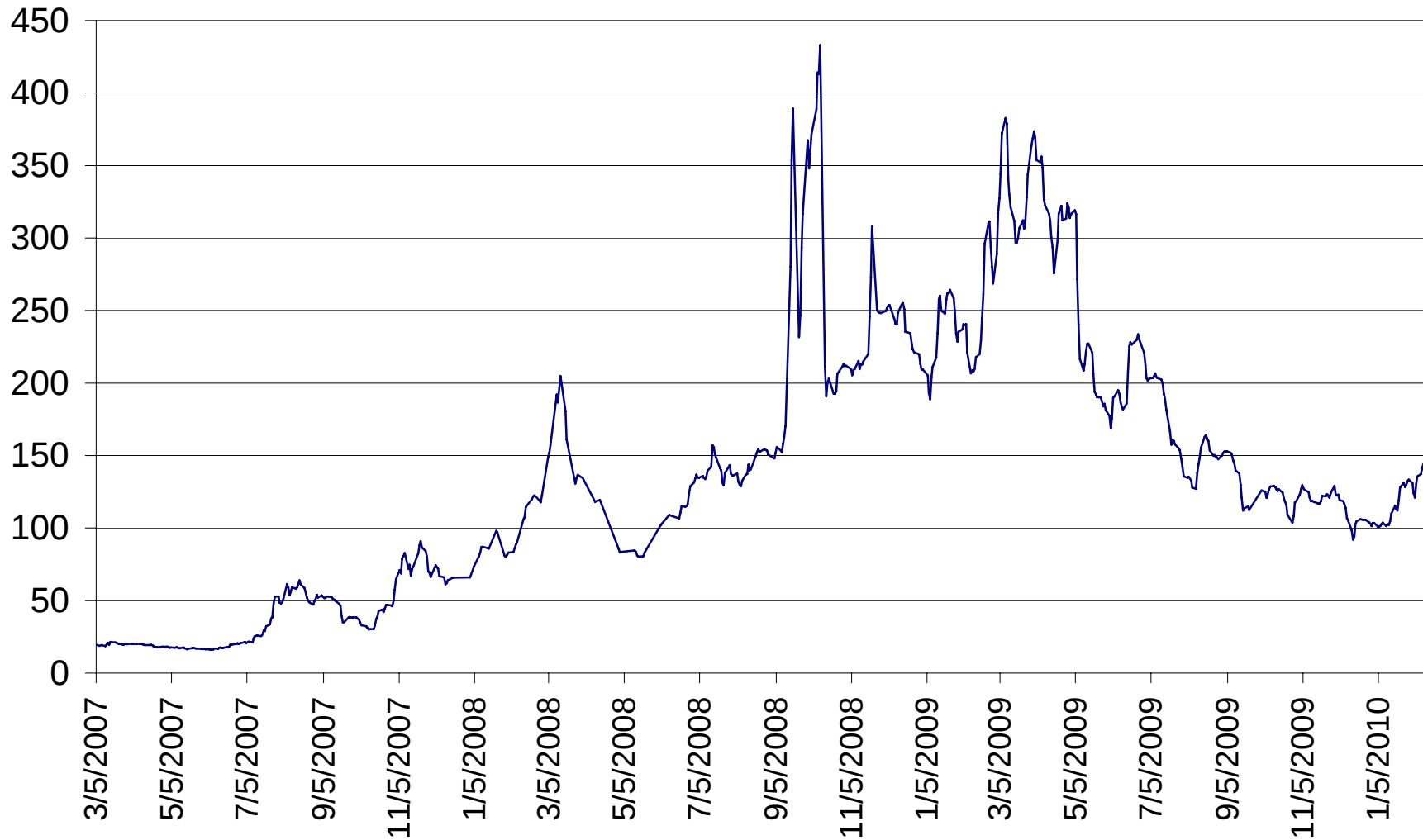


Exhibit 11

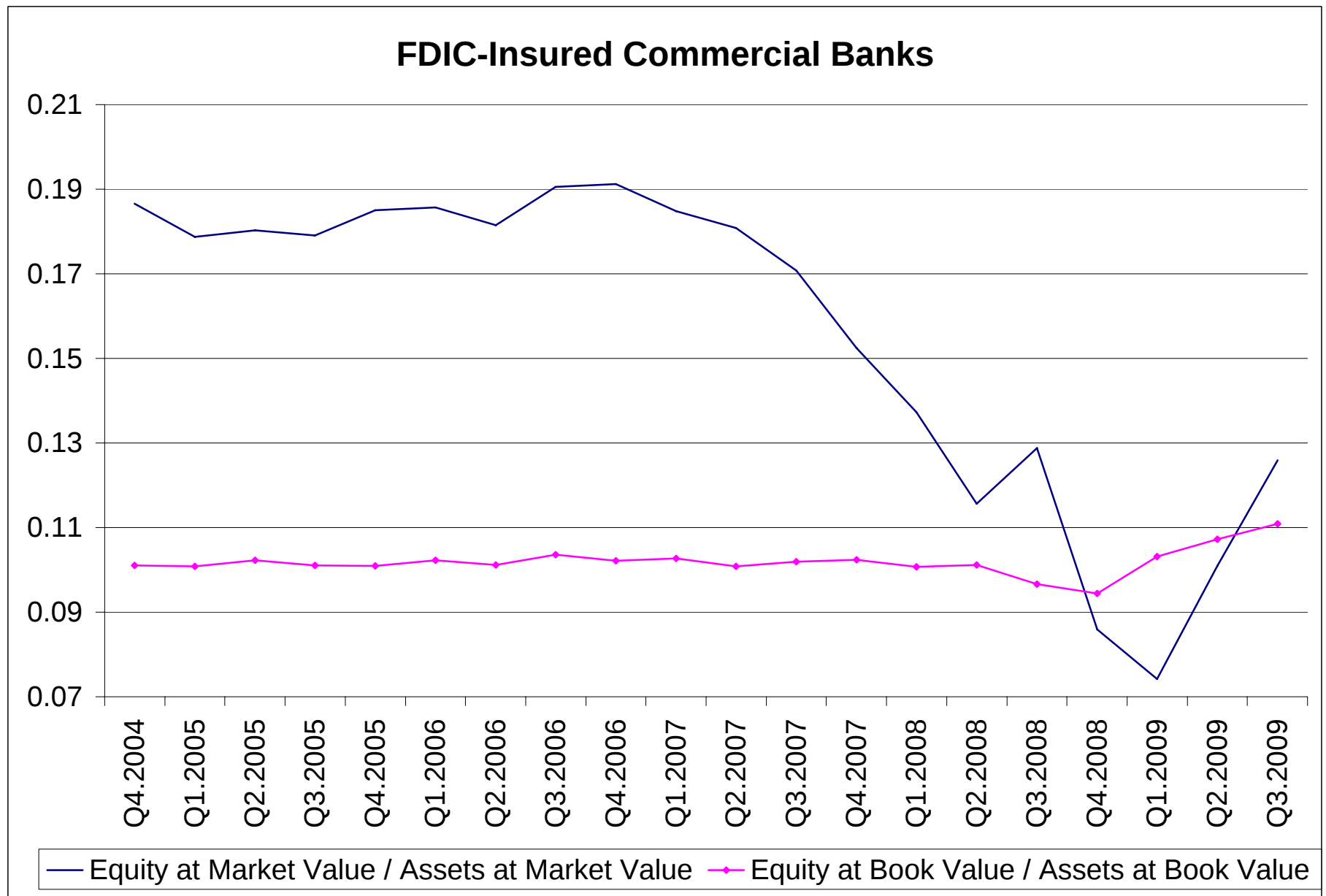


Exhibit 12

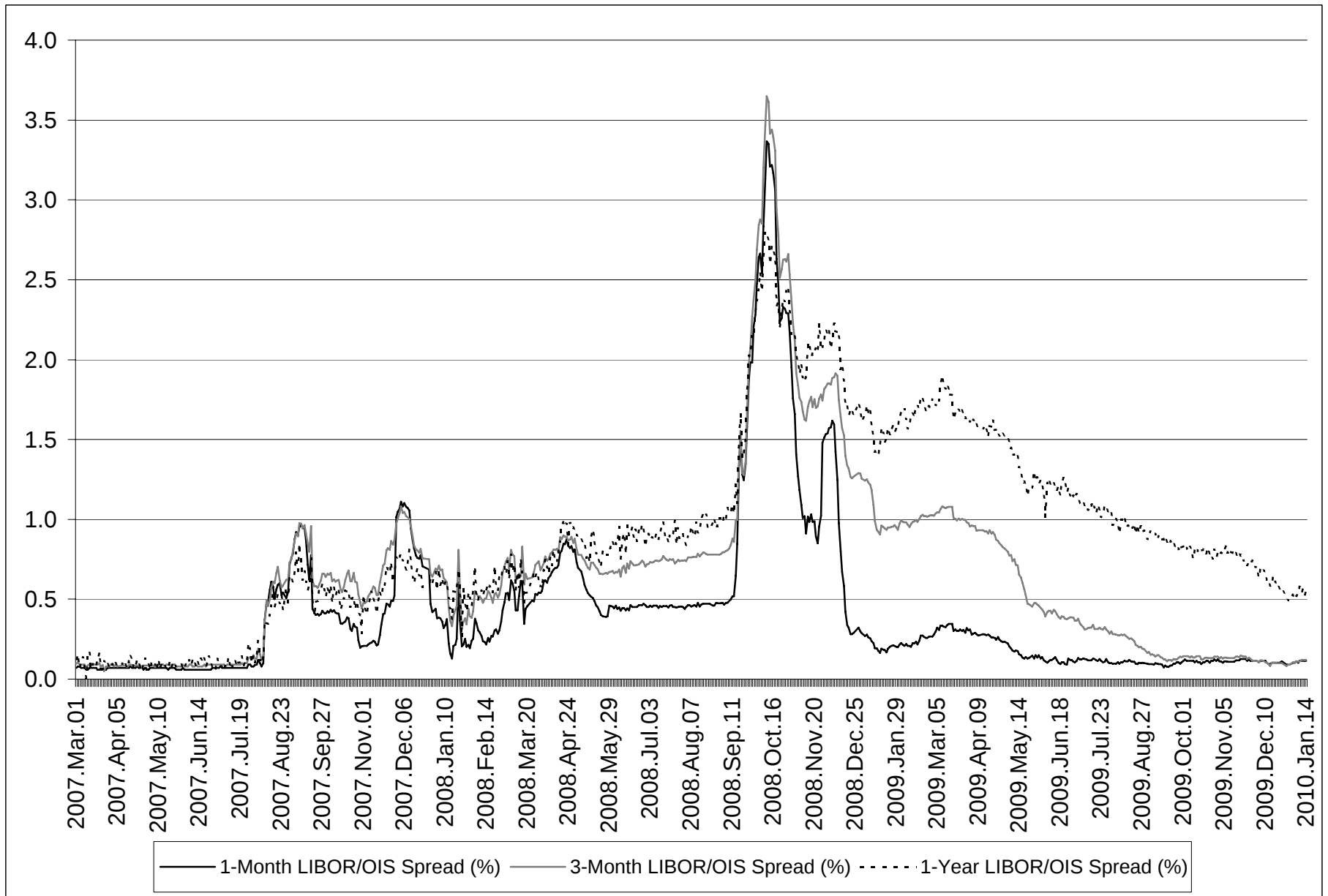


Exhibit 13

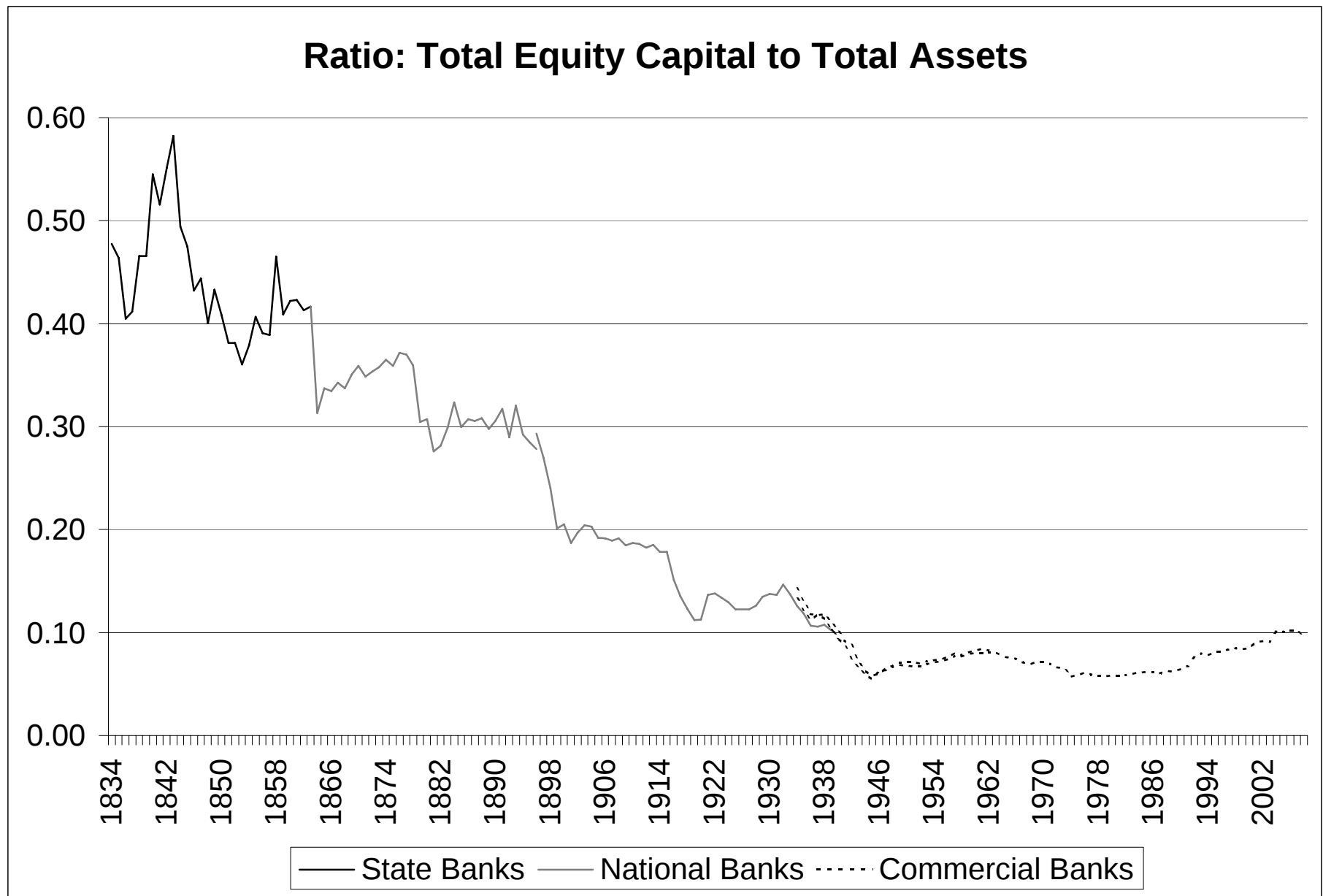


Exhibit 14

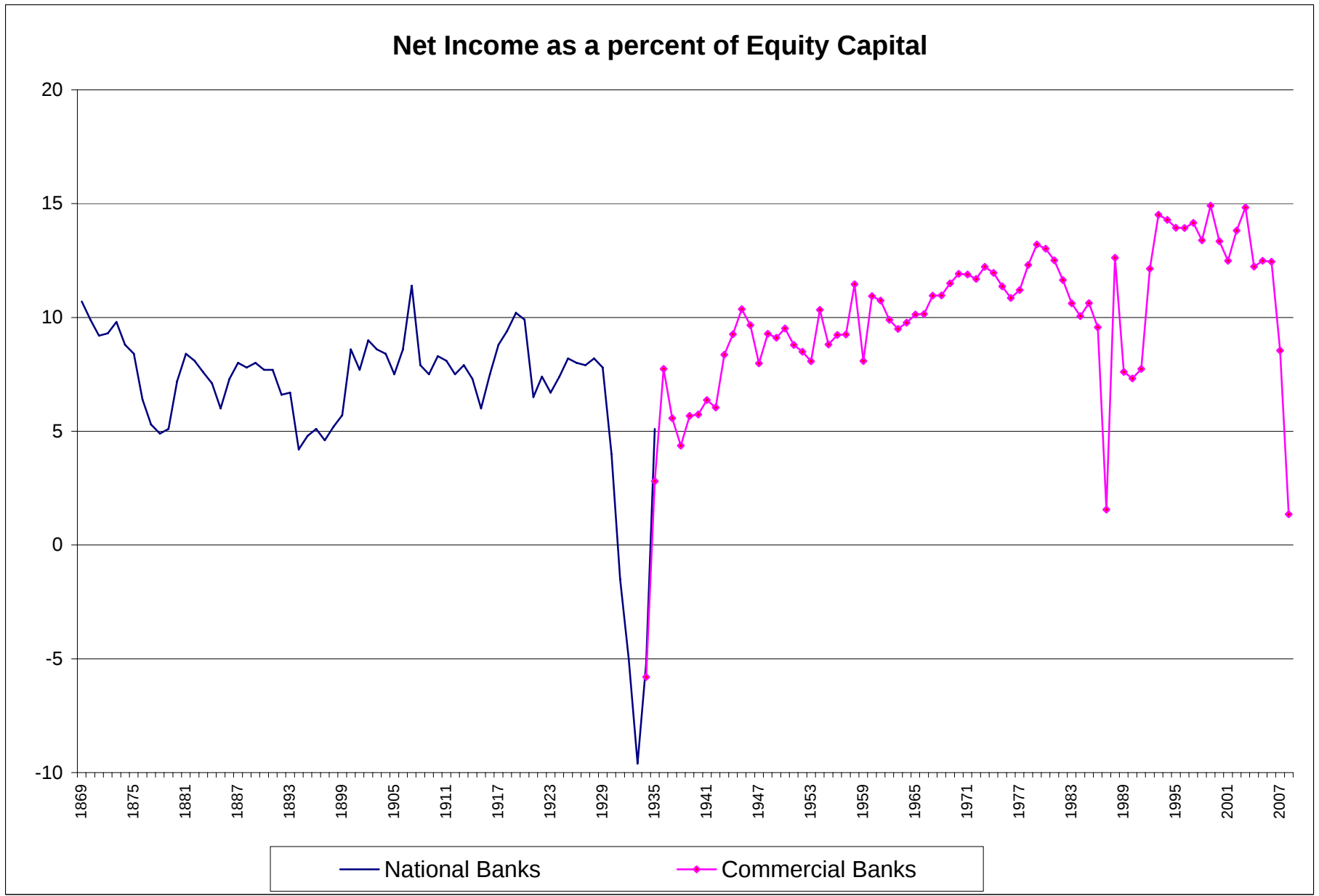


Exhibit 15

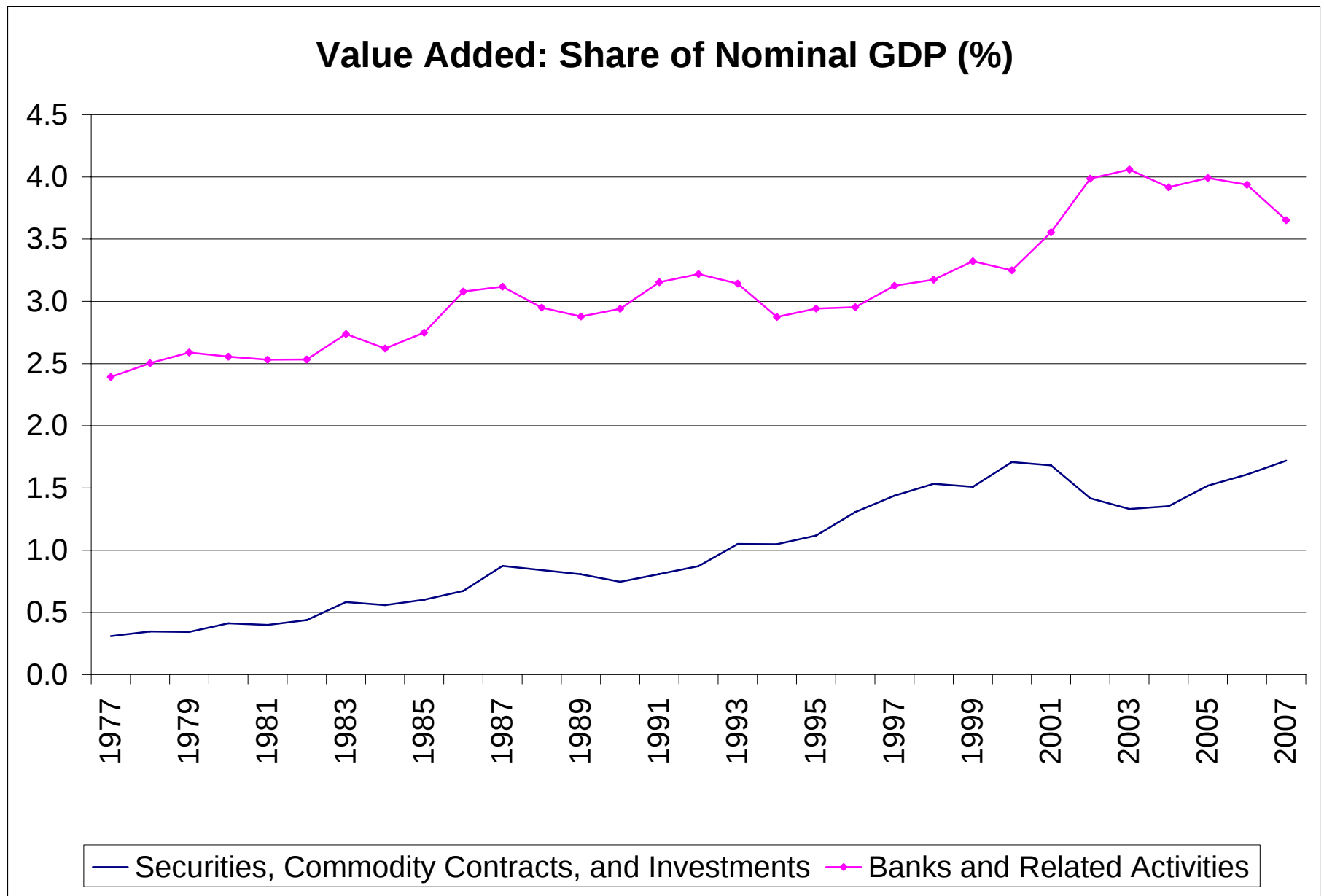


Exhibit 16

	π/A	$w*r$	$w*k$	$n=N/A$	$e=E/A$	$\alpha=T/A$
	Net Income divided by Total Assets	Interest Rate Spread * Earning Assets Share of Total Assets	Provisions for Loan and Lease Losses and Allocated Transfer Risk divided by Earning Assets * Earning Assets Share of Total Assets	Noninterest Income divided by Total Assets	Noninterest Expense divided by Total Assets	Taxes plus Minor Items, Net divided by Total Assets
Ratios as Percents						
Levels:	=	+	-	+	-	-
Avg: 1962-1966	0.766	2.580	0.079	0.566	1.965	0.335
Avg: 1978-1982	0.728	3.035	0.265	0.774	2.546	0.269
Avg: 1992-1996	1.092	3.673	0.426	1.949	3.617	0.488
Avg: 2002-2006	1.276	3.048	0.399	2.296	3.106	0.563
Change:						
78-'82 less '62-'66	-0.038	0.455	0.186	0.207	0.581	-0.067
92-'96 less '78 to '82	0.363	0.638	0.161	1.176	1.071	0.219
02-'06 less '92-'06	0.184	-0.624	-0.027	0.347	-0.511	0.075

Exhibit 17

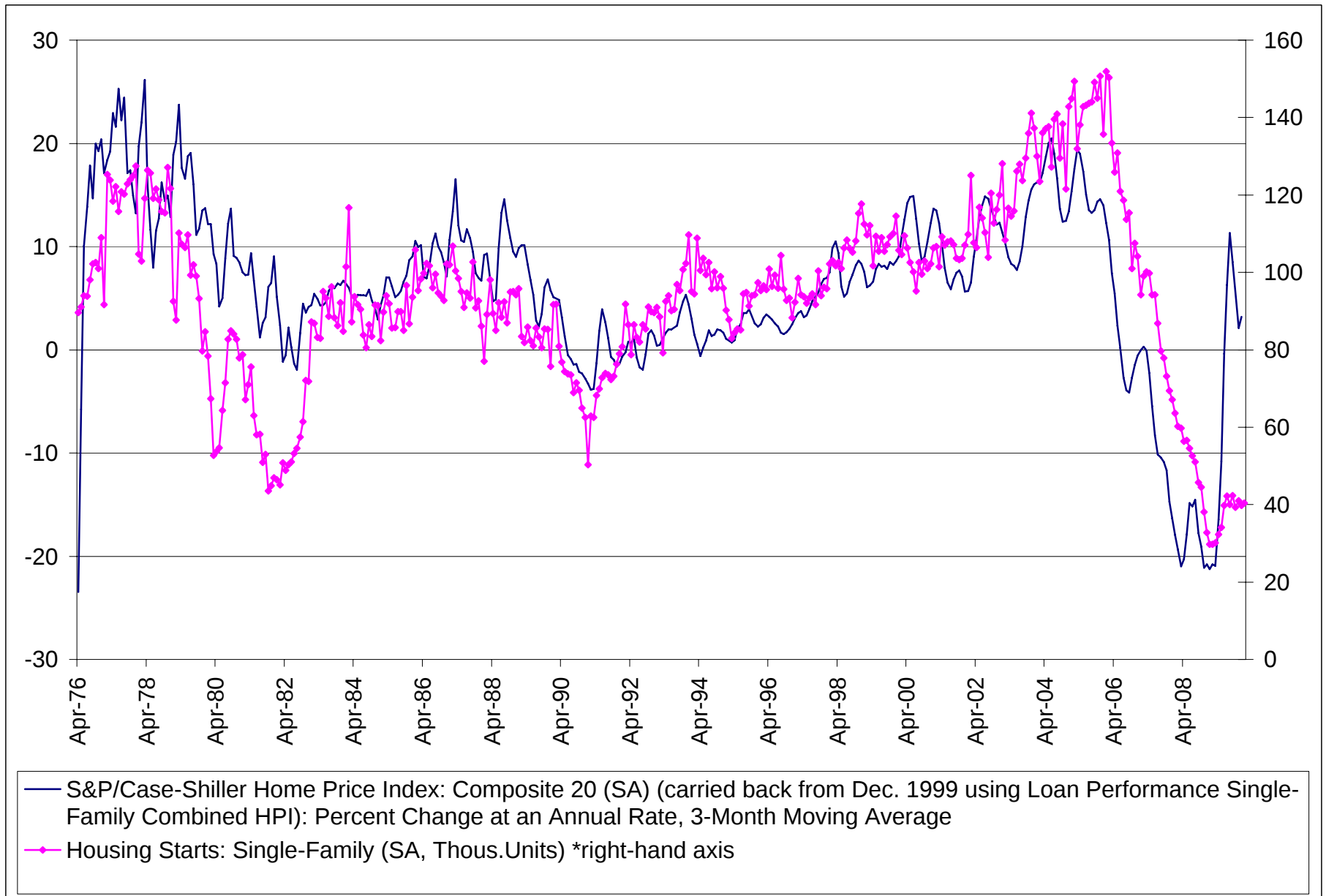


Exhibit 18

