ECONOMIC ADVISORY PANEL MEETING

APRIL 18, 2008

OVERVIEW OF U.S. ECONOMIC AND FINANCIAL MARKET DEVELOPMENTS

Discussion and Charts

Prepared by the staff of the
Research and Statistics Group

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Recent U.S. Economic and Financial Market Developments

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We last met on October 12, 2007, roughly midway between the September and October FOMC meetings. As you will recall, after about a year of below-potential growth, real GDP growth rebounded in 2007Q2 and that strength looked to be continuing in 2007Q3. Growth of real consumer spending was well maintained around 3%, business investment in nonresidential structures was booming, and net exports were contributing over a full percentage point to growth. Measured on a year-over-year basis, overall inflation had moderated from over 3% in mid-2006 to just over 2% in mid-2007 due to steep declines in energy prices in late 2006 and early 2007. Moreover, core inflation, as measured by the core PCE deflator, had moderated to around 2%, the top of the so-called "comfort zone", after having been in the 2¼% to 2½% range for most of the preceding year.

Despite these very favorable background conditions, financial market turmoil was by then in full swing. The non-agency mortgage securitization process had essentially shut down. Housing starts and sales, which appeared to be stabilizing during the first half of 2007, began to decline again while anecdotal reports from that industry turned very gloomy. The FOMC reduced the federal funds rate by 50 basis points at its September meeting, from 5¼% to 4¾%, citing this tightening of credit conditions and its potential to "…intensify the housing correction and to restrain economic growth more generally." At the same time, the FOMC noted that while inflation had recently moderated, "…some inflation risks remain."

The financial market turmoil became more acute in the intervening months, leading to significant disruptions in market functioning and the near-collapse of a major financial firm. Moreover, the turmoil appeared to begin to have greater effect on real economic activity, which deteriorated notably during the period. Consensus forecasts for GDP growth have been reduced over the period [**Figure 2**]. Although overall inflation was elevated over the period, core inflation fluctuated relatively little, and medium-term consensus forecasts of inflation have changed relatively little [**Figure 1**]. In response, policy rates were reduced considerably and the Fed instituted a number of measures and new facilities to promote liquidity and orderly market functioning.

Economic developments

Inflation. The moderation of energy prices from mid-2006 through mid-2007 turned out to be short-lived. From around $80/barrel in early October, oil prices rose steadily over the past six months and as of this writing are at $110/ barrel. Over the six months ending in February the energy component of the CPI increased at a 24% annual rate. Over that same period prices of food consumed at home rose at nearly a 5% annual rate. Finally, core inflation moved up as well over this period, due primarily to a firming in core goods prices. The 12-month change of the overall CPI rose from around 2% in October to just over 4% in February. While near-term inflation expectations held reasonably steady over this period, medium- and longer-term inflation expectations moved significantly higher [**Figures 4, 5**]

Very recent data on core inflation have been quite favorable. The core CPI rose just 0.04% (monthly rate) in February, well below expectations. The core PCE deflator for February rose just 0.1% while price data for several preceding months was revised lower. Statistical analysis suggests that some of this decline in the pace of core inflation is transitory. However, it is quite likely that core goods prices will likely start falling again given the ensuing weakness in demand.

Moreover, there has been some slowing in the rate of increase of rents, which is consistent with the combination of high vacancy rates and slowing growth of real disposable income. Indeed, several measures of underlying trend inflation have been declining for some time [**Figure 3**]. In response to these better-than-expected price data, inflation expectations at all horizons have declined recently, with medium-term expectations back down to about where they were last October. However, long-dated inflation expectations remain about 30 basis points above their October level [**Figures 4, 5**].

Real Activity. The anticipated slowing of growth has turned out to be more pronounced despite a much more aggressive easing of monetary policy than was assumed. Growth of real GDP was a modest 0.6% (annual rate) in 2007Q4 while private-sector forecasts for 2008Q1 are in the range of -0.5% to +0.5%.

First and foremost, the effect of the tightening of conditions in financial markets on housing starts and sales has been much worse than expected. Single-family housing starts have dropped almost 40% in the past eight months [**Figure 13**]. Despite this very steep decline in starts, the inventory of unsold new homes relative to the pace of sales has continued to increase [**Figure 14**]. Nominal home prices declined in several major metropolitan areas, particularly those that experienced the largest price increases during the boom years. Moreover, the decline became more severe and widespread as the period progressed. [*The Home Price section of the Reference Charts provides more information on home price developments.*] Mortgage delinquencies and foreclosures have increased much more than anticipated, even accounting for the decline in home prices, suggesting that there was considerably more speculative activity in housing markets than previously believed [**Figure 16**]. Moreover, the increase in foreclosures is no longer confined to just subprime mortgages [**Figure 17**]. The unexpectedly large increase in foreclosures has fed back into assessments of the credit risk inherent in newly originated mortgage assets, reinforcing the initial decline in credit supply. Interest rates on both agency and nonagency mortgage products relative to treasury yields have widened substantially, negating much of the usual transmission of the easing of monetary policy to the housing market. Moreover, there reportedly has been a significant tightening of underwriting standards for mortgages and private mortgage insurance.

The pace of consumer spending has also slowed much more than anticipated. After growing at a reasonably steady pace of around 3% over the preceding two years, growth of real personal consumption expenditures began to falter in 2004Q4 and looks to have been barely positive in 2008Q1 [**Figure 7**]. Growth of real disposable income has slowed quite sharply over the past six months due to a combination of declining hours worked and rapid increases in prices of food and energy. In addition, there is now growing evidence that the contraction in the supply of credit has spread to other consumer products, in particular automobile loans. Finally, while the personal saving rate is still essentially zero, the increase in the unemployment rate, decline in consumer confidence, and reports of declining home prices may collectively be dampening consumers' attitudes about taking on more debt.

Business investment in equipment and software, which had faltered in 2006, gradually rebounded in 2007, reaching a compound annual growth rate of 6.2% in 2007Q3. The rebound was primarily in IT equipment; growth in investment in more traditional capital goods such as industrial and transportation equipment remained sluggish [**Figure 8**]. Over the past six months growth in this category of final demand has slowed once again and was likely negative in 2008Q1. Investment in IT equipment has actually strengthened over the past six months. Growth of investment in agricultural equipment also remains robust. But this strength has been overcome by a steep plunge in demand for transportation and construction equipment.

Growth of investment in nonresidential structures was quite strong in 2007, up 15% on a Q4/Q4 basis, and was gaining strength as the year progressed [**Figure 9**]. This strength was reasonably broad-based, but particularly notable in categories such as power and communication, mining exploration, shafts and wells, and lodging. However, very recent data on nominal construction spending suggest an abrupt slowing in this category of spending in 2008Q1. An occasional negative growth quarter for real nonresidential structures is not unusual, even in periods of a strong underlying trend. Indeed, January was unseasonably cold while both January and February saw well above average amounts of precipitation in the 48 contiguous states. Nonetheless, the recent data reinforce the perception of downside risk for real activity going forward.

While contributing positively to growth in 2007Q2 and 2007Q3, business investment in inventories turned deeply negative in the fourth quarter, subtracting a full 1.8 percentage points from the overall growth rate [**Figure 10**]. Available data for 2008Q1 suggest that inventories are continuing to decline, but at a slower rate than in the fourth quarter and so should be a modest plus to growth. Inventories relative to final sales of goods and structures have been declining for about five years, and so it is tempting to conclude that inventories are relatively lean. Unfortunately, it is difficult to ascertain the desired inventory-sales ratio. Surveys indicate that the vast majority of firms regard their inventories as being about right.

After surging in 2002 and 2003, growth of real federal spending has settled down to a trend of around 2% [**Figure 12**]. However, it has been quite volatile around this trend, and has been the primary source of misses in our estimates of current quarter GDP. Last October our projection for the federal deficit in FY2008 was $190 billion or 1.3% of GDP. With lower growth and the passage of the fiscal stimulus package earlier this year, our projection is now $430 billion or 3% of GDP. All of this deterioration is due to lower projected revenues, only half of which is due to the stimulus package.

In contrast, real spending by state and local governments had been quite weak from 2003 through 2005 but has since been strengthening, rising at roughly a 2½% annual rate in the second half of 2007 [**Figure 12**]. In addition to a stronger pace of employment growth, state and local government spending on both structures and equipment has increased. Until fairly recently, state and local government receipt and expenditure growth were well balanced. However, in recent quarters growth of receipts has slowed well below that of expenditures.

One upside surprise for the real economy has been the continued strong growth of exports and significant slowing in the growth of imports [**Figure 11**]. The U.S. trade deficit has been declining for the past two years, with the rate of decline increasing in 2007. As of February, the trend rate of growth of real exports was around 10% (annual rate) and still rising while the trend rate of growth of real imports had declined to around 3%. The increase in export growth has been broad based across products categories. However, because it is the largest category, exports of capital goods excluding automobiles has contributed the most to the overall increase. Similarly, most major categories of imports have experienced a slowing in growth. But nonfood, nonauto consumer goods and industrial supplies and materials have experienced the sharpest slowing.

Manufacturing output rose at a brisk pace during the second and third quarters of 2007. However, that growth slowed quite suddenly in the fourth quarter and thus far this year manufacturing output is essentially unchanged from its 2007Q4 level. Production of IT equipment has continued to expand, but elsewhere production is declining. Production declines have been most pronounced in the motor vehicles and parts sector where both business and consumer demand have softened.

The demand for labor input began to decline in mid-2007. Hours worked in the nonfarm business sector declined at a 1% annual rate during the second half of 2007. This measure includes hours worked by the self-employed, the number of which declined rapidly during that period. Available data suggest that hours worked declined at a 1.5% annual rate in 2008Q1. Despite this ongoing decline in labor input, nonfarm payroll employment held up reasonably well through November of 2007. Since then, this measure of labor market conditions has deteriorated, with private payroll employment declining an average of 95,000 per month over the first three months of 2008 [**Figure 20**]. The unemployment rate has edged up from 4½% in mid-2007 to 5.1% in March [**Figure 21**]. This increase has been primarily among job losers rather than new entrants, reentrants, or job leavers. The labor force participation rate has been relatively stable over the past nine months after having declined slightly during the first half of 2007. While the aggregate has been stable, the participation rate of teenagers has declined somewhat over the period while that of workers aged 55 and over has increased. Year-over-year growth of average hourly earning peaked in 2007Q1 and has since been slowing [**Figure 22**]. The labor compensation share of national income, while volatile quarter to quarter, has been relatively stable around 64.5% for the past four years.

Productivity growth was quite strong during the first few years of this expansion, but began to slow in 2004 and eventually reached just 1% in 2006. Since then it has begun to recover, reaching 2.9% on a four-quarter change basis by the end of 2007 [**Figure 23**]. We continue to assume that the trend growth of productivity is 1.8% on a nonfarm business sector basis (1.5% on a GDP basis). With a constant labor force participation rate and trend growth of the working-age population around 1.2%, our assumption of the economy's potential growth rate remains 2.7%.

Corporate profits as a share of national income rose steadily over this expansion, peaking in mid 2006 around 13.6%. As of the fourth quarter they were down to 12.7% with a further decline likely to have occurred in 2008Q1.

Financial market and monetary policy developments

Financial markets. The financial crisis that had started in mid-summer 2007 continued through the period since the last EAP meeting in mid-October. Financial markets became more brittle, displaying greater stresses and more widespread dislocations. Prices on many riskier assets fell sharply while various spreads surged, market volatility increased, and liquidity in a number of markets appeared to dissipate significantly at times. These developments appeared to reflect greater perceived downside real risks of market participants, in part because of fears of an adverse feedback loop between financial markets and the real economy. In addition, they apparently reflected greater risk aversion and liquidity hoarding by market participants in an environment of greater asset writedowns, financial institution losses, and financial sector de-leveraging. The reversal of some of these trends since mid-March may suggest the reduction of the probability of the more extreme downside risks in light of the Fed liquidity initiatives discussed in the next section. To a lesser extent, some financial market developments reflected concerns about upside inflation risks given the more aggressive monetary easing since mid-January.

The developments in the economy, credit markets, and the perceived risk assessments of market participants led to sizable drops in Treasury interest rates [**Figure 26**]. The 10-year nominal rate, which was near 4¾% in mid-October, generally fell during the period and is now around 3½%, which is just above its lows during the "deflation scare" of mid-2003. Short-term interest rates fell even more sharply as market participants displayed great reluctance to take on perceived risks and thus engaged in considerable "flight to quality" behavior, although some of these pressures

have alleviated some since mid-March with the market-functioning liquidity measures taken by the Fed at that time. The 3-month Treasury rate, which was about 4¼% in mid-October, is about 1¼%; it was well under 1% in mid-March [**Figure 26**]. Consequently, the 3-month/10-year term premium has become more positive over the period, although given the impact of the credit market developments on the short rate during the period, we do not take much signal from the positive slope to the yield curve [**Figure 27**].

The concerns about the outlook and risks for the real economy also affected long-term real interest rates [**Figure 28**]. The 5-year real interest rate from TIPS fell from about 2¼% in mid-October to about ½%; for several days in March, the on-the-run 5-year TIPS rate was negative. The 10-year real rate also fell to a level (about 1¼%) that is well below common estimates of the equilibrium long-term real rate. Longer-horizon real forward rates declined relatively little, indicating that the concerns of market participants about the real outlook and risks pertain more to short- to medium-term horizons than to longer horizons [**Figures 29, 30**].

The developments that led to declines in Treasury rates also led to sharp increases in many credit spreads during the period. This development was evident in the initial epicenter of the financial crisis, the subprime mortgage market. With delinquencies and foreclosures continuing to run at a pace well above prior expectations [**Figures 16, 17**], rating downgrades for subprime MBS and CDOs, and changes in rating methodologies for these securities, the values of these securities continued to fall over the period and led to significant writedowns of these assets by financial institutions. Consequently, the ABX fell further since October, with particularly notable declines in the higher-rated (AA and AAA) tranches [**Figure 31**].

As was the case in the summer-2007 phase of the crisis, the developments in the subprime market also affected other parts of the mortgage market. There continued to be little issuance of non-agency MBS; as a result, the spread between conforming and non-conforming mortgage rates remained unusually wide throughout the period [the difference between the blue and red lines in **Figure 32**]. Moreover, with evidence that delinquency rates on conforming loans were increasing, the spread between conforming mortgages and Treasuries rose to wide levels [**Figure 32**]. The developments in the economy as well as in the mortgage and credit markets also led market participants to become more concerned about the condition of the GSEs, with the result that the spread between agency-backed MBS and Treasuries rose in early March to its highest level in about 20 years [**Figure 33**]. This spread has declined in the last few weeks with the Fed liquidity initiatives, some loosening of capital rules on the GSEs, and GSE promises to raise capital, but it remains wide.

As already stated, the developments in mortgage and other credit markets led financial institutions to take significant asset writedowns during the period, leading to sizable losses at a number of firms. In some cases, the losses were exacerbated because the institutions had taken the assets from off-balance-sheet conduits (such as SIVs) onto their balance sheets. As these developments occurred and the financial crisis persisted, estimates of the eventual aggregate losses from the crisis have risen considerably. Recent estimates of these losses are still wide at $300 – 2700 billion, but many estimates are about $1 trillion (recent estimated losses on mortgage-related securities are about $250 – 500 billion) [**Table 1**]. Losses of this magnitude would severely impact the capital base of the financial sector, and is one reason that a number of financial firms have sought additional capital or taken capital-conserving measures (e.g., reducing dividends) during the period.

In part because these realized and prospective losses increased concerns about counterparty risks as well as raised desires of financial institutions to hold liquidity, inter-bank lending markets were

very strained during the period, especially around year-end in December and quarter-end in March. In each of those cases, LIBOR-OIS spreads rose sharply to very high levels [**Figure 34**]. Although the liquidity initiatives by the Fed appeared to mitigate some of these stresses, these spreads continued to be wide compared to those prior to the onset of the crisis. In addition, these strains are evident in the Fed funds market, which has shown considerable daily volatility as well as intraday volatility [**Figure 35**].

The stresses in the inter-bank lending markets also were evident in other short-term financing markets. The asset writedowns and losses at banks also occurred at other financial institutions. These events raised concerns about the financial conditions at these firms, as evident in the rising CDS spreads for all types of financial institutions, particularly in early March [**Figure 36**]. The concerns about the quality of assets meant that the spreads between repurchase agreement (repo) rates on non-Treasury assets (including agency MBS) and on Treasury securities rose, especially in early March; at the same time, repo rates on Treasuries were extremely low. The concerns about asset quality as well as counterparty risk also led to greater haircuts on non-Treasury repo collateral. The concerns about counterparty risks led risk-averse market participants to avoid trades with some firms; most prominently, this affected Bear Stearns in the days before its sale to JP Morgan. After the latest set of liquidity initiatives from the Fed as well as the initial resolution of the Bear Stearns situation, some of the pressures on the repo market were alleviated, but repo spreads and haircuts remained elevated.

Financial guarantors were another entity negatively impacted by the financial crisis. Because of actual and prospective losses from financial guarantor-insured subprime MBS and CDOs, the ratings of a number of guarantors were downgraded while others were put under watch for downgrades, which called into question their financial condition [**Figure 37**]. Because the financial guarantors insure many municipal bonds, their troubles affected the municipal financing market. One manifestation of these effects was the seizing of the auction-rate securities (ARS) market: doubts about the quality of the debt (with the insurance in question) as well as reluctance of the ARS brokers to commit capital in the current environment led to many rate-setting auctions to "fail." The resulting dislocations (including resets to high "penalty" rates in a number of cases) in the ARS market as well as less-valuable insurance led municipal bond rates to rise above Treasury rates despite their tax advantage [**Figure 38**]. ARS also were used for financing by student loan providers. The seizure of the market thus contributed to rising spreads for student loan ABS as well as the exit of some firms from the market.

In another indication of the concern about downside real risks, corporate bond spreads rose during the period for investment- and speculative-grade firms [**Figure 39**]. The levels of the investment- and speculative-grade spreads are above their corresponding levels at the onset of the 2001 recession. Issuance of investment-grade bonds during the period was fairly well maintained, but speculative-grade issuance was subdued. Commercial paper outstanding was little changed on net, although asset-backed commercial paper continued to fall for most of the period (it has stabilized more recently) [**Figure 40**]. Commercial and industrial loans at banks continued to rise sharply, but indications of tightening credit standards suggest that some of the increase may reflect the drawing down of credit lines in an environment of overall tighter credit.

Equity market indices, which were near record highs in mid-October, generally fell over the period as the outlook deteriorated and the downside risks to real activity and corporate profits (in part from an adverse feedback loop with credit markets) increased [**Figure 41**]. Realized price volatility was quite high. Implied volatility generally remained elevated and spiked near or above recent highs during some of the more extreme episodes of the financial crisis [**Figure 42**]. Consistent with the financial crisis have a larger impact on financial firms, equity prices of these

firms were hit especially hard. Nevertheless, equity prices generally did not did not deteriorate to the extent that a number of other financial assets did.

Despite the deterioration in the US real economic outlook and the greater downside risks to that outlook, commodity prices generally rose since mid-October. Spot oil prices reached an inflation-adjusted high during the period, and futures prices indicated expectations that these prices will remain current levels for the foreseeable future. Prices for precious metals and agricultural products hit nominal highs. In part, the rise in commodity prices reflected stronger growth prospects outside of the U.S. (especially in emerging markets) and other real factors that have raised demand and tightened supplies for many commodities. However, some of the recent demand for commodities appeared to reflect a desire to hedge against inflation pressures and perceived upside inflation risks, which is a potential worry for policy.

International equity markets behaved similarly to that of the U.S., generally dropping through most of the period. Declines were somewhat greater than those in the U.S. market, perhaps surprising given that growth prospects outside of the U.S. are thought generally to be somewhat more favorable. One possible explanation is that possible recession in the U.S. and dollar depreciation would have a significant impact on profit growth for exporters. Long-term interest rates in Europe and Japan declined, but to a less extent than in the U.S., probably reflecting expectations of less monetary easing in those areas than in the U.S. Reflecting the impact of the U.S. financial crisis on financial institutions worldwide, LIBOR-OIS spreads for the euro and the pound behaved similarly as those for the U.S. dollar, and remain elevated.

Dollar depreciation, a general trend since 2002, continued and intensified during the period, with the major currencies dollar index falling over 5% [**Figure 43**]. The depreciation appears consistent with changes in expectations for U.S. real growth relative to the rest of the world as well as changes in monetary policy expectations and interest rate differentials. The latter factor appeared to be particularly important for the dollar/euro exchange rate, which reached record highs during the period [**Figure 44**]. Another factor affecting the yen/dollar exchange rate was further reductions in carry trade positions as risk appetite waned with the continuing financial crisis. The dollar depreciation may be "desirable" in enabling the adjustment of U.S. economic growth from domestic-oriented production (e.g., housing) to more external-oriented production. Nevertheless, dollar depreciation could raise U.S. domestic inflation pressures, which would be a concern for policy. Moreover, although it has remained "orderly" so far, a "disorderly" depreciation could have serious impact on the global outlook through its effects on capital flows.

Monetary policy. Although the FOMC faced both downside real risks and upward underlying inflation pressures since mid-October, it largely deemed the downside real threats as its more immediate concern. Consequently, it has responded to the deteriorating real outlook, greater downside real risks, and concerns about the possibility of the development of an adverse feedback loop between financial markets and the real economy. In addition, with financial markets becoming increasingly brittle, the Fed engaged in a number of initiatives in response to threats to orderly market functioning.

After making its initial reduction in the Fed funds rate in September, the FOMC lowered the policy rate repeatedly during this period for a cumulative reduction of 250 basis points since mid-October [**Figure 35**]. In the latter part of 2007, when the financial crisis appeared relatively contained, the real outlook and risk assessment less downbeat, and some upside inflation risks apparent, the pace of policy rate reduction was relatively slow compared to the pace in 2001. However, entering 2008, it became increasingly apparent that the real outlook was deteriorating and the downside risks to the real outlook were increasing. In particular, the increasing breadth

and depth of the financial crisis was increasing the probability of the establishment of an adverse feedback loop between financial markets and the real economy, whereby tightening financial conditions and disruptions lead to a weaker real outlook, which in turn leads to further tightening of financial conditions (the accompanying note by Tobias Adrian more fully describes a potential adverse feedback loop). Consequently, the pace of policy rate reductions became more rapid, with a 75 basis point inter-meeting cut in the Fed funds rate on January 22 and further sizable reductions at the January and March FOMC meetings.

Despite the more rapid pace of policy rate reductions, the market-expected path of the Fed funds rate moved down even more during most of the period as the financial crisis progressed [**Figure 45**]. During the period of the most extreme financial market stress in mid-March, market participants expectations of the Fed funds rate were very low: less than 1½% for the second half of 2008 and early 2009, and only about 2½% for mid-2010. With the Fed actions and other developments apparently reducing some of the direr downside risks, the implied path has risen since mid-March, with the minimum rate now about 1¾%. Still, the expected rate for mid-2010 is only about 3%, suggesting a slow (perhaps too slow) renormalization of policy. With the economic and financial market developments raising the risks and uncertainty about the outlook, market participants also were less certain about the path of monetary policy, and interest rate uncertainty rose during much of the period [**Figure 46**]. It has receded some since mid-March, but it is still elevated. Given the low expectations for the funds rate and the uncertainty around it, market participants appear to have a high implied probability of an extremely low (less than or equal to 1%) funds rate over the coming months.

There are a number of reasons why the Fed funds rate and the expected curve fell so much over this period. First, as has been stated before, the real outlook deteriorated and the perceived downside risks to real activity increased notably. Second, the further tightening of credit conditions suggests that the "neutral" Fed funds rate is lower than its typical estimates in more normal financial environments. Third, based on FOMC reactions in prior financial crises and FOMC communications indicating that the possible real economic consequences of the financial crisis were the more immediate concern for policy, the FOMC and market participants saw a more aggressive reduction in policy rates as appropriate in the current environment to insure against the downside real risks. The accompanying note by Simon Potter provides some measures of the current policy stance.

Besides the more aggressive easing of policy rates, the Fed initiated a number of additional measures meant to promote orderly market functioning in this period of extraordinary financial stress. In mid-December, as year-end funding problems discussed in the previous section became more acute, the Fed established the Term Auction Facility (TAF), whereby the Fed auctions a fixed amount of term funds to depository institutions against collateral that can be used to secure discount loans; it was expected (appears to be the case so far) that the auction format would not lead to the "stigma" attached to discount window loans. At the same time, the FOMC authorized currency swap lines with the ECB and Swiss National Bank (SNB) to help enable those central banks to meet dollar funding demands from institutions in their jurisdictions. For a time, these initiatives appeared to alleviate some of the funding pressures.

However, by early March, funding pressures again became acute and more widespread across financial institutions, as discussed in the previous section. In response to these greater risks to orderly market functioning, the Fed initiated several measures. First, it increased the size of the TAF. Second, it initiated a series of single-tranche 28-day term repurchase agreements, whereby primary dealers could deliver as collateral any type of security eligible as collateral for conventional open market operations (Treasuries, agency debt, agency MBS). Later, the Fed

established the Term Securities Lending Facility (TSLF), whereby the Fed lends Treasury securities from its portfolio for a term of 28 days by a pledge of other securities (agency debt, agency MBS, non-agency AAA-rated private MBS). At the same time, the FOMC authorized larger currency swap lines with the ECB and SNB. Finally, in mid-March, the Fed authorized the creation of a Primary Dealer Lending Facility (PDCF), whereby primary dealers could borrow from the Fed against a wide range of collateral similar to that used by depository institutions at the discount window. The Fed also reduced the discount-Fed funds spread from 50 basis points to 25 basis points, and raised the maximum maturity of discount loans from 30 to 90 days. During this same period, the Fed also approved financing to assist in the purchase of Bear Stearns and preclude its likely bankruptcy, which given its role in short-term financing markets, could have led to severe disruptions in those markets.

Because these various initiatives were directed at promoting orderly financial market functioning rather than monetary easing, they have had little effect on the size of the Federal Reserve balance sheet. However, they have had a substantial effect on the composition of the Fed's balance sheet: the amount of Treasuries held outright by the Fed has dropped considerably since the summer, replaced by more credit provided through the discount window, the TAF, the PDCF, and repos [**Figure 47**]. This change in composition implies that the Fed has provided to financial markets more securities in demand for their liquidity in the current environment (Treasuries), while taking in some securities that are in less demand because of their illiquidity in the current environment (MBS). It is still unclear the extent to which these facilities have promoted orderly market functioning: financial markets appear less stressed than in early- to mid-March, but market conditions are still considerably worse than "normal." The accompanying note by Jamie McAndrews provides more details and analysis about these new facilities.

Conclusion. Conditions in the economy and financial markets have changed considerably since the last Economic Advisory Panel meeting. The real outlook for the U.S. economy has deteriorated as employment has started to decline, the unemployment rate has risen, production and consumption growth has turned sluggish at best, and housing has remained in a severe downturn. Consequently, the probability that the economy is in a recession has increased greatly with the consensus of economists being that a recession indeed has started. Meanwhile, overall inflation has been elevated as energy and food prices have risen sharply during the period. Core inflation also was elevated for much of the period, but has moderated more recently to return to the top of the perceived "mandate-consistent" range of the FOMC, suggesting that underlying inflation will be within that range over the medium term. Still, with financial market inflation compensation rather high relative to its levels over the past few years, dollar depreciation, and rising commodity prices, upside inflation risks remain.

Financial markets and institutions were under considerable stress through much of the period, as the financial crisis that began last summer became more widespread and acute. Market functioning become more disrupted at times, and a large financial institution came close to failure. The policy response to these developments was considerable. The target for the Federal funds rate was reduced 250 basis points since October and the discount rate was reduced 275 basis points with an increase in the maximum maturity. The Fed also initiated a number of measures to promote more orderly market functioning and raise liquidity: these included the introduction of new facilities such as the TAF, TSLF, and PDCF. These various policy measures appear at the moment to have mitigated some of the stresses in financial markets, but it still remains to be seen whether policy will preclude the further establishment of an adverse feedback loop between financial markets and the real economy.

Adverse Feedback Loops

With an analysis of pro-cyclical leverage and the near failure of Bear Stearns[*]

Notes for the April 2008 EAP

Tobias Adrian[#]

Preliminary and Not for Distribution

Most modern macroeconomic models used in monetary policy advice have little detail on the structure of the financial sector. For example, models such as FRBUS and MacroAdvisors proxy the effects of financial market disruptions through wealth effects and increased spreads over risk free rates for a limited range of debt instruments.[1] In simulations of the FRBUS model before the financial crisis the effects of a fall in home prices was modeled mainly through the wealth effect on consumption. The appropriate monetary policy response is to lower short-term real rates to cushion the impact on total household wealth. As discussed by Governor Mishkin at Jackson Hole this cushioning from monetary policy is very effective within the confines of the FRBUS model.[2]

There are other macroeconomic models that specify greater detail on frictions within the real economy and/or the financial system. A feature of many of these models is that they contain feedback dynamics between the real economy and the financial sector. The underlying source of the feedback dynamics comes from the use of collateralized borrowing to finance household and business investment. For example, in the financial accelerator model of Bernanke and Gertler (1989) the value of collateral affects the borrowing capacity of households and firms. Shocks to the real economy in the model are amplified by changes in borrowing capacity induced through fluctuations in the value of the underlying collateral.

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[*] The views expressed in this note are those of the author and do not necessarily represent those of the Federal Reserve Bank of New York or the Federal Reserve System.

[#] Research Group, Federal Reserve Bank of New York, 33 Liberty Street, New York, NY 10045, http://nyfedeconomists.org/adrian/. Many thanks to Simon Potter for substantial comments on earlier versions of this note.

[1] For example, recently MacroAdvisers has judgmentally adjusted some of the interest rates in its macro model to capture the increased spreads on a range of debt instruments not included in model.

[2] "Housing and Monetary Policy Transmission Mechanism," FEDS 2007-40. It is available at http://www.federalreserve.gov/pubs/feds/2007/200740/200740pap.pdf.

An important downside risk in the current situation is that the recent fall in home prices in the United States will be amplified by financial frictions that are not captured by the scenarios of large house price falls within standard macroeconomic models. One of the major surprises over the last year is that mortgage debt securitization, intended as a means to reduce financial frictions and monitoring costs, has been a strong source of amplification of the actual and expected home price decline to financial markets.

Some insight into these developments can be obtained by considering the effects of pro-cyclical leverage in parts of the U.S. (and other countries') financial sectors as well as specific events within the U.S. financial system when adverse feedback loops have developed very quickly. Through fluctuations in the valuation of collateral the balance sheet leverage of financial institutions is pro-cyclical: leverage expands when balance sheets expand, and contracts in downturns. Thus, lending capacity increases with signals of economic strength and contracts with signals of economic weakness. This behavior further exacerbates financial market fluctuations, as institutions tend to buy assets when prices increase, and sell assets in downturns.[3]

The pro-cyclical leverage of an important set of U.S. financial intermediaries, investment banks, is illustrated in Figure 1. We plot leverage growth against total asset growth for these institutions. Historically, leverage tends to expand one-to-one with total assets. The largest unwind of leverage within our sample coincided with the largest contraction in total assets in the fourth quarter of 1998, following the LTCM crisis. This event occurred following an "exogenous" shock and in the context of robust real growth in the U.S. economy. In contrast, the realizations shown for the second half of 2007 are relatively far below the 45-degree line. Because leverage growth equals total asset growth minus equity returns, the two values for 2007Q3 and Q4 correspond to negative equity returns. One prediction based on these developments was that financial institutions would try to de-lever in 2008Q1; as we now know, this de-leveraging was one major factor that produced the substantial strains in financial markets during this period.

[3] See Brunnermeier and Pedersen (2007) and Adrian and Shin (2007).

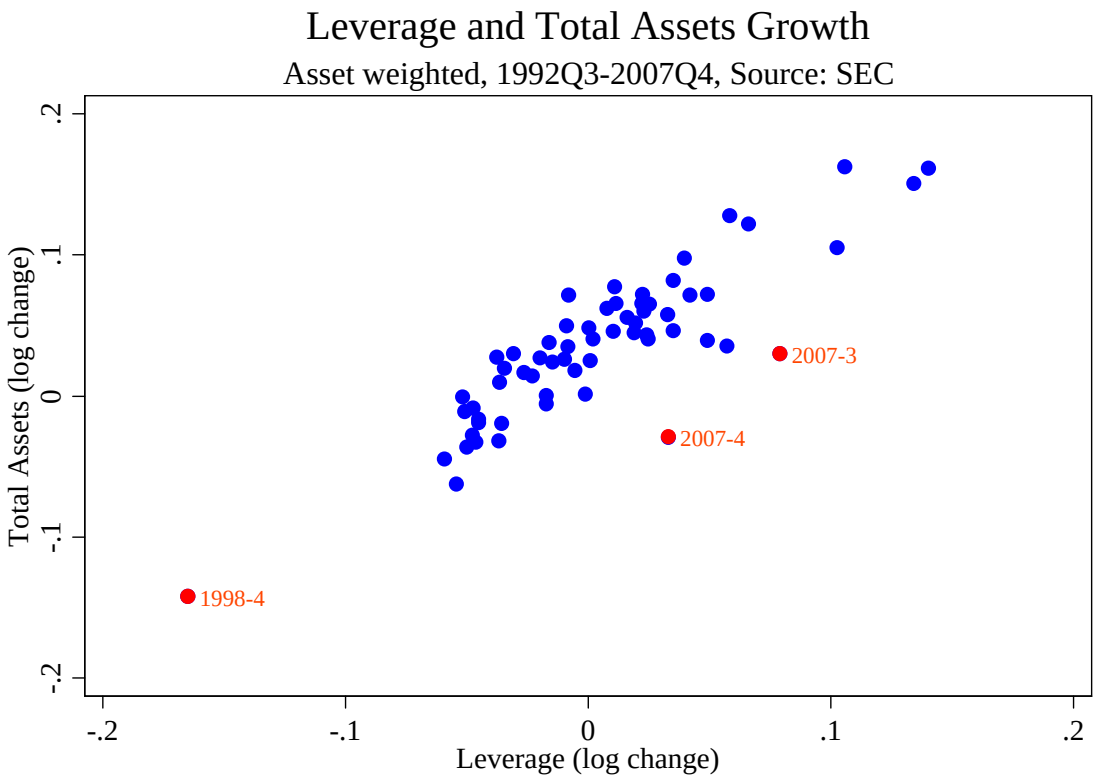

Figure 1: Pro-cyclical Leverage of U.S. Investment Banks

This type of pro-cyclical leverage can be obtained in theoretical models as the outcome of agency problems that arise from delegated decision-making in financial institutions that are marking-to-market.[4] For institutions such as banks and dealers, lenders impose constraints such as Value-at-Risk constraints or leverage ratios. For institutions such as hedge funds, lenders impose haircuts that are determined by the riskiness of the fund and the collateral.

A decline in the value of intermediaries assets' leads to a decline in equity, and – ceteris paribus—an increase in leverage. In response, intermediaries can reduce leverage in two ways: either by selling assets, or by increasing equity (for example by issuing shares, or cutting dividends). Declines of asset prices are also associated with higher market volatility, which further tightens the financial constraints of intermediaries.

[4] See Holmström and Tirole (1998) and Adrian and Shin (2008b).

In extreme cases, the unwinding of intermediaries' balance sheets can result in margin spirals. In margin spirals, counterparties to financial institutions increase haircuts, which forces institutions to unwind. The unwinding puts downward pressure on asset prices, which further deteriorates balance sheet ratios.

The near failure of Bear Stearns illustrates the dynamics and speed of a margin spiral. Early that in the week of March 10th, anecdotal reports indicate that hedge funds were being charged a premium to execute swaps in which Bear was a counterparty. By Thursday March 13th, hedge fund clients started to close their prime brokerage accounts and other counterparties such as money market mutual funds no longer wanted to provide financing. This, combined with Bear's heavy reliance on short-term financing, caused it to be quickly drained of cash. By Thursday night, Bear had told government officials it might have to file for bankruptcy protection.

On Friday, Bear Stearns was downgraded by the credit rating firms. This reduced the viability of Bear as a going concern because it reduced its number of potential trading partners. By late Friday, other counterparties were refusing to do business with Bear and prime brokerage clients were leaving. A rationale for stepping in to secure financing and the ultimate takeover of Bear was to preclude a disorderly unwinding of positions that could cause systemic problems. In particular, an event of default would likely have caused many of Bear's counterparties to liquidate their positions to mitigate potential losses. Such counterparties would have had little incentive to time their trades to minimize market impact or to retain positions until market conditions improved because such parties retain all of the downside risk of asset value changes, but little or none of the upside risk.

The liquidations would have likely caused price declines and increased price volatility. In an environment of already high volatility and uncertainty, it's unlikely that there would have been be sufficient providers of liquidity on the other sides of trades to stabilize prices. In fact, the traditional providers of short-term liquidity – other dealers and hedge funds – were already facing higher haircuts, reducing their ability to take levered positions that might improve liquidity. Moreover, the price declines, increased price volatility, and resulting increased uncertainty about counterparty creditworthiness

would have likely lead to further increases in haircuts, increased margin calls, and further deleveraging.

While a margin spiral is an extreme consequence of the pro-cyclical nature of intermediaries balance sheets, the more orderly deleveraging of balance sheets now taking place has the potential to restrict lending capacity of the financial system. With the real economy in a weakened state, reductions in lending might intensify the weakness and lead to further deleveraging of balance sheets and restrictions in lending capacity.

Recall that in simulations of FRBUS under large house price declines the transmission mechanism was through household wealth. In FRBUS it takes take for consumers to react to changes in their wealth, thus monetary policy has considerable time to react. However, as illustrated by recent developments, the transmission of the house price decline through pro-cyclical leverage can be very quick and it is difficult to assess in real-time its effects on lending capacity. In general the prescription for monetary policy is similar, i.e., lower short-term real rates. This lowers funding costs and by steepening the yield curve makes financial intermediation more profitable. As discussed in the note by Jamie McAndrews the Fed has also taken steps to improve market functioning as the deleveraging has taken place. One interpretation of these steps is that the Fed has temporarily increased the leverage on its balance sheet to ease the adjustments taking place in private institutions. Other government related enterprises such as the GSEs and Federal Home Loan Banks have been doing something similar.

Empirical work on the size of these effects is not fully developed. Adrian and Shin (2008a) show that changes in the Fed Funds target orthogonal to macroeconomic conditions are negatively related to leverage growth: when the policy rate is low relative to the implications of the output and inflation gaps, intermediary balance sheets tend to grow rapidly. In addition, this growth of intermediary leverage helps to forecast future real activity. The latter forecasting power is robust to inclusion of other financial proxies such as senior loan officer tightening standards, non-financial net worth, or growth rates of house prices.

In Figure 2, we plot dynamic forecasts from two (non-structural) VAR models with initial conditions given by a credit crunch scenario used in the FRBNY risk assessment. The right hand panel shows conditional forecasts from a standard VAR with

the Fed Funds target, GDP growth, and core PCE inflation as state variables. The left hand panel shows the forecasts from the model augmented by financial intermediary balance sheet variables (financial sector equity returns and financial sector repo borrowing growth). As can be seen, the point estimates of future GDP growth differ substantially in these two models (the cumulated difference is around 2% of GDP or about 300 billion dollars). These very preliminary results provide one estimate of the size of the downside risk produced by adverse feedback loops between the real economy and financial markets.

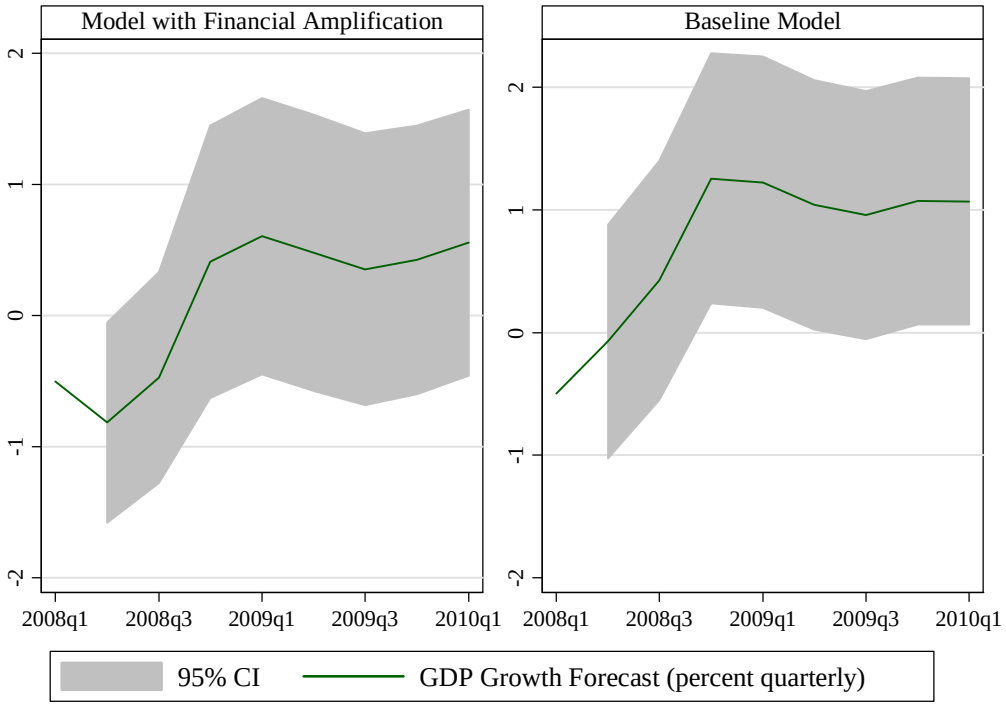

Figure 2: GDP Growth Forecasts

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Some Measures of the Current Stance of Monetary Policy

Simon Potter

Three alternative measures of the stance of monetary policy are examined:

1. Prescriptions of contemporaneous feedback rules with response coefficients to output and inflation gaps taken from Taylor's original work. The 2008Q1 data values are set equal to the FRBNY projections.

2. Prescriptions of forecast based rules with response coefficients to output and inflation gaps taken from Taylor's original work. The forecasts are set equal to either the FRBNY projection or the FRBNY forecast taking into account our risk assessment.

3. A counterfactual simulation of a Bayesian vector autoregression with a prior generated by a Dynamic Stochastic General Equilibrium. The model is estimated using data from the last 20 years on GDP and core PCE with the average target FFR in the 3rd month of the quarter as the policy rate. The counterfactual is constructed by setting the shock to the policy rate to zero after 2007Q1. The 2008Q1 data values for output and inflation are set equal to the FRBNY projections or the FRBNY forecast taking into account the risk from a credit crunch scenario.

These measures are meant as illustrations and are not intended to span the prescription of all policy type rules, optimal policy or robust control.

In Taylor's original formulation the policy rate is moved by 1.5 times the size of the inflation gap and 0.5 times the size of the output gap. We use the Summary of Economic Projections to center the inflation gap at 1.75% for core PCE inflation. This leaves the value of intercept (often called the neutral rate) to be determined. It is difficult to obtain precise estimates of this time varying value. In the past we have assessed the plausible range of values to be between 3.0 to 5.5%. Because the tighter financial conditions during the financial crisis, the neutral rate probably is in the lower half of this range and thus we focus on the policy prescriptions obtained using the lower half. A summary of the results is presented in the Table at the end of this note.

The contemporaneous feedback rule combined with our 2008Q1 projections prescribes a policy rate very close to the neutral rate, that is the inflation gap and output gap approximately cancel out when using Taylor's response coefficients. Using the forecast based rule with the FRBNY point projection, the prescriptions fall to about 100bps below the neutral rate. Taking into account the risks around the FRBNY projection prescribes an additional 50bps of easing.

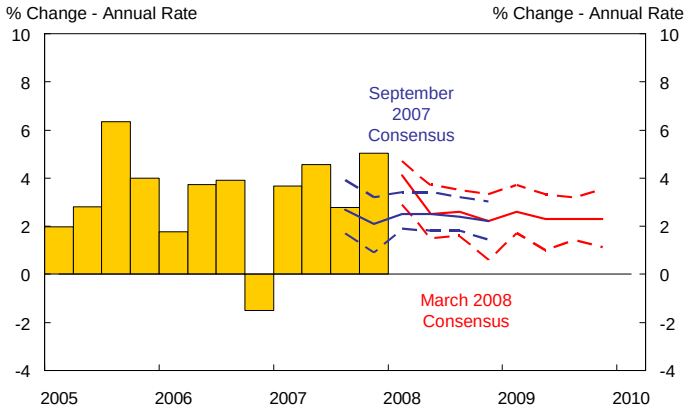
The calculations above assume the policy rate is not adjusted in an inertial manner. The counterfactual generated by the estimated Vector Autoregression captures in its path some of the inertia policy rates observed over the last 20 years, the average neutral rate over this period and estimated response coefficients to inflation and output deviation. For March 2008 the average value of the target FFR was 2.6%.

First, consider the counterfactual value based on the FRBNY projection. This predicts an average target of 3.5% in March 2008. If the model is iterated forward to the end of 2008 the counterfactual policy rate falls to 2%. Next we initialized the VAR with data drawn from a credit crunch scenario for 2008Q1. This predicts an average target of 2.6% in March 2008 and when the model is iterated forward to the end of 2008 the counterfactual policy rate falls to 1.25%.

Policy Rule	**Rate Prescription**
Contemporaneous Feedback	3.0-4.25
Forecast Based	2.0-3.25
Forecast Based with Risks	1.5-2.75
Counterfactual	2.0-3.5
Counterfactual with Credit Crunch scenario	1.25 to 2.6

Overview

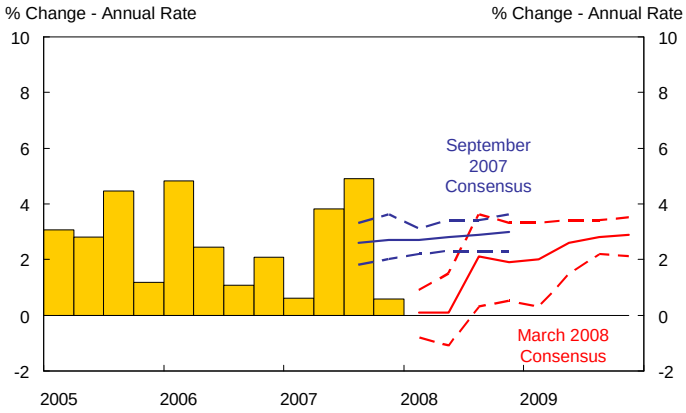
Figure 1: Actual and Projected Growth of CPI



Source: Bureau of Economic Analysis and Blue Chips

Note: Dotted lines represent top and bottom ten forecasts.

Figure 2: Actual and Projected Growth of Real GDP

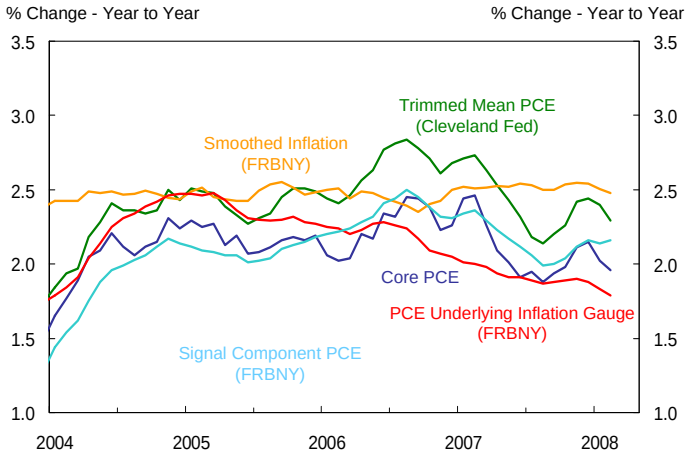


Source: Bureau of Economic Analysis and Blue Chips

Note: Dotted lines represent top and bottom ten forecasts.

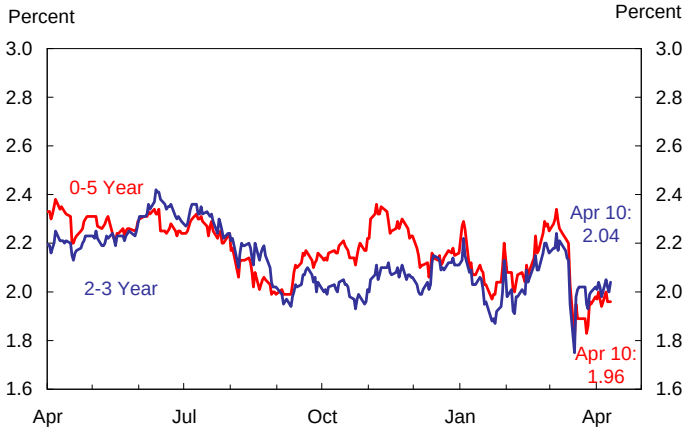
Inflation

Figure 3: Alternative Measures of PCE Inflation



Source: Bureau of Economic Analysis, Cleveland Fed, Swiss National Bank and FRBNY

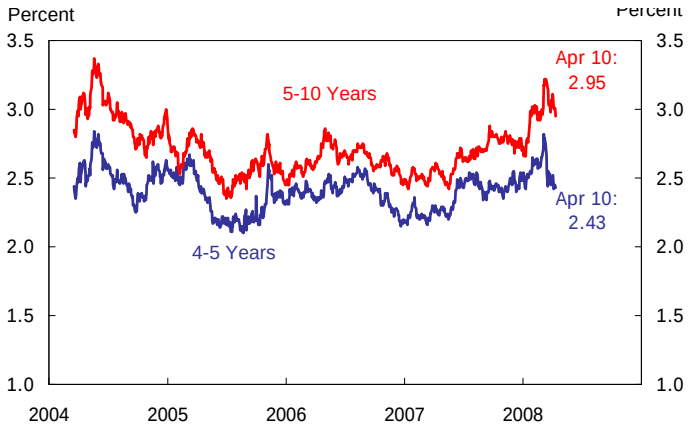
Figure 4: TIPS Implied Inflation: 0-5, 2-3 Year Horizons



Source: Federal Reserve Board

Note: Carry-adjusted

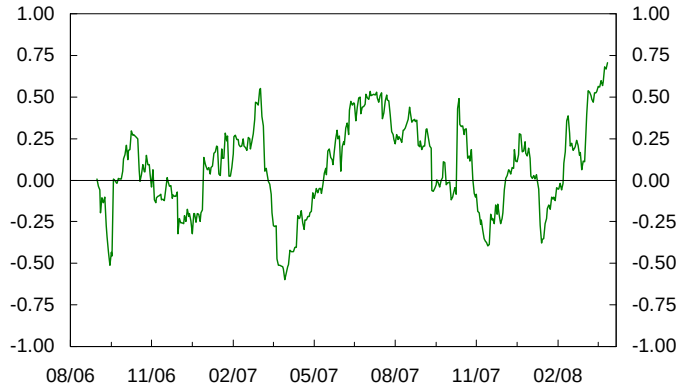
Figure 5: TIPS implied Inflation: 4-5, 5-10 Year



Source: Federal Reserve Board

Note: Carry-adjusted.

Figure 6: Rolling 20-Day Correlation of Daily Changes in 4-5 Year Inflation Compensation and One-Year Ahead Eurodollar Futures Rate

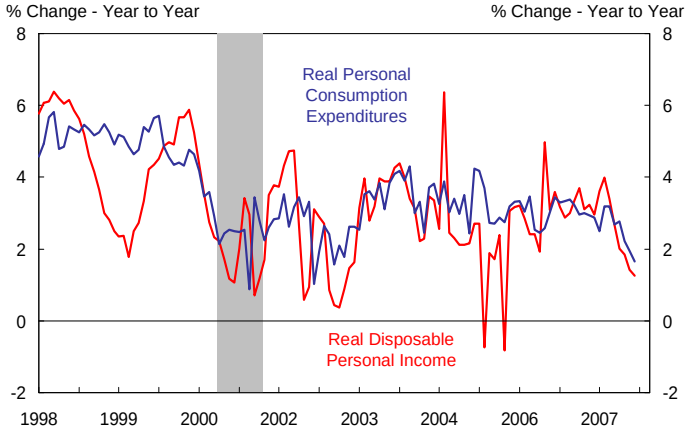


Source: FRBNY Calculations, Board of Governors

Note: Shading represents NBER recessions, unless otherwise noted.

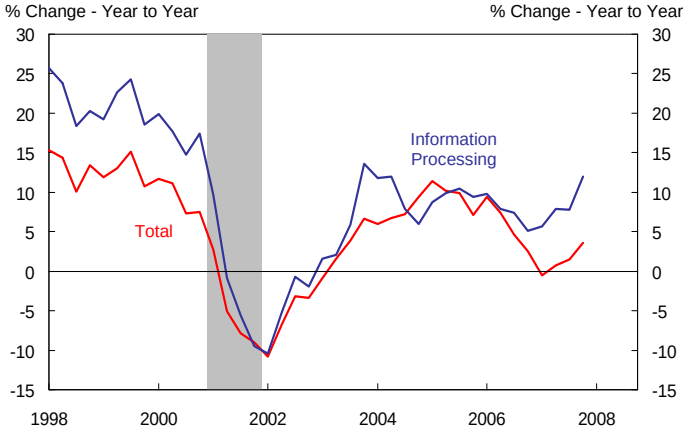
Real Activity

Figure 7: Personal Income and Consumption: Real PCE and DPI



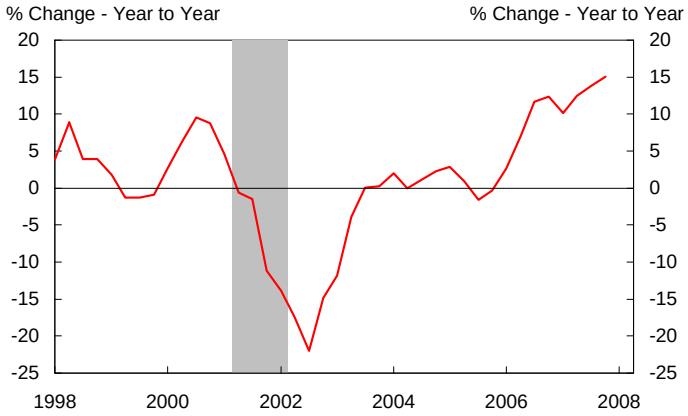
Source: Bureau of Economic Analysis

Figure 8: Real Business Investment: Equipment and Software



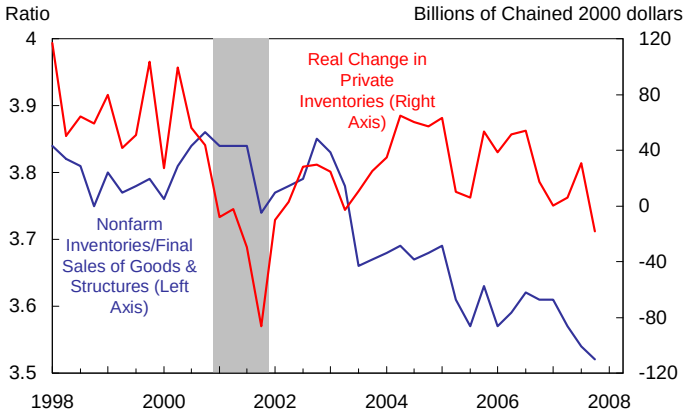
Source: Bureau of Economic Analysis

Figure 9: Business Investment: Nonresidential Structures



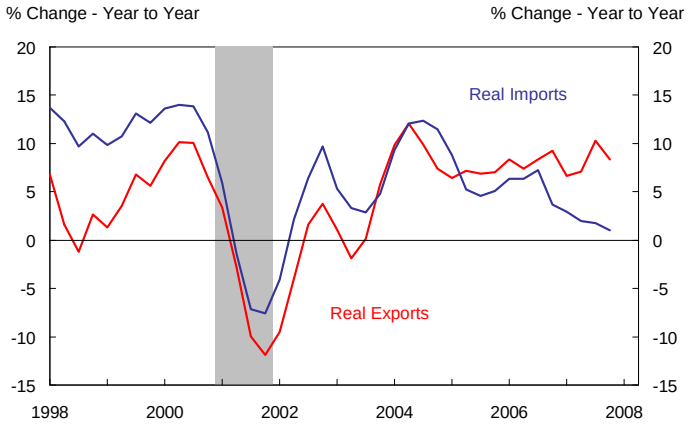
Source: Bureau of Economic Analysis

Figure 10: Inventory Change and Inventories over Final Sales



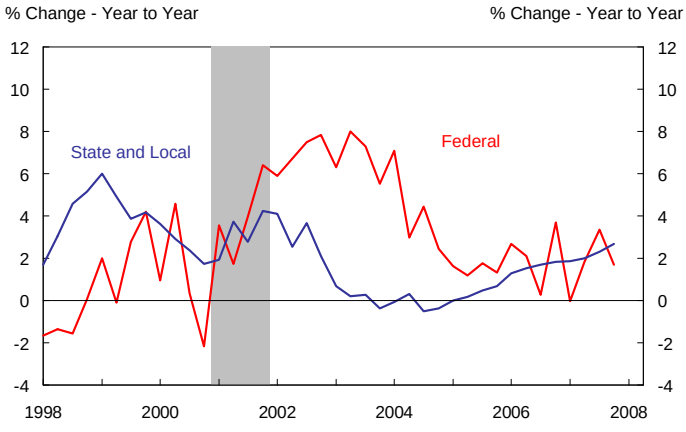
Source: Bureau of Economic Analysis

Figure 11: U.S. Trade



Source: Bureau of Economic Analysis

Figure 12: Real Government Consumption and Gross Investment



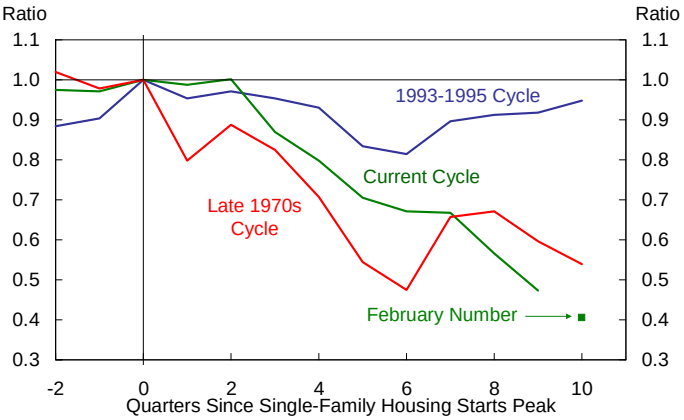
Source: Bureau of Economic Analysis

Note: Shading represents NBER recessions, unless otherwise noted.

The Housing Sector

Figure 13: Single-Family Housing Starts

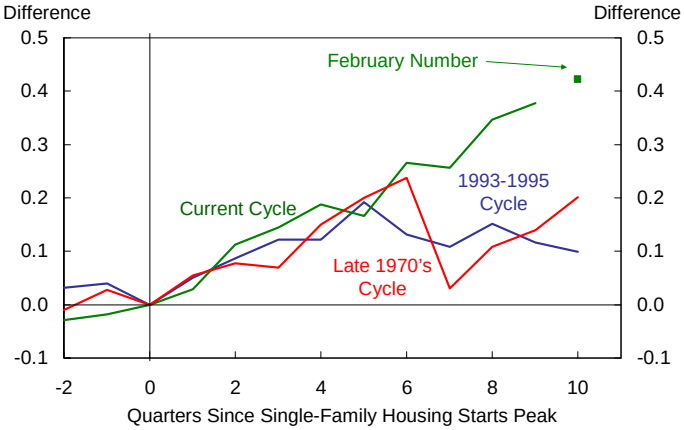
(Series Set to 1.0 at Housing Start Peak)



Source: Census Bureau

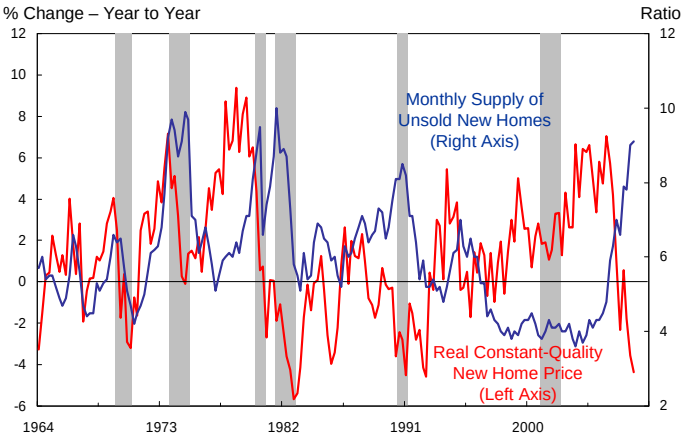
Figure 14: New Home Inventory / Sales Ratio

(Series Set to 0.0 at Housing Start Peak)



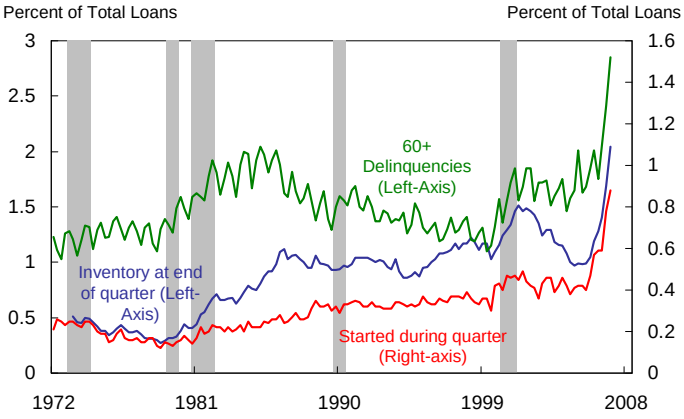
Source: Census Bureau

Figure 15: New Home Inventories & Real Price Change



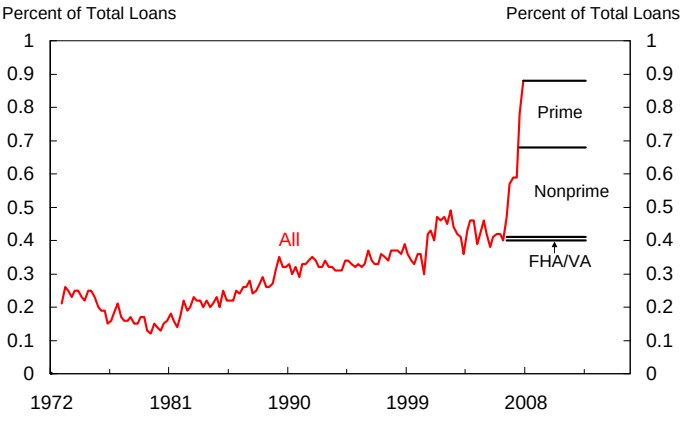
Source: Census Bureau and Bureau of Economic Analysis

Figure 16: Delinquency and Foreclosure Rates for All Loans, NSA



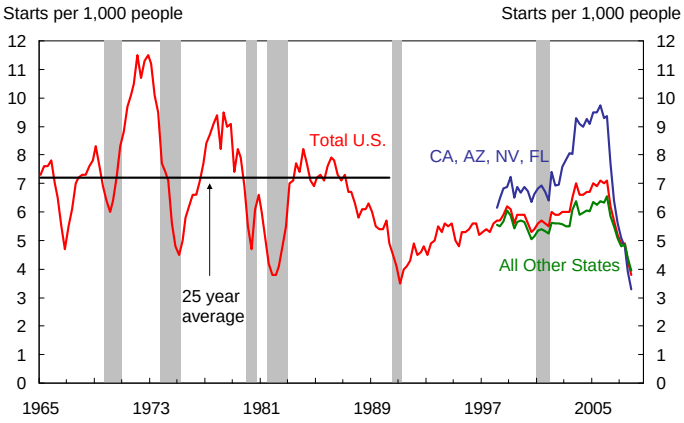
Source: Mortgage Bankers Association and Bureau of the Census

Figure 17: Foreclosures Started for All Loans, NSA



Source: Mortgage Bankers Association

Figure 18: Housing Starts per 1,000 People



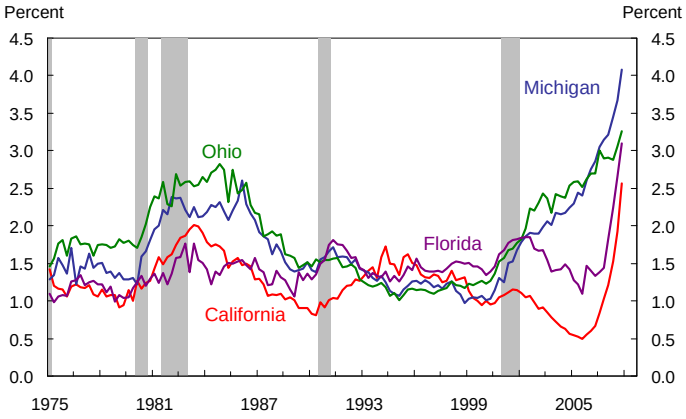
Source: Census Bureau and Economy.com

Note: Shading represents NBER recessions.

Note: Shading represents NBER recessions, unless otherwise noted.

The Housing Sector, ctd.

Figure 19: Serious Delinquencies By State for All Loans (SA)



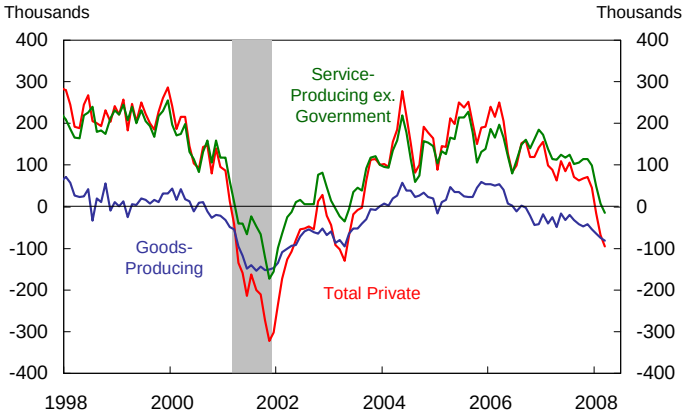
Source: Mortgage Bankers Association

Note: Shading represents NBER recessions, unless otherwise noted.

Labor Markets

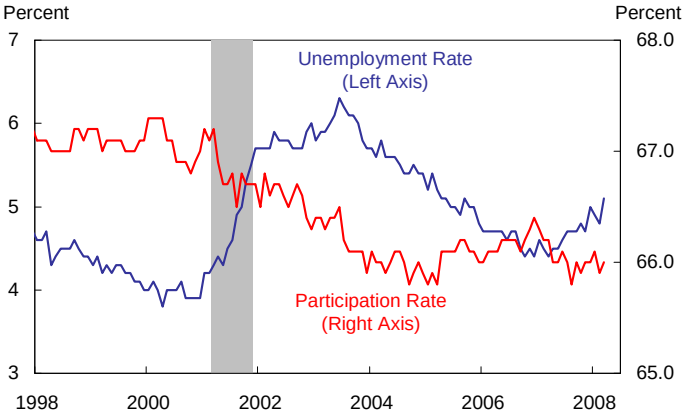
Figure 20: Private Nonfarm Payroll Employment

3-Month Moving Average of Change



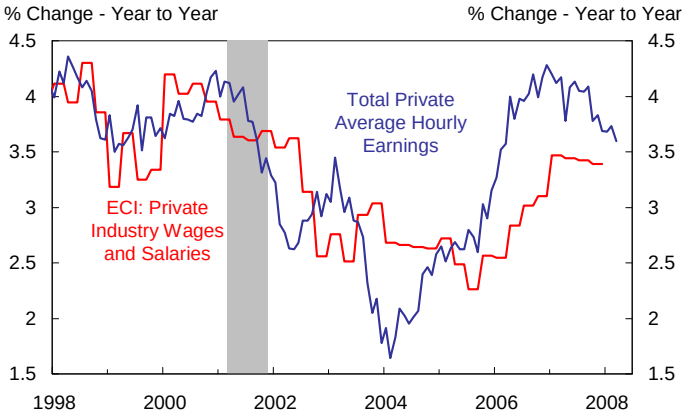
Source: Bureau of Labor Statistics

Figure 21: Unemployment and Participation Rates



Source: Bureau of Labor Statistics

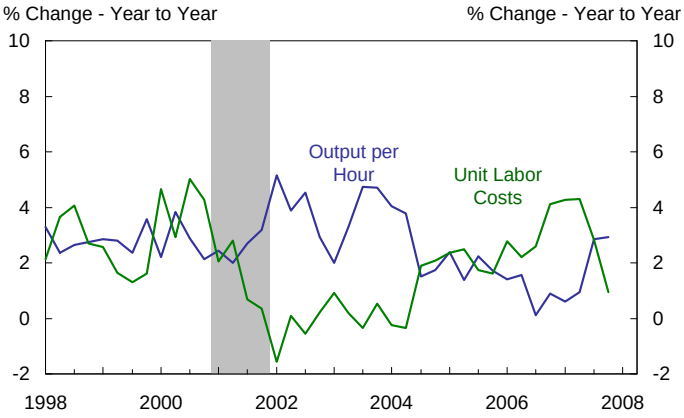
Figure 22: Average Hourly Earnings vs. ECI



Source: Bureau of Labor Statistics

Figure 23: Productivity and Unit Labor Costs

Nonfarm Business Sector

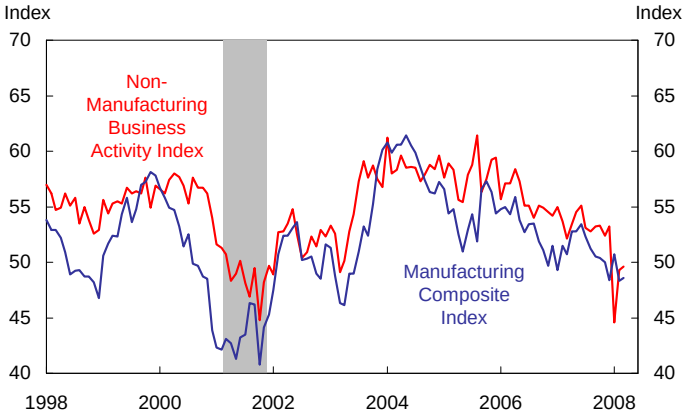


Source: Bureau of Labor Statistics

Note: Shading represents NBER recessions, unless otherwise noted.

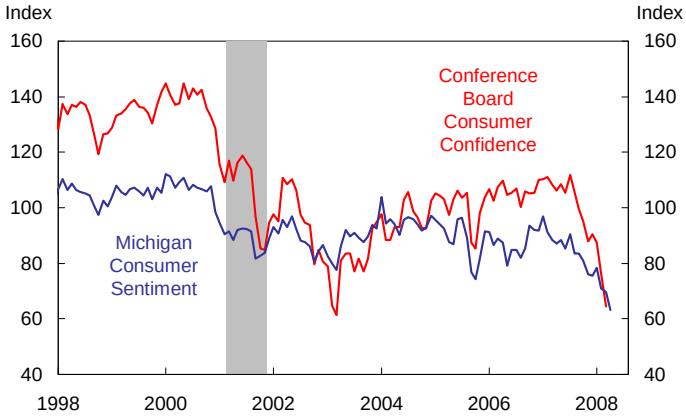
Surveys

Figure 24: ISM Indices



Source: Institute for Supply Management

Figure 25: Consumer Confidence Surveys



Source: University of Michigan and Conference Board

Note: Shading represents NBER recessions, unless otherwise noted.

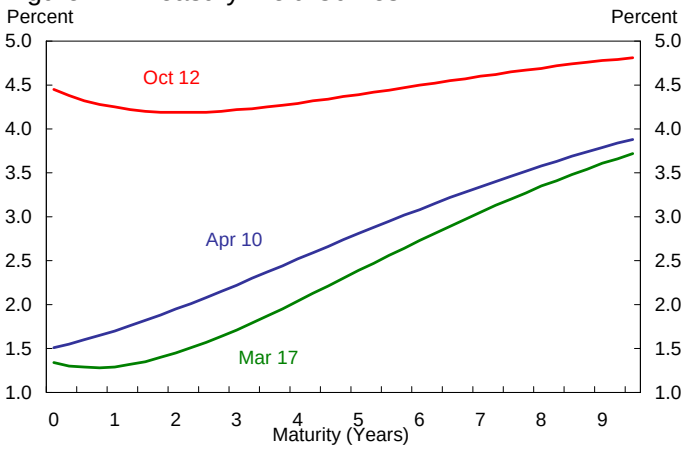
Financial Markets

Figure 26: Short- and Long-Term Rates

Source: Bloomberg

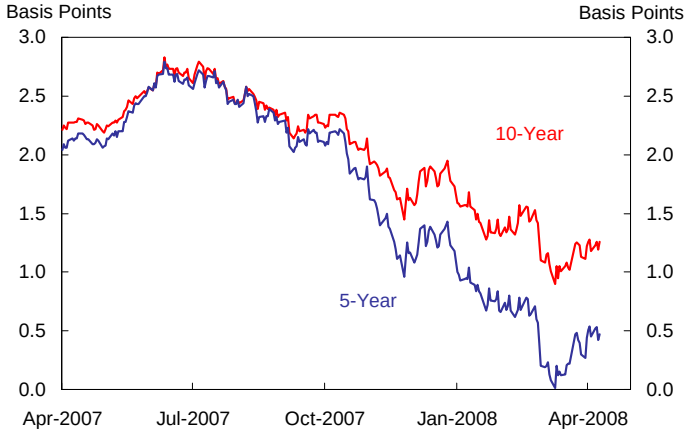
Note: Yields of on-the-run securities

Figure 27: Treasury Yield Curves



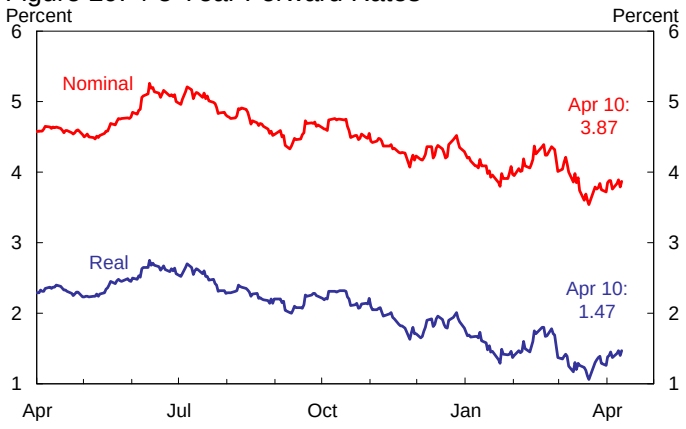
Source: Federal Reserve Board

Figure 28: 5- and 10-Year Real Treasury Rate



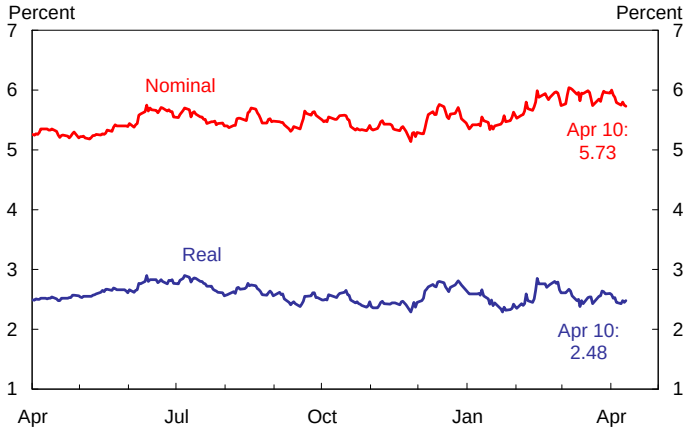
Source: Federal Reserve Board

Figure 29: 4-5 Year Forward Rates



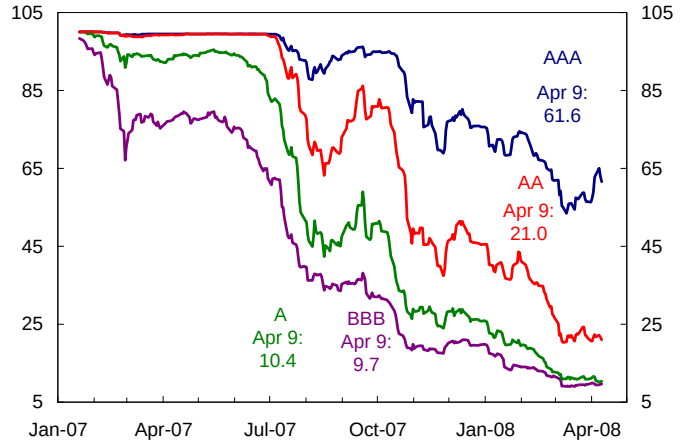
Source: Federal Reserve Board

Figure 30: 9-10 Year Forward Rates



Source: Federal Reserve Board

Figure 31: 2007-1 ABX Closing Price

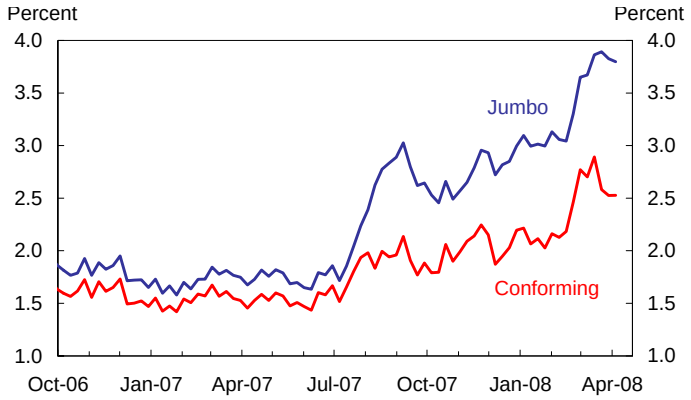


Source: JPMorgan

Note: Shading represents NBER recessions, unless otherwise noted.

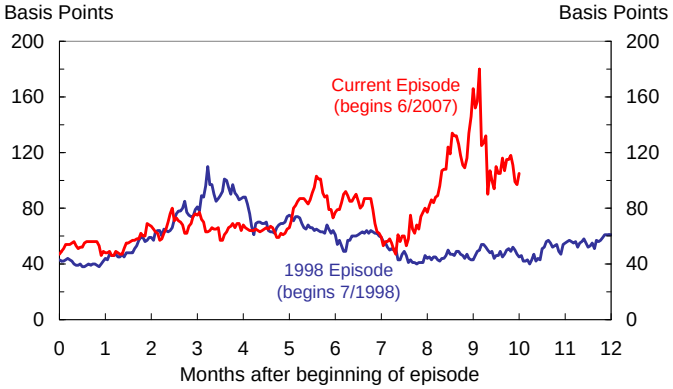
Financial Markets, ctd.

Figure 32: 30-Year FRM – 10-Year Treasury Spreads



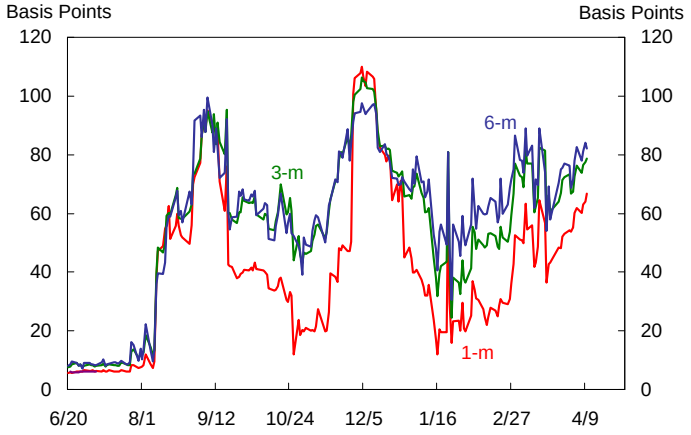
Source: HSH Associates and Datastream

Figure 33: 30-year FNMA Mortgage Spreads (OAS to Treasury)



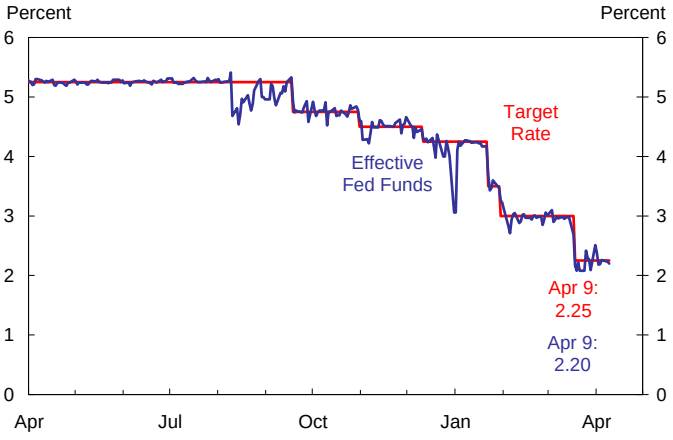
Source: Merrill Lynch and Bloomberg

Figure 34: USD LIBOR-to-OIS Spread



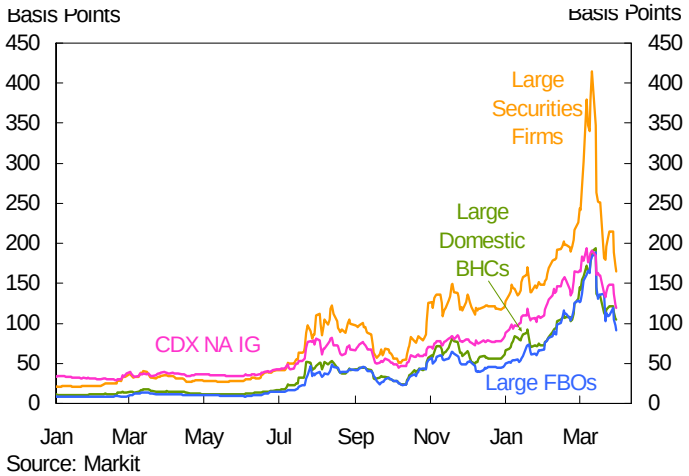
Source: Bloomberg

Figure 35: Effective Fed Funds Rate and Target



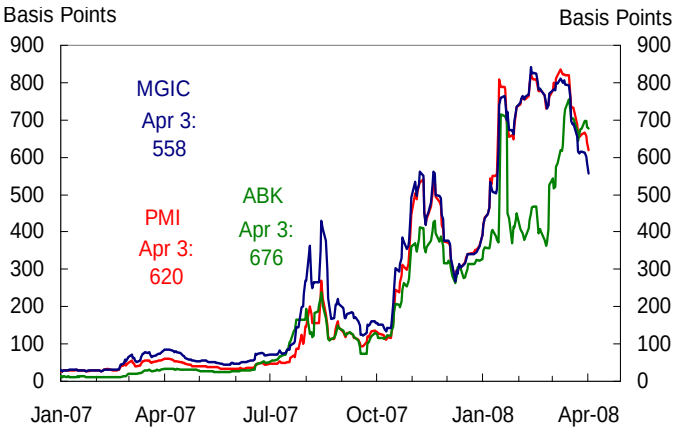
Source: Bloomberg

Figure 36: Credit Default Swap Spreads



Source: Markit

Figure 37: CDS Spreads, Mortg. Insurers and Fin. Guarantors



Source: OptionMetrics, Markit

Note: Shading represents NBER recessions, unless otherwise noted.

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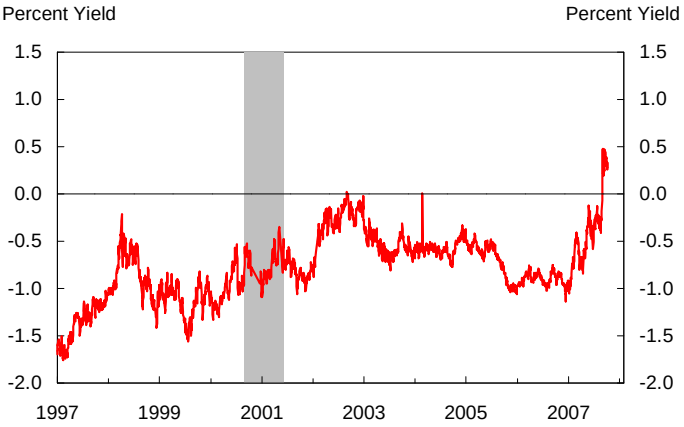
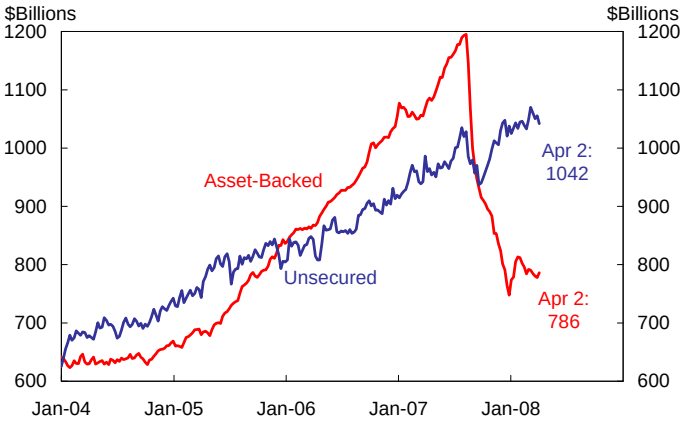
Figure 38: 10-Year Municipal Bond - Treasury Spread



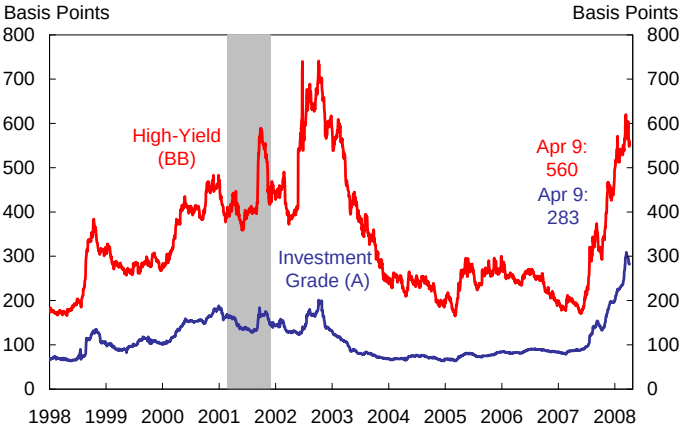
Source: Wall Street Journal

Figure 39: Commercial Paper Outstanding



Source: Federal Reserve Board

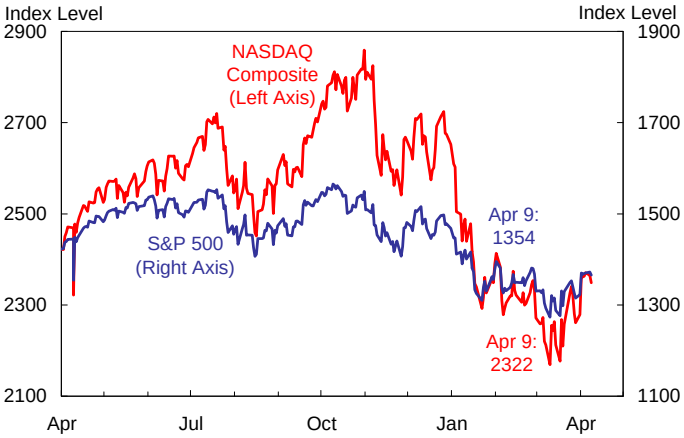
Figure 40: Corporate Credit Spreads



Source: Merrill Lynch

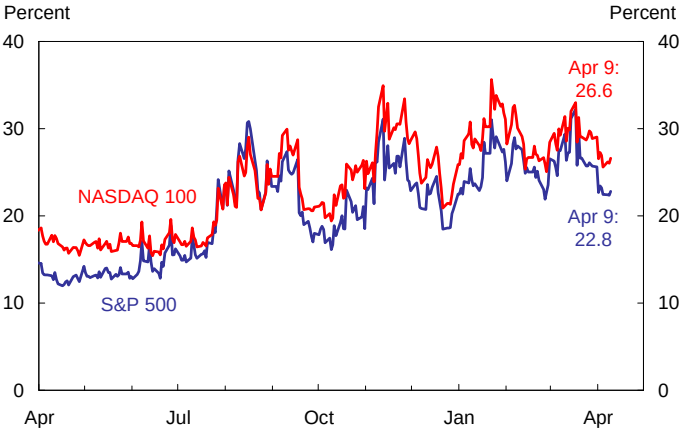
Note: Option-adjusted spreads

Figure 41: Equity Market Performance



Source: Bloomberg

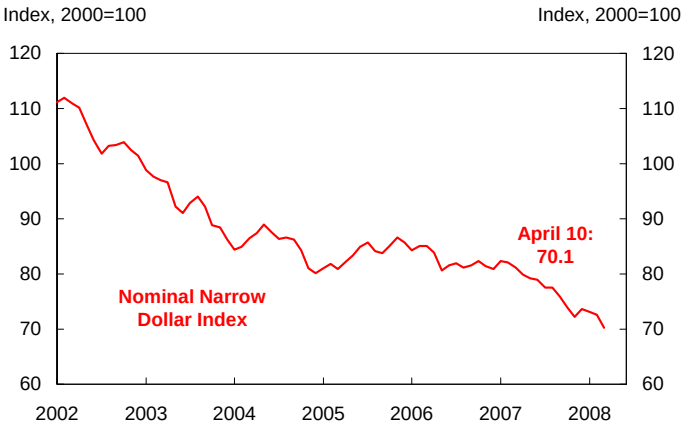
Figure 42: Equity Market Implied 1-Month Volatility



Source: CBOE

Note: Annualized

Figure 43: Narrow Dollar Index



Source: BIS and Federal Reserve Board

Note: Data are monthly averages.

Note: Shading represents NBER recessions, unless otherwise noted.

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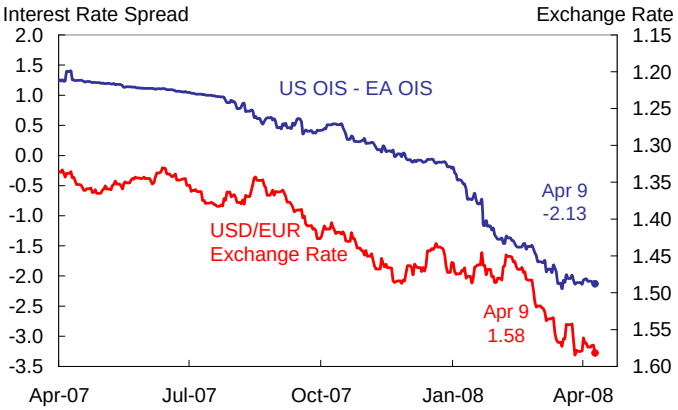
Figure 44: US vs. Euro Area

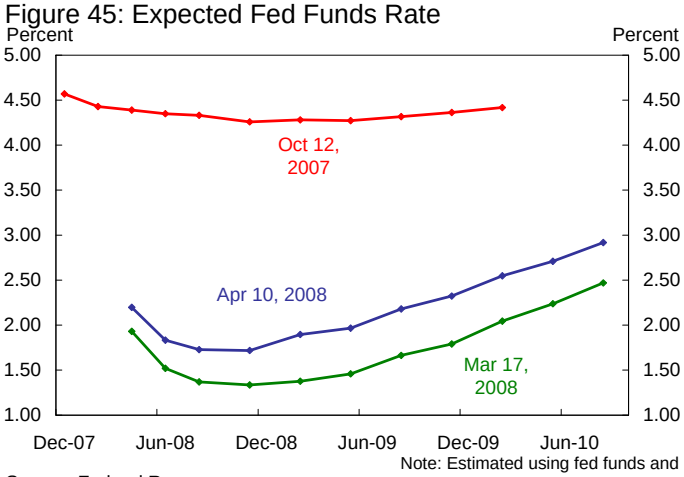
OIS Rate Differentials and Exchange Rates



Source: Bloomberg

OIS: Overnight Index Swap Rates (6 mo). Exchange rate scale is

Figure 45: Expected Fed Funds Rate

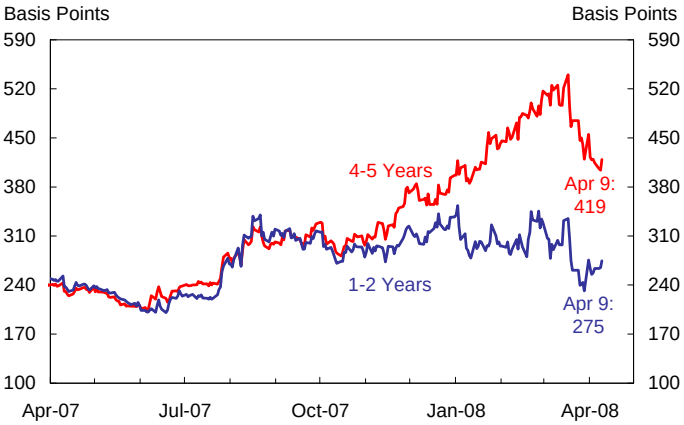


Source: Federal Reserve

Note: Estimated using fed funds and Eurodollar futures.

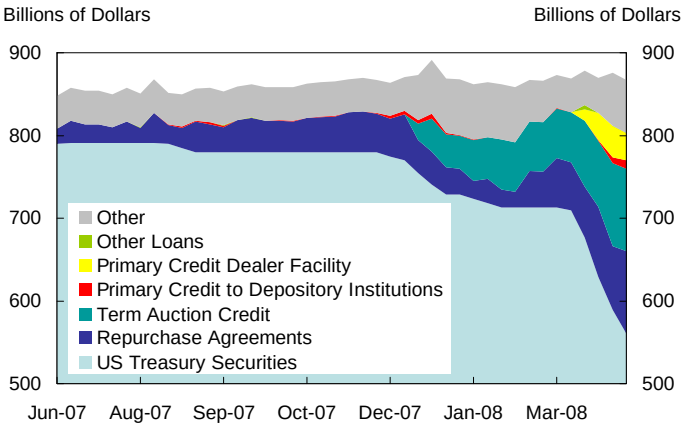
Figure 46: Expected Interest Rate Volatility

Width of 90% Confidence Interval Implied by Swaptions



Source: Datastream, Federal Reserve Board, FRBNY calculations

Figure 47: Composition of Fed Balance Sheet



Source: Federal Reserve Board

Note: Shading represents NBER recessions, unless otherwise noted.

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Table 1: Recent Estimates of Financial Sector Losses

Estimated Loss	Source	Date	Other Relevant Details
Estimates of financial-sector losses on all assets			
$1,000bn	Nouriel Roubini	2/5/2008	$300-400bn: financial intermediaries losses on mortgages; $600-700bn: losses on other assets (consumer debt, commercial real estate loans, etc.)
$1,000bn	George Magnus (UBS)	2/25/2008	$500-600bn: subprime and CDOs and related instruments $400-500bn: losses from recession and credit-cycle problems of credit cards, consumer loans, corporate debt, corporate loans
$1,000bn - $2,700bn	Nouriel Roubini	2/29/2008	For $1,000bn: assuming peak-to-trough HPA of -20% and 50% of households with negative equity walk away (assuming avg. mortgage is $250k and loss to creditor is 50%, based on fall in home price, foreclosure costs and cost of selling home in illiquid market); For $2,000bn: larger HPA (-30%) and, thus, more households walking away; Add'l $700bn: $1-2 trillion + credit losses from consumer credit, commercial real estate, leveraged loans, etc.
$1,000bn	Charles Morris (*The Trillion Dollar Meltdown*)	3/3/2008	Include losses from subprime mortgages, high-yield bonds, commercial mortgages, leveraged loans, credit cards and CDS Assumes an orderly unwinding
$1,156bn	Goldman Sachs	3/7/2008	$500bn: mortgage-related losses; $656bn: other losses; assumptions: peak-to-trough HPA of -25%; 20% of homeowners with negative equity walk away; loss to creditor if homeowners walk away is 50%
$298bn	Goldman Sachs	3/7/2008	GS's etimate of $1,156bn from 3/7, allowing for loan-loss provisions, proportion of loss-making loans advanced by non-leveraged sector, ability to write-off losses against tax
$750bn	Nouriel Roubini/Martin Wolf/GS	3/12/2008	Roubini's $1,000-2,000bn, calculated by Wolf using GS's argument that we should allow for loan-loss provisions, proportion of loss-making loans advanced by non-leveraged sector, ability to write-off losses against tax
$945bn	IMF	4/8/2008	$565bn: US residential loans and securities $240bn: commercial real estate escurities $120bn: Corporate loans (incl leveraged loans and CLOs) $20bn: consumer loans losses Global banks shoulder half; insurance companies, pension funds, money market funds, hedge funds, other institutional investors shoulder other half

Range of Loss Estimates on All Assets
$298bn to $2.7tn

Estimated Loss	Source	Date	Other Relevant Details
Estimates of financial-sector losses on ONLY mortgage-related assets			
$243bn-495bn	Goldman Sachs	Nov. 2007	$243bn: baseline $495: stress scenario
$250bn-$320bn	Lehman Brothers	Dec. 2007	$250bn: assumes -15% peak-to-trough HPA (baseline) $320bn: assumes -30% peak-to-trough HPA (stress scenario)
Several multiples of $100bn	Bernanke	1/17/2008	
$400bn	Greenlaw (Morgan Stanley), Hatzius (GS), Kashyap (Chicago Fed), Shin (Princeton)	2/29/2008	approx. half of $400bn will be borne by leveraged US financial institutions
$430bn	BaFin	3/19/2008	Direct effects of subprime and Alt-A losses
$460bn	Goldman Sachs	3/24/2008	Credit losses suffered by leveraged US financial institutions, after loan loss provisions --> approx. 2x Greenlaw, Hatzius, Kashyap & Shin's estimate (above)
$343bn	FRBNY (Warren Hrung)	3/26/2008	subprime and Alt-A losses; assumptions: HPA of -10.5% in 2008, -7.5% in 2009, -5% in 2010; lower default timing curve than in 1990s
Other Estimates			
$285bn	S&P	3/13/2008	estimated valuation write-downs of subprime ABS

Range of Loss Estimates on Mortgage-Related Securities
$243bn to approx. $500bn

Note: Shading represents NBER recessions, unless otherwise noted.

ECONOMIC ADVISORY PANEL MEETING

APRIL 18, 2008

REFERENCE CHARTS AND TABLES

Prepared by the staff of the
Research and Statistics Group

Inflation: PCE Deflator

PCE Deflator

(percent change at an annual rate)

	24 Month	12 Month	6 Month	3 Month	1 Month
PCE Deflator	2.9	3.4	3.8	2.8	1.5
Market-Based	2.8	3.4	3.9	2.8	1.2
Durable Goods	-1.5	-1.3	-0.8	-0.3	0.9
Motor Vehicles and Parts	-0.3	0.4	-0.7	-1.7	-2.1
Nondurable Goods	4.1	6.3	7.1	4.4	-1.1
Clothing and Shoes	0.0	-1.6	1.5	0.5	-5.7
Services	3.1	2.9	3.1	2.6	2.8
Housing	3.6	2.9	3.1	2.8	1.2
Transportation	2.6	2.9	1.6	3.1	-1.0
Medical Care	3.1	2.4	2.6	0.8	1.1
PCE Deflator Excluding Food and Energy	2.2	2.0	2.4	2.1	1.3
Market-Based	2.0	1.7	2.2	1.9	1.0
Personal Business Services-MB	4.0	4.5	4.0	0.8	-2.3
Personal Business Services-NMB	2.8	3.0	2.8	2.9	3.0

Source: Bureau of Economic Analysis

Note: Data through February 2008

Note: Shading represents NBER recessions, unless otherwise noted.

Inflation: Consumer Prices

Consumer Price Data

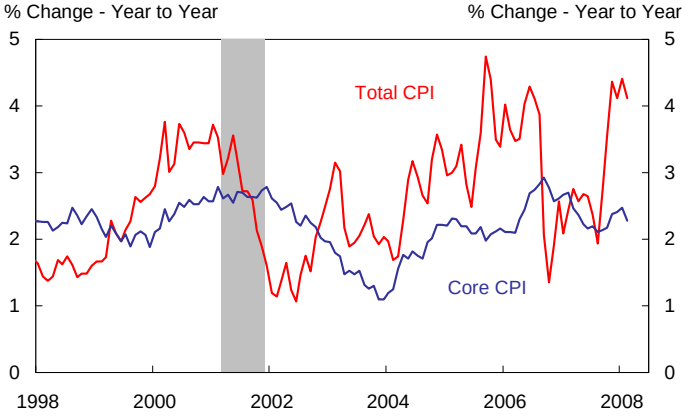
(percent change at an annual rate)

	Weights (December 2007) Total	Core	24 Month	12 Month	6 Month	3 Month	1 Month
Consumer Price Index	100.00		3.3	4.1	4.7	3.1	0.3
Energy	9.70		8.7	19.4	24.3	7.6	-6.3
All Items Ex. Energy			2.7	2.6	2.8	2.7	1.1
Food	13.83		3.8	4.6	4.5	4.7	4.4
Food Away From Home (NSA)	6.17		3.7	3.9	4.0	3.9	4.7
All Items Ex. Food and Energy	76.47	100.00	2.5	2.3	2.5	2.3	0.5
Core Chain-Weight CPI (NSA)			2.1	2.0	2.5	2.4	4.1
Core Goods	21.60	28.25	0.0	0.0	0.5	0.4	-0.9
Apparel	3.73	4.88	0.5	-1.0	2.1	0.8	-4.0
Medical Care Commodities	1.60	2.09	2.3	2.9	3.7	3.9	1.6
Durable Goods	10.84	14.17	-1.4	-1.0	-1.1	-1.4	-2.8
New Vehicles	4.63	6.06	-1.1	-0.8	-1.7	-2.5	-3.5
Used Vehicles	1.77	2.32	-0.8	2.0	0.2	1.9	0.4
Core Services	54.87	71.75	3.5	3.2	3.2	3.1	1.0
Rent of Primary Residence	5.77	7.54	4.1	3.7	4.1	3.6	2.3
Owners' Equivalent Rent	23.94	31.31	3.4	2.6	2.9	2.6	1.8
Lodging Away from Home	2.56	3.35	3.9	3.5	0.1	1.0	-13.4
Medical Care Services	4.63	6.05	5.1	5.0	4.8	3.9	1.0
Transportation Services	5.27	6.89	2.0	2.6	3.6	4.0	1.1

Source: Bureau of Labor Statistics

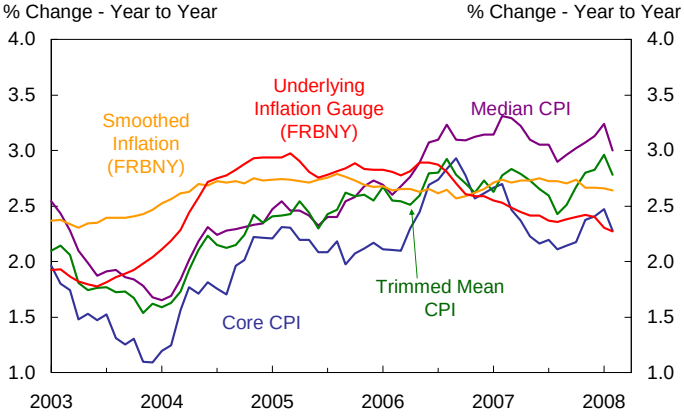
Note: Data through February 2008

Total and Core CPI



Source: Bureau of Labor Statistics

Alternative Measures of CPI

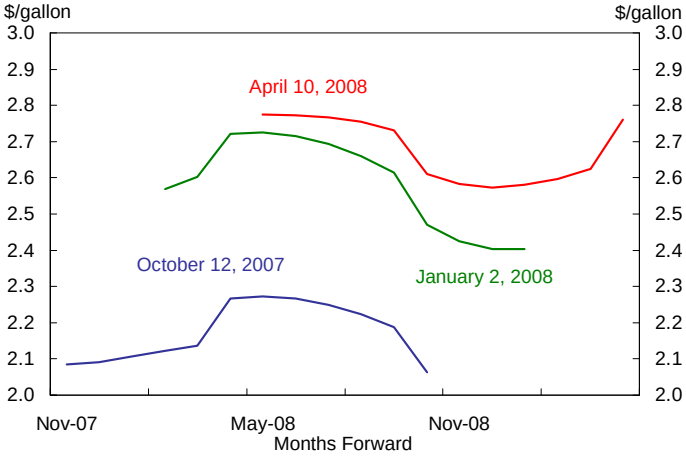


Source: Bureau of Labor Statistics, Cleveland Fed, and FRBNY

Note: Shading represents NBER recessions, unless otherwise noted.

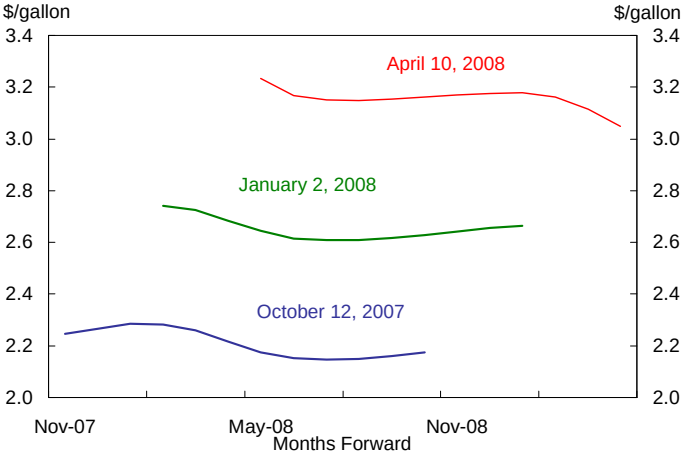
Energy Prices

Gasoline Futures



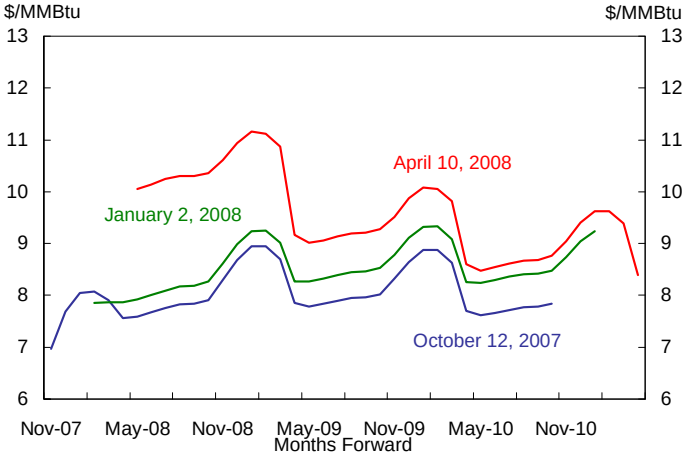
Source: Bloomberg, End-of-Day Quotes

Heating Oil Futures



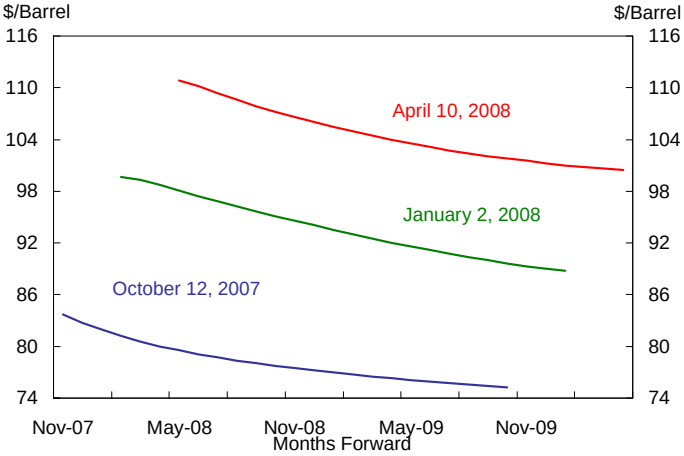
Source: Bloomberg, End-of-Day Quotes

Natural Gas Futures



Source: Bloomberg, End-of-Day Quotes

Crude Oil Futures



Source: Bloomberg, End-of-Day Quotes

Note: Shading represents NBER recessions, unless otherwise noted.

Real Activity: Consumer Spending

Real Personal Consumption Expenditures
(percent change at an annual rate)

	2007Q4 Nominal Share	24 Months	12 Months	6 Months	3 Months	1 Month
Personal Consumption Expenditures	100.0	2.4	1.7	1.4	0.3	0.0
Durable Goods	10.9	3.0	0.9	-2.6	-5.4	2.5
Motor vehicles and parts	4.4	0.1	-4.4	-6.1	-7.4	4.2
Furniture and household equipment	4.2	6.8	4.8	2.7	-2.1	3.2
Other durable goods	2.3	2.1	4.5	-5.1	-7.7	-2.1
Nondurable goods	29.3	1.7	0.3	0.3	-2.4	-1.8
Food	13.8	1.9	1.0	2.0	-1.2	1.2
Clothing and shoes	3.7	3.1	2.6	-1.8	-1.5	17.5
Gasoline, fuel oil, and other energy goods	4.0	-2.3	-5.8	-2.6	-9.0	-30.9
Other nondurable goods	7.8	2.5	1.2	0.0	-1.3	3.3
Services	59.8	2.7	2.4	2.7	2.7	0.4
Housing services	15.1	2.4	2.7	2.5	2.0	2.2
Household operation services	5.4	2.7	1.0	4.1	-0.7	-12.2
Gas and electric	2.3	4.7	0.6	7.5	-3.3	-26.4
Other	3.1	1.2	1.4	1.6	1.4	1.1
Transportation services	3.7	2.6	3.2	2.5	2.8	1.5
Medical care services	17.4	2.7	3.0	3.7	3.4	2.6
Recreation services	4.1	2.7	0.8	-0.9	-0.3	-4.3
Other	14.2	2.9	2.3	2.0	4.8	2.3
Energy goods and services	6.3	0.2	-3.7	1.0	-7.0	-29.2
PCE less food and energy	79.9	2.7	2.2	1.3	1.2	2.7
PCE less autos and household operation	90.1	2.6	2.1	1.7	0.8	0.5

Source: Bureau of Economic Analysis

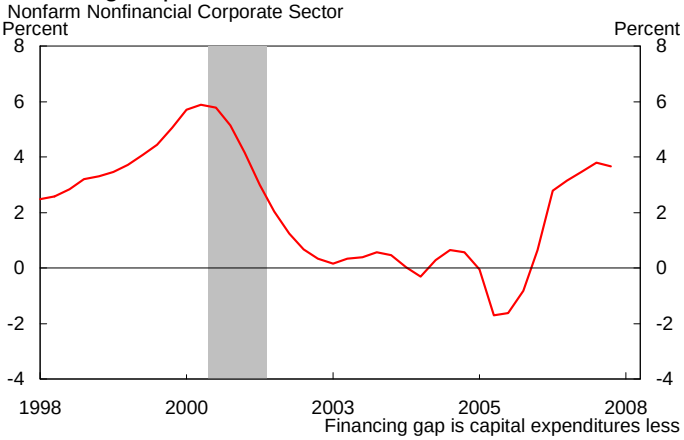
Note: Data through February 2008.

Note: Shading represents NBER recessions, unless otherwise noted.

Household and Business Finances

Financing Gap as a Percent of Value Added

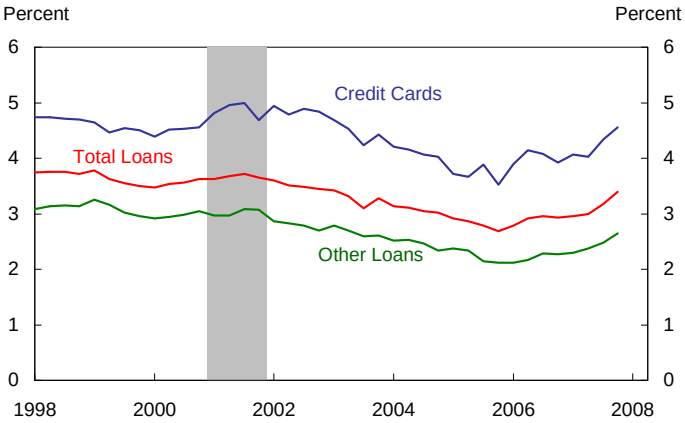
Nonfarm Nonfinancial Corporate Sector



Source: Flow of Funds, Federal Reserve Board, and BEA

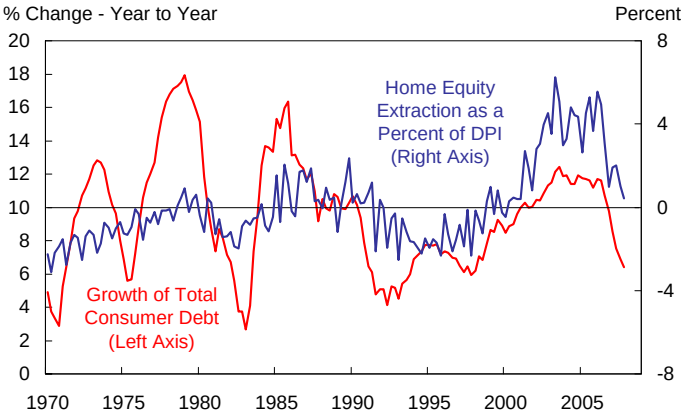
Financing gap is capital expenditures less the sum of U.S. internal funds and inventory valuation adjustment (IVA).

Consumer Installment Debt Delinquency Rates



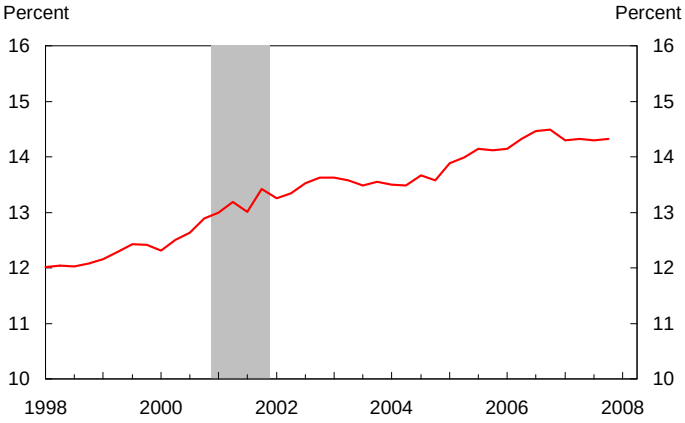
Source: Federal Reserve Board

Consumer Debt and Home Equity Extraction



Source: Flow of Funds and Bureau of Economic Analysis

Consumer Debt Service over DPI

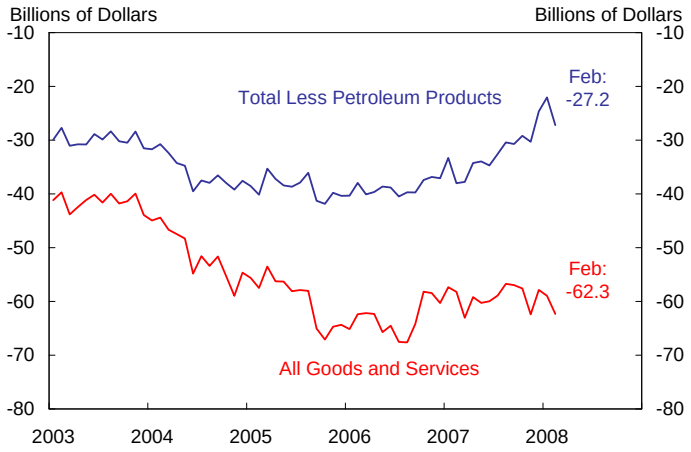


Source: Federal Reserve Board

Note: Shading represents NBER recessions, unless otherwise noted.

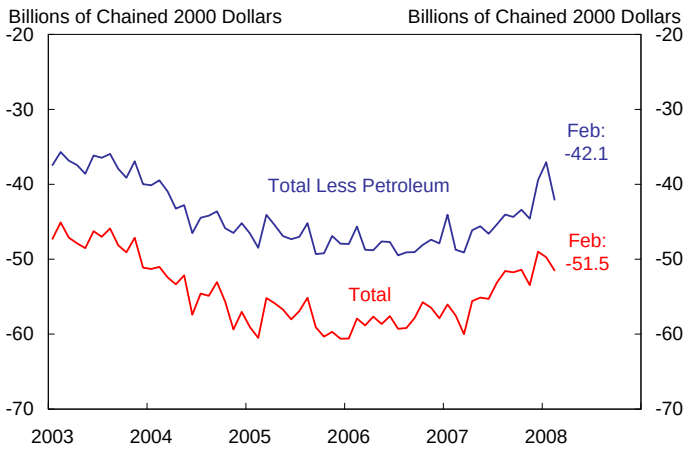
U.S. Trade: Goods and Services

Total Balance in Goods and Services



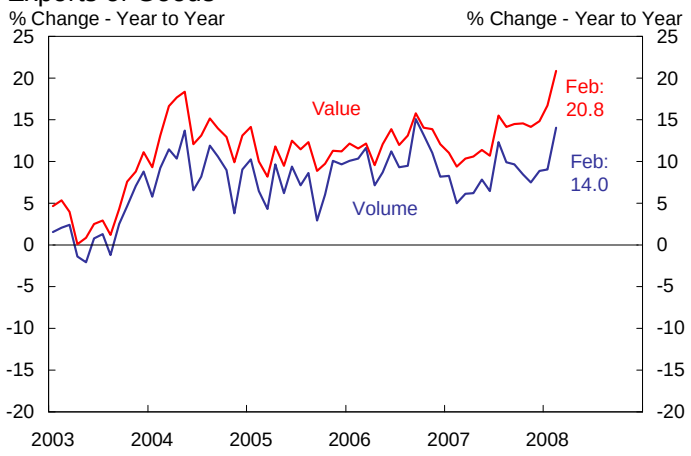
Source: Census Bureau

Real Total Balance of Goods



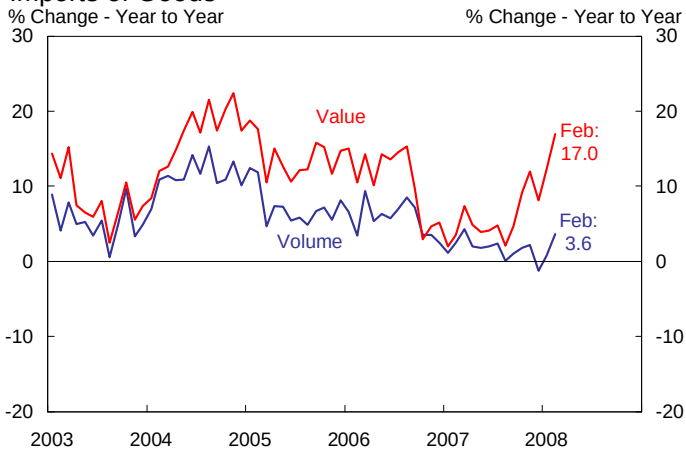
Source: Census Bureau

Exports of Goods



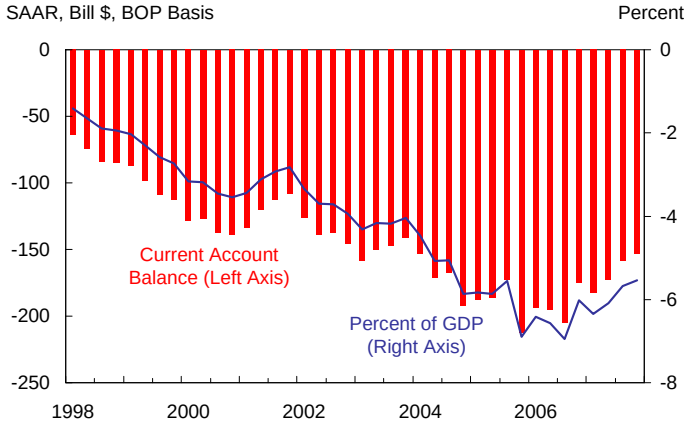
Source: Census Bureau

Imports of Goods



Source: Census Bureau

Current Account Balance



Source: Bureau of Economic Analysis

Note: Shading represents NBER recessions, unless otherwise noted.

Labor Market: Nonfarm Payroll Employment

Annualized Growth of Nonfarm Payroll Employment
(percent change at an annual rate)

	24 Month	12 Month	6 Month	3 Month	1 Month
Total	0.8	0.4	0.0	-0.7	-0.7
Private	0.7	0.3	-0.3	-1.0	-1.0
Goods-Producing	-1.9	-2.8	-3.6	-4.4	-5.0
Construction	-2.3	-4.6	-6.5	-6.6	-8.0
Manufacturing	-2.0	-2.2	-2.6	-3.7	-4.1
Durables	-1.9	-2.4	-2.8	-3.9	-4.7
Nondurables	-2.1	-2.0	-2.1	-3.4	-3.1
Private Service Providing	1.4	1.0	0.5	-0.2	-0.1
Wholesale Trade	1.5	1.2	-0.1	-1.2	-0.9
Retail Trade	0.1	-0.7	-1.0	-1.9	-1.0
Transportation and Warehousing	1.2	0.0	-0.9	-0.7	-1.0
Utilities	0.8	1.3	0.8	-0.1	1.1
Information	-0.7	-0.7	-1.4	-1.1	-2.4
Financial Activities	-0.5	-1.3	-1.6	-1.2	-0.7
Professional and Business Services	1.7	0.9	0.4	-2.1	-2.3
Temporary Help Services	-2.2	-4.5	-3.5	-8.9	-9.7
Education and Health Services	2.7	3.0	2.7	2.9	2.7
Leisure and Hospitality	2.5	2.5	1.9	1.4	1.6
Food and Drinking Places	2.7	3.0	2.2	2.0	2.9
Other Services	0.9	0.7	0.8	0.7	0.2
Government	1.1	1.1	1.4	1.0	1.0
Federal Government	-0.1	-0.1	0.4	-1.3	0.9
State Government	1.1	1.1	1.2	1.2	0.7
Local Government	1.3	1.3	1.7	1.3	1.1

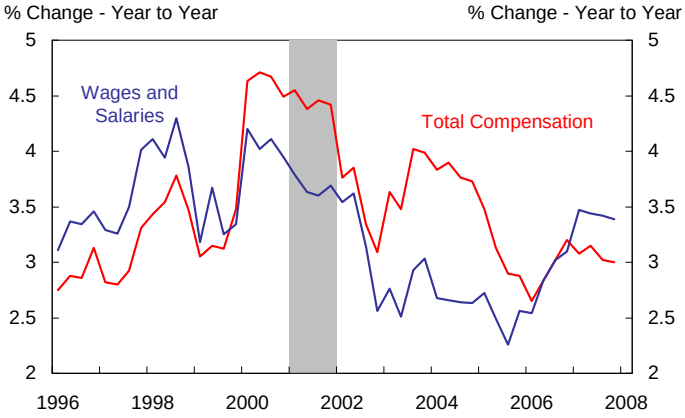
Source: Bureau of Labor Statistics

Note: Data through March 2008.

Note: Shading represents NBER recessions, unless otherwise noted.

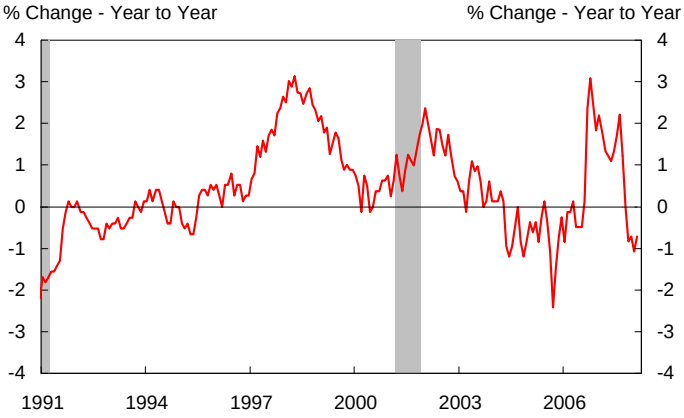
Labor Market: Labor Costs, Earnings and Hours

Employment Cost Index: Private Industry



Source: Bureau of Labor Statistics

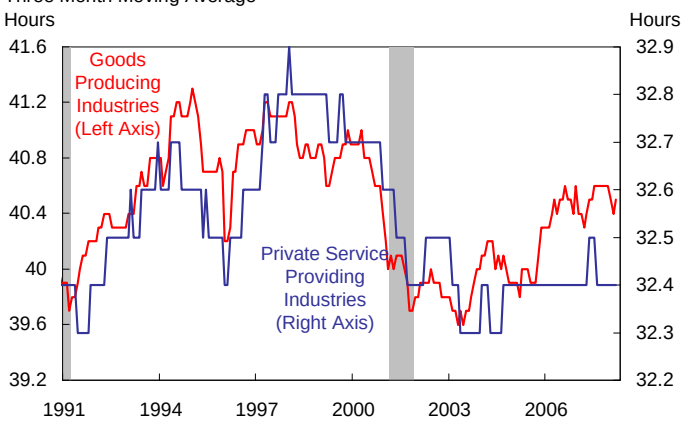
Real Average Hourly Earnings



Source: Bureau of Labor Statistics

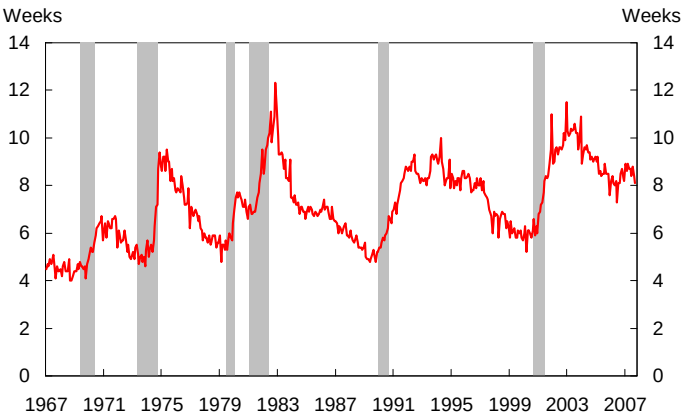
Average Weekly Hours

Three Month Moving Average



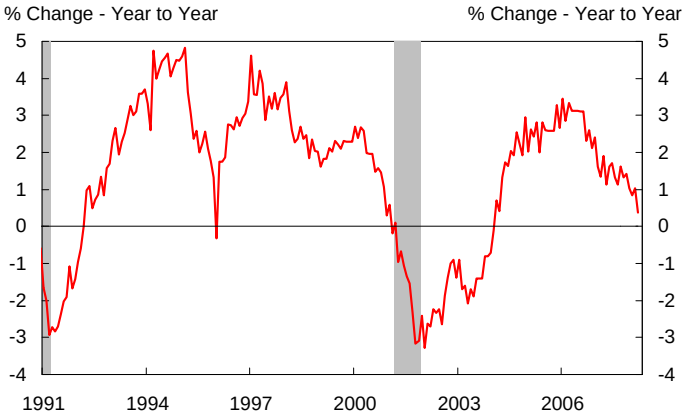
Source: Bureau of Labor Statistics

Median Duration of Unemployment



Source: Bureau of Labor Statistics

Aggregate Weekly Hours Index: Total Private Industries

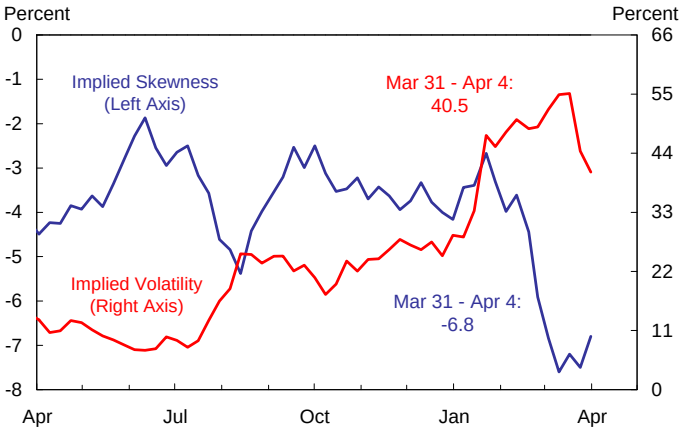


Source: Bureau of Labor Statistics

Note: Shading represents NBER recessions, unless otherwise noted.

Financial Markets

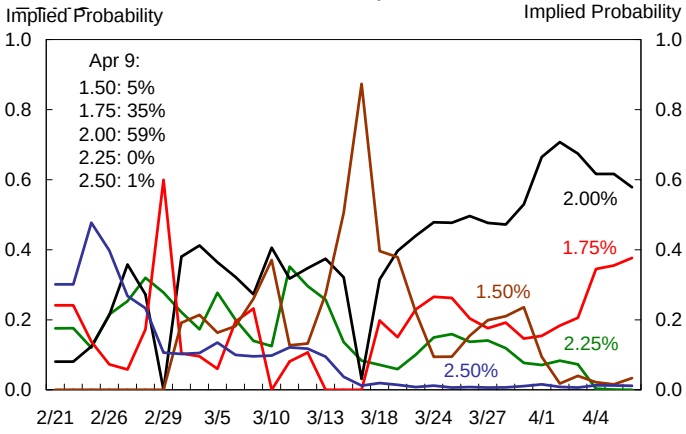
Implied Skewness and Volatility of Fed Funds Rate



Source: CME and FRBNY calculations

Note: Weekly averages based on 3-9 month implied volatilities from Eurodollar futures options.

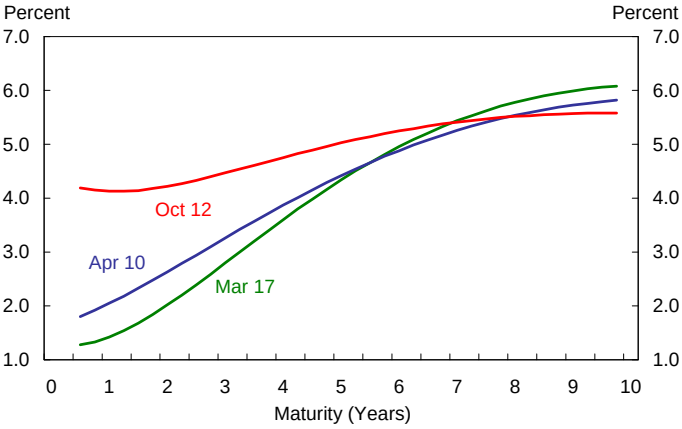
Alternative Fed Funds Rates: April 2008 FOMC



Source: Cleveland FRB

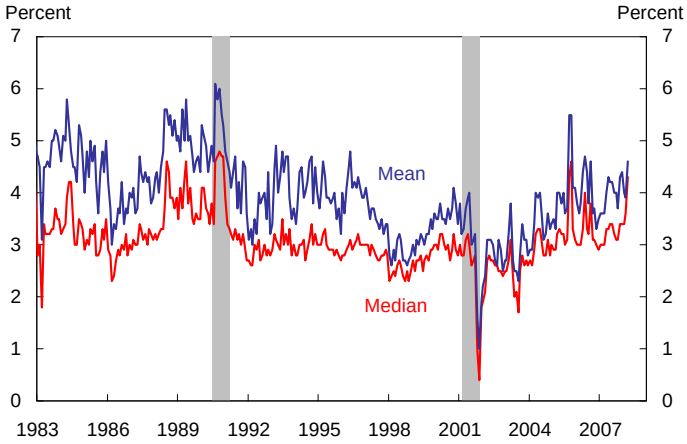
Note: Estimated using options on fed funds futures.

Implied One-Year Forward Rates



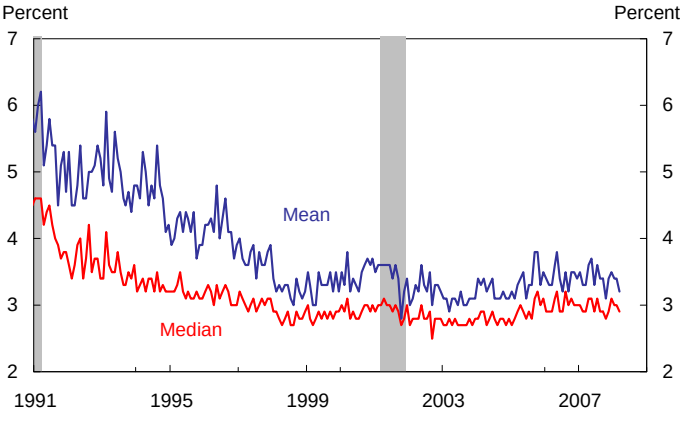
Source: Federal Reserve Board

Michigan Survey Inflation Expectations: One Year Ahead



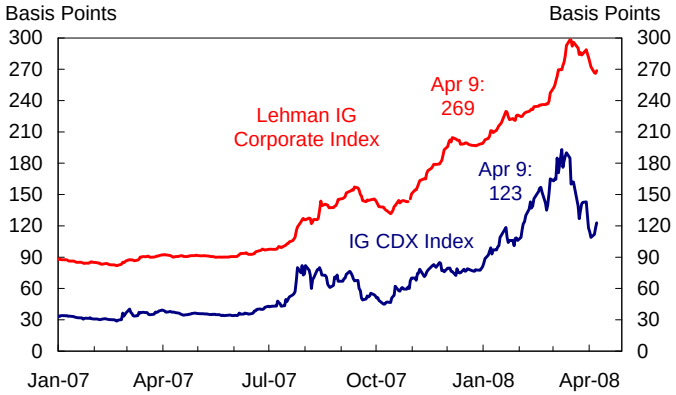
Source: University of Michigan

Michigan Survey Inflation Expectations: 5 Years Ahead



Source: University of Michigan

Cash and Synthetic Investment Grade Corporate Spreads

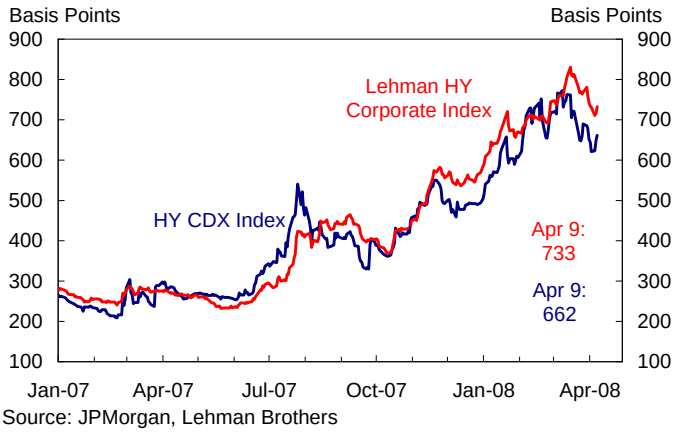


Source: JPMorgan, Lehman Brothers

Note: Shading represents NBER recessions, unless otherwise noted.

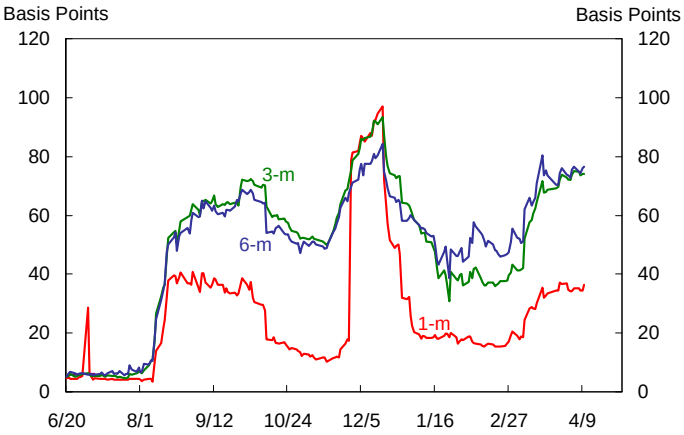
Financial Markets, ctd.

Cash and Synthetic High Yield Corporate Spreads



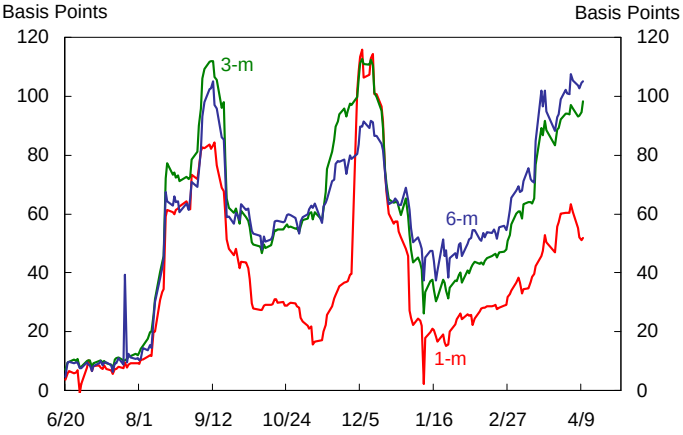
Source: JPMorgan, Lehman Brothers

Euro LIBOR-to-OIS Spread



Source: Bloomberg

GBP LIBOR-to-OIS Spread

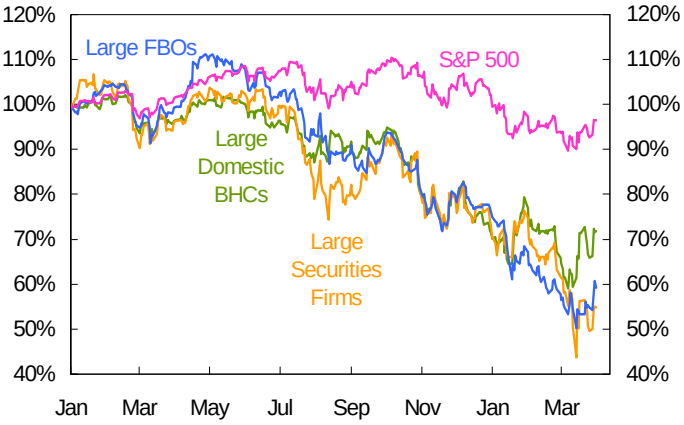


Source: Bloomberg

Note: Shading represents NBER recessions, unless otherwise noted.

Financial Markets: Large Bank and Securities Firms

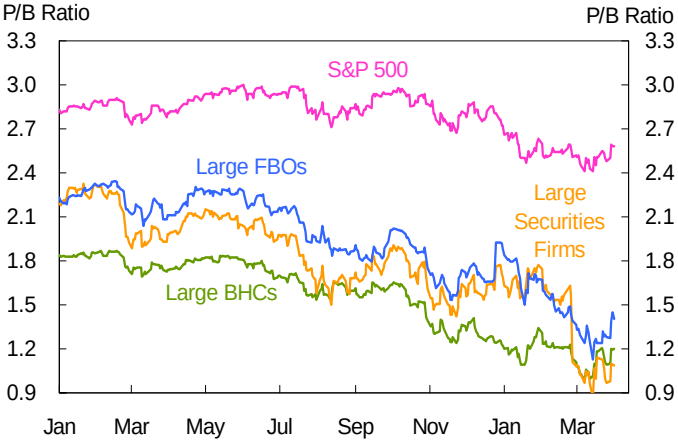
Equity Price Indices*



Source: Bloomberg

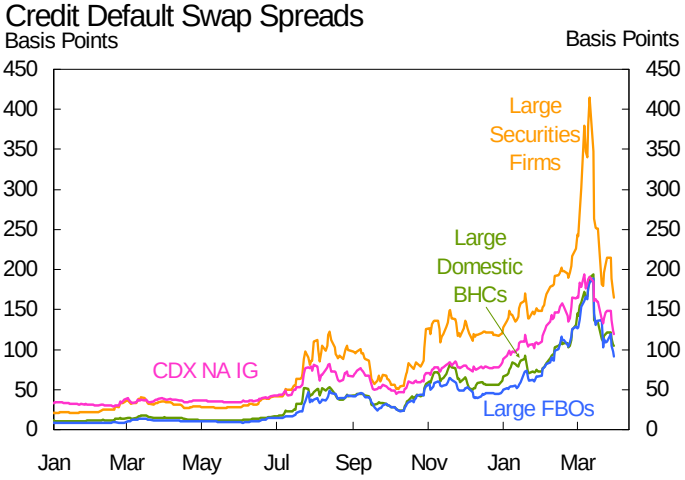
*Equity prices indexed to 1/4/07

Price-to-Book Ratios



Source: Bloomberg

Credit Default Swap Spreads

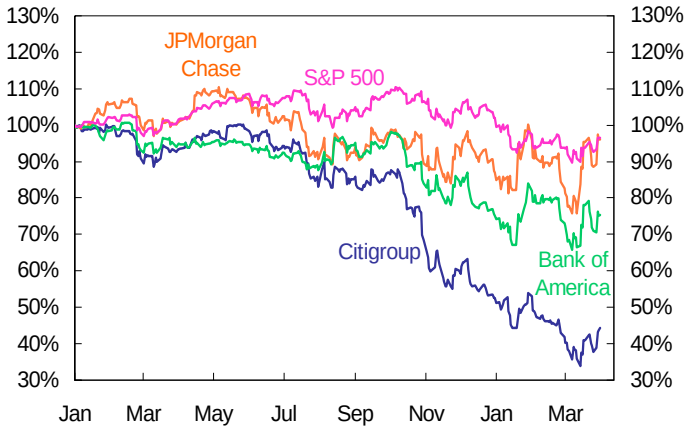


Source: Markit

Note: Shading represents NBER recessions, unless otherwise noted.

Financial Markets: Large Domestic Bank Holding Companies

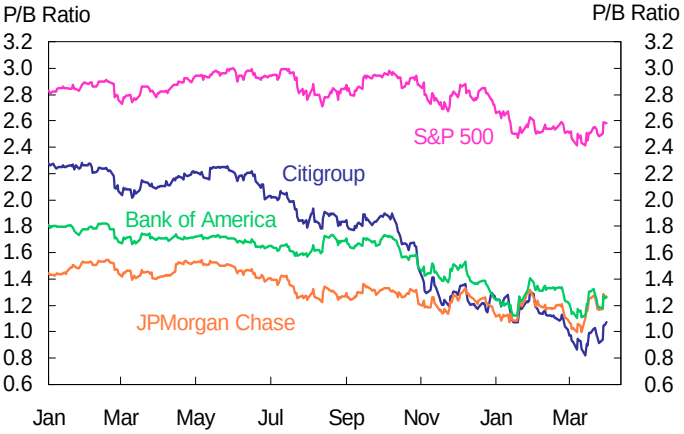
Indexed Equity Prices*



Source: Bloomberg

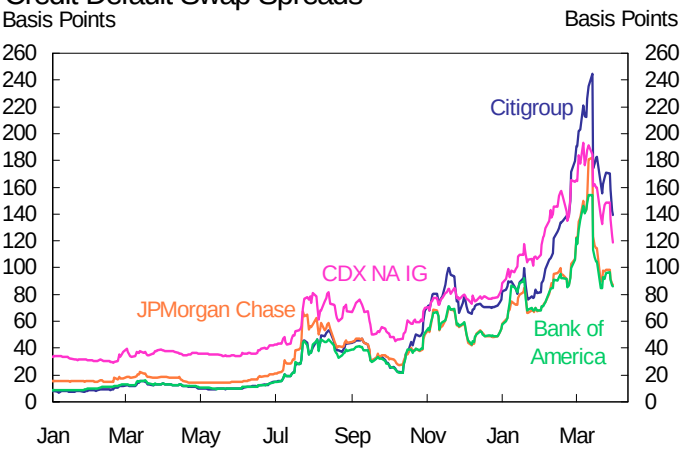
*Equity prices indexed to 1/4/07

Price-to-Book Ratios



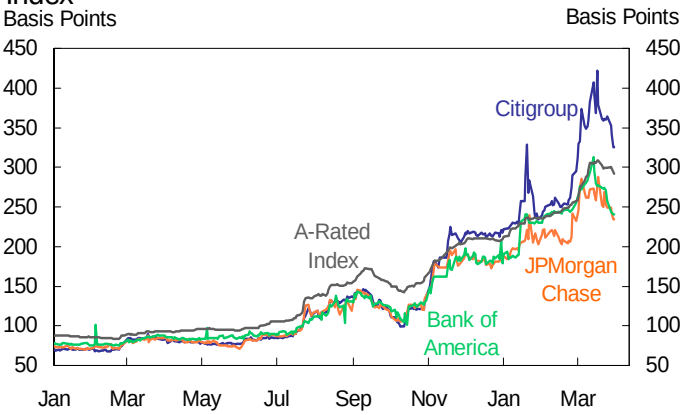
Source: Bloomberg

Credit Default Swap Spreads



Source: Markit

Subordinated Debt Spreads vs. Corporate A-Rated Index

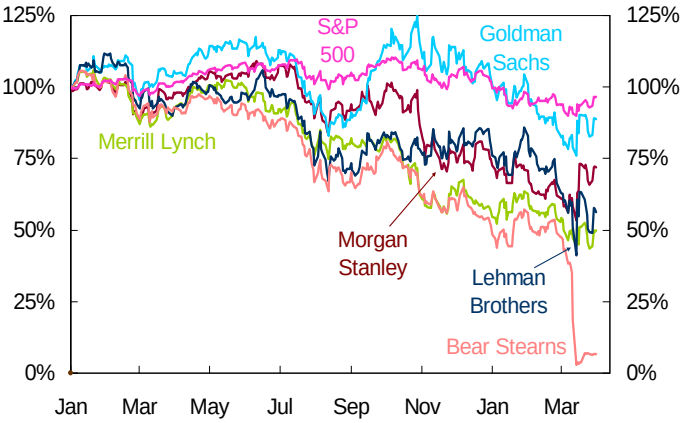


Source: Bloomberg

Note: Shading represents NBER recessions, unless otherwise noted.

Financial Markets: Large Securities Firms

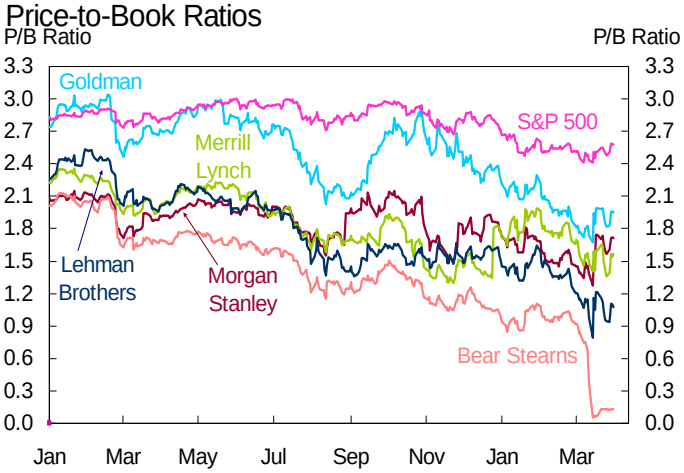
Indexed Equity Prices*



Source: Bloomberg

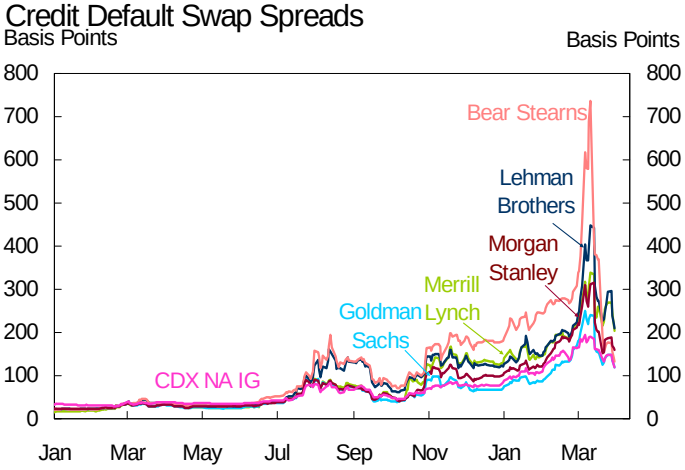
*Equity prices indexed to 1/4/07

Price-to-Book Ratios



Source:

Credit Default Swap Spreads

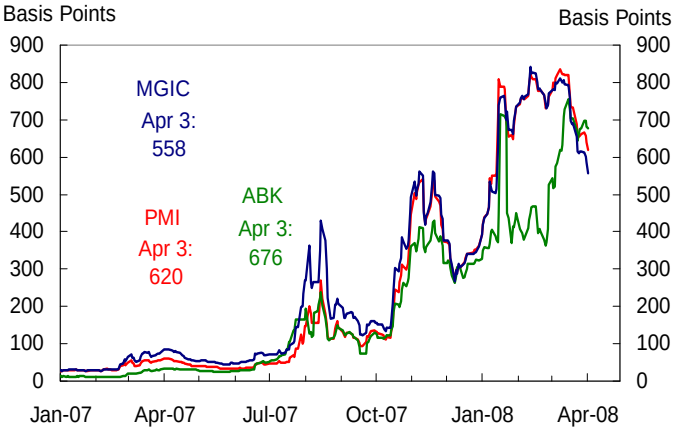


Source: Markit

Note: Shading represents NBER recessions, unless otherwise noted.

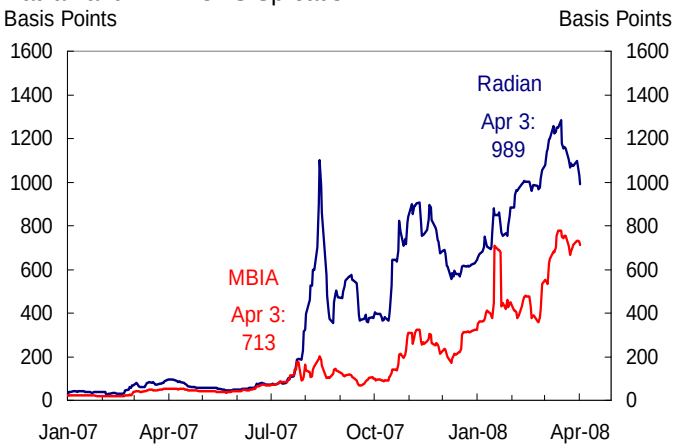
Financial Markets: Mortgage Insurers and Financial Guarantors

CDS Spreads, Mortgage Insurers and Financial Guarantors



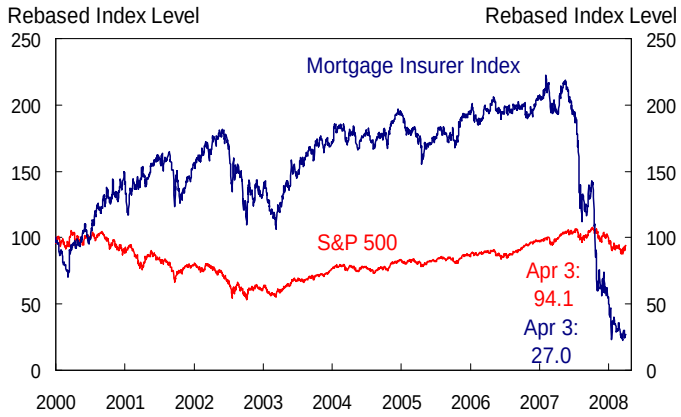
Source: OptionMetrics, Markit

Radian and MBIA CDS Spreads



Source: OptionMetrics,

Equal Weighted Mortgage Insurer Index Versus S&P 500



Source: Bloomberg

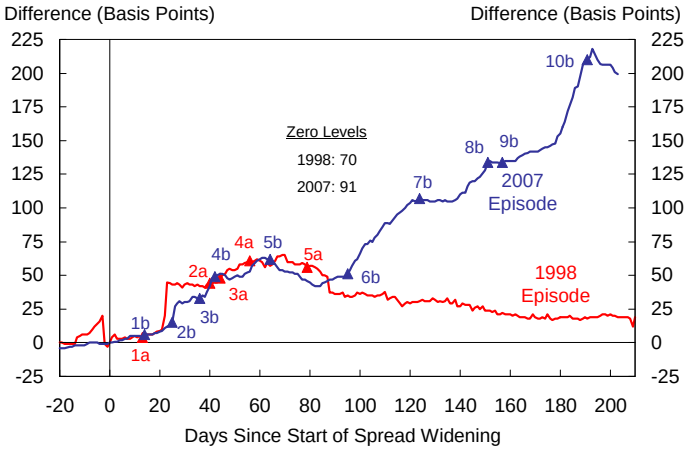
Note: January 2000 = 100

Note: Shading represents NBER recessions, unless otherwise noted.

1998 to 2007 Comparison: Spreads

Research and Statistics Group

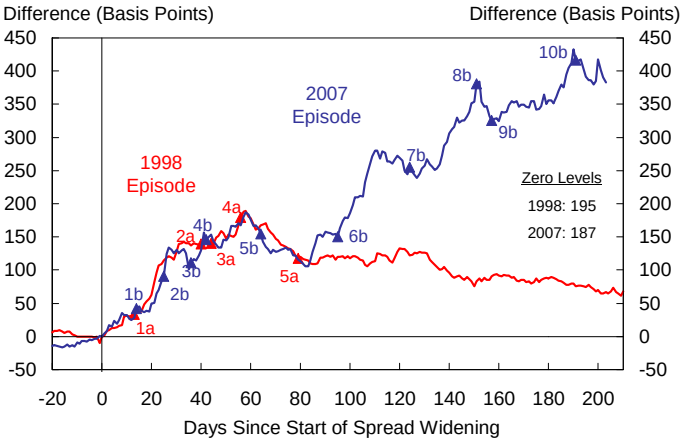
Investment-Grade (A) Corporate Bond Spreads



Source: Merrill Lynch

Note: Option-adjusted.

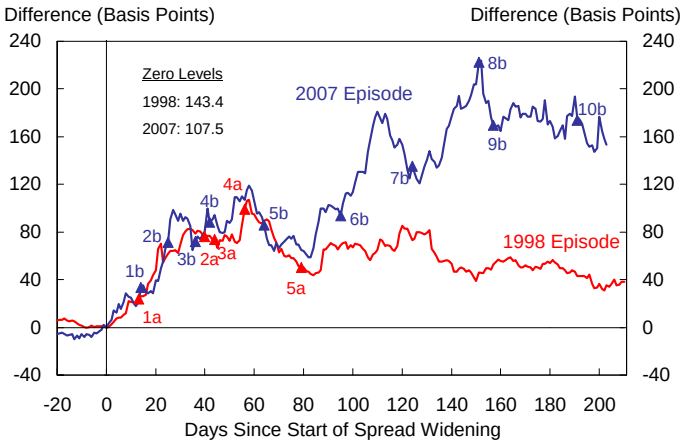
High-Yield (BB) Corporate Bond Spreads



Source: Merrill Lynch

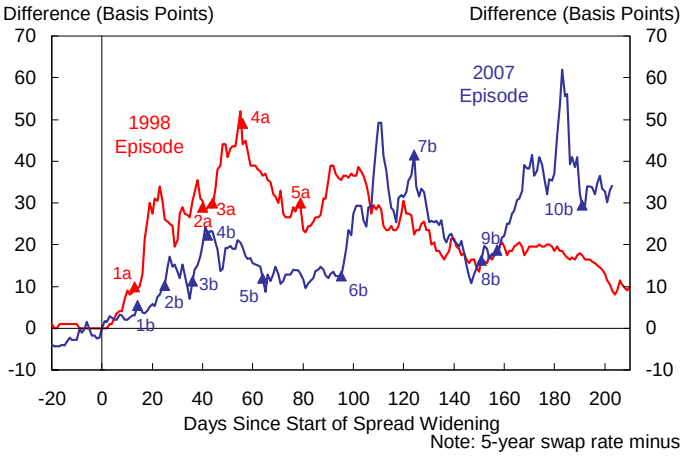
Note: Option-adjusted.

High-Yield (BB) to Investment-Grade (A) Corp. Bond Spread



Source: Merrill Lynch

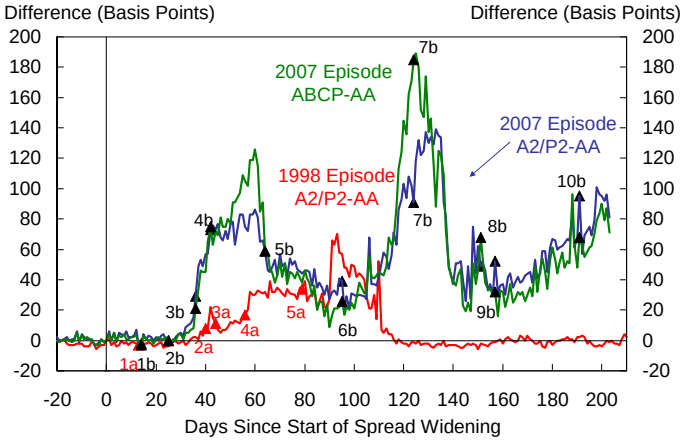
Swap Spreads



Source: Bloomberg

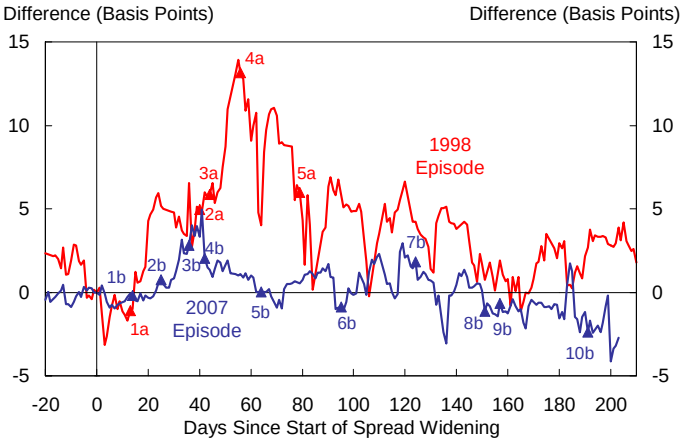
Note: 5-year swap rate minus 5-year Treasury yield.

Non-Financial 30-Day CP Spreads



Source: Federal Reserve Board

2-Year On-Off the Run Spreads



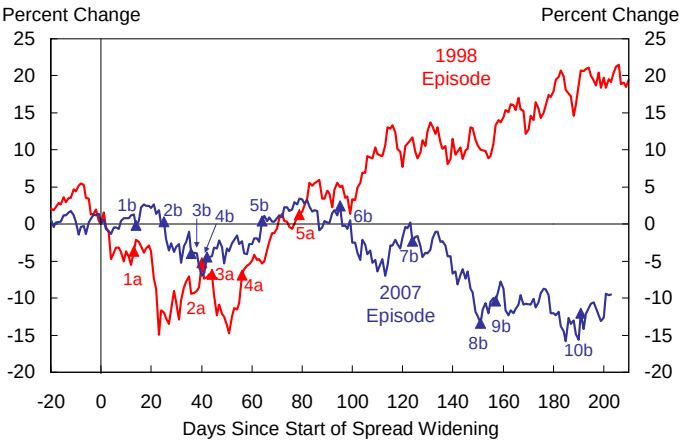
Source: Bloomberg and FRBNY calculations (Capital Markets)

Note: Shading represents NBER recessions, unless otherwise noted.

1998 to 2007 Comparison: Equity Indicators and Yields

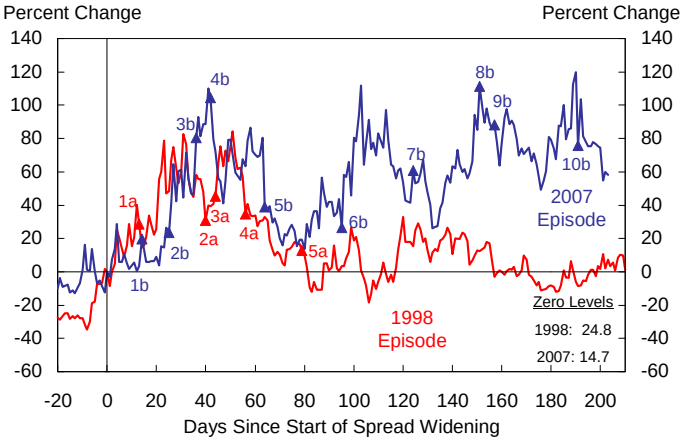
Research and Statistics Group

S&P 500



Source: Wall Street Journal

S&P 500 Volatility (VIX)



Source: Wall Street Journal

Significant Events

Please note that chart labels indicate business close on event day.

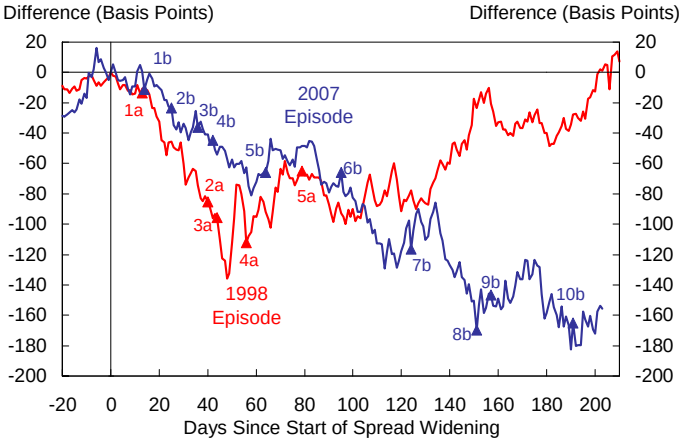
1998 Episode

- 1a: 8.17.98: Russian debt crisis
- 2a: 9.23.98: Long-Term Capital Management bailout
- 3a: 9.29.98: FOMC lowers target 25 basis points
- 4a: 10.15.98: FOMC lowers target 25 basis points
- 5a: 11.17.98: FOMC lowers target 25 basis points

2007 Episode

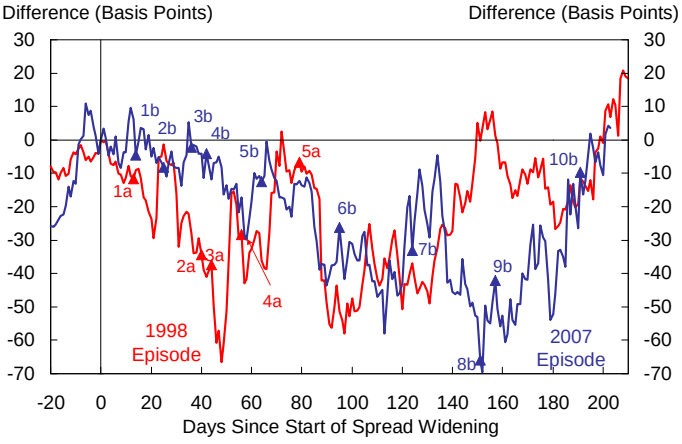
- 1b: 7.10.07: S&P changes rating methodology, places subprime bonds on watch
- 2b: 7.25.07: Chrysler and Alliance Boots buyout financings postponed
- 3b: 8.9.07: BNP Paribas freezes three funds; ECB initiates first ad hoc tender
- 4b: 8.17.07: FOMC lowers discount rate and releases statement
- 5b: 9.18.07: FOMC lowers target 50 basis points
- 6b: 10.31.07: FOMC lowers target 25 basis points
- 7b: 12.11.07: FOMC lowers target 25 basis points
- 8b: 1.22.08: FOMC lowers target 75 basis points
- 9b: 1.30.08: FOMC lowers target 50 basis points
- 10b: 3.18.08: FOMC lowers target 75 basis points

On-the-Run 10-Year Treasury Yields



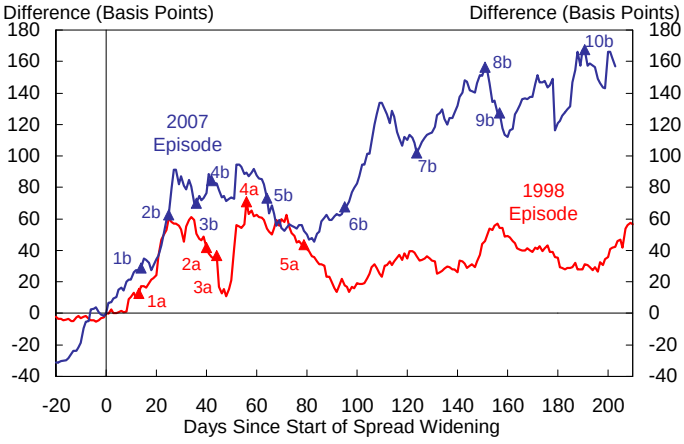
Source: Bloomberg

Investment-Grade (A) Corporate Bond Yields



Source: Merrill Lynch

High-Yield (BB) Corporate Bond Yields

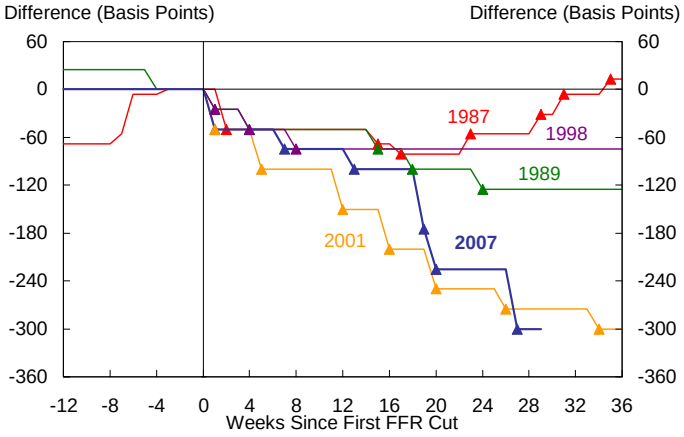


Source: Merrill Lynch

Note: Shading represents NBER recessions, unless otherwise noted.

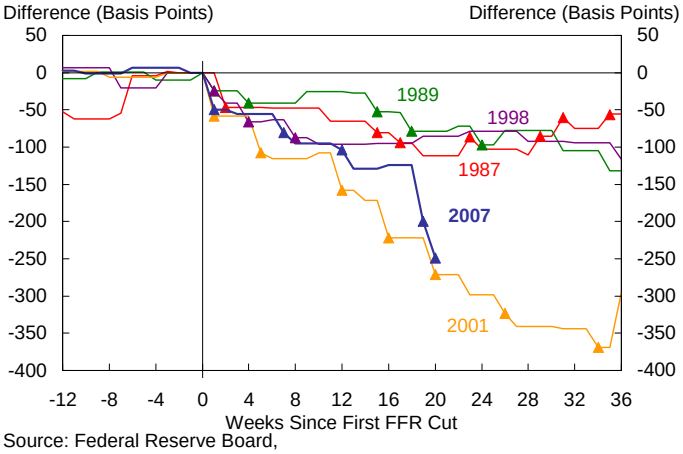
Financial Disturbances

Fed Funds Rate Target



Source: Federal Reserve Board

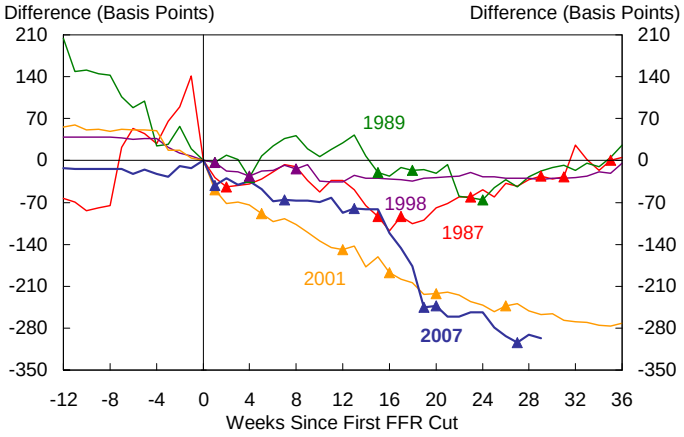
Real* Target Fed Funds Rate



Source: Federal Reserve Board,
Bureau of Economic Analysis

*Deflated by monthly core PCE.

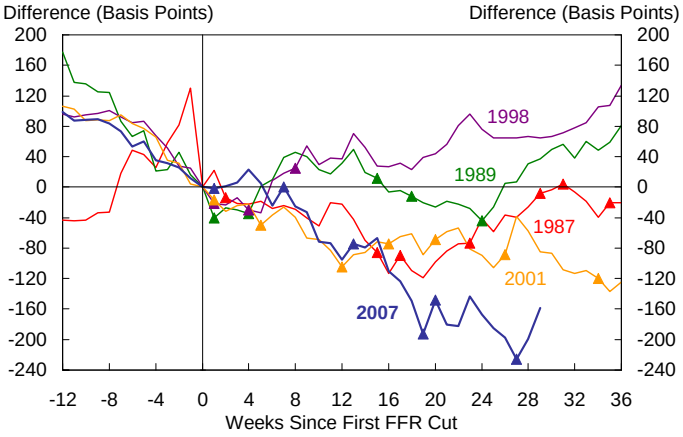
Near-term* Eurodollar Futures



Source: Federal Reserve Board

*Relative to the zero week.

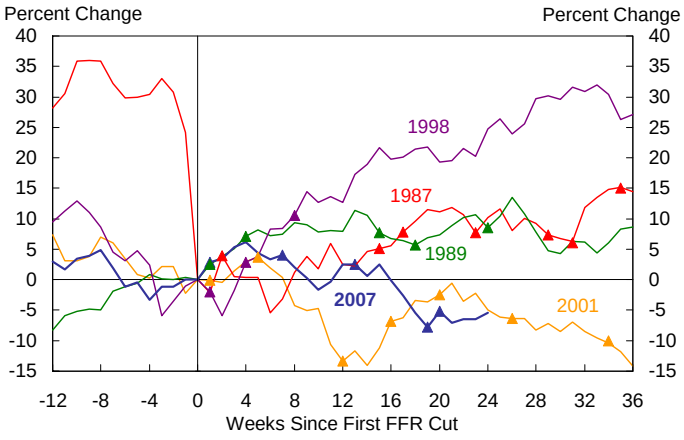
One-Year Ahead* Eurodollar Futures



Source: Federal Reserve Board

*Relative to the zero week.

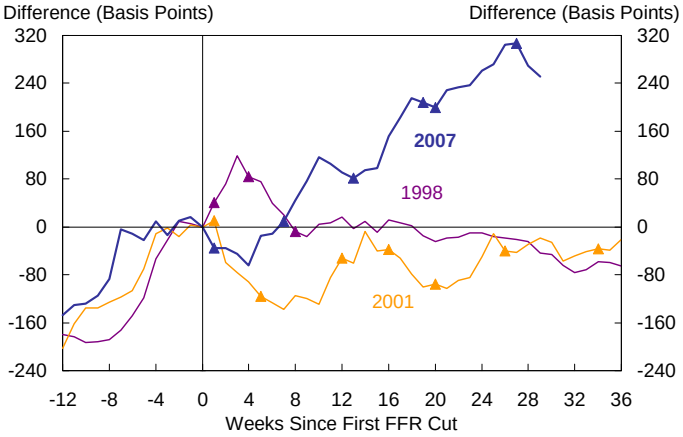
Real* S&P 500



Source: Bureau of Labor and Statistics and WSJ

*Deflated by total CPI.

Speculative-Grade to AAA Corporate Bond Spread

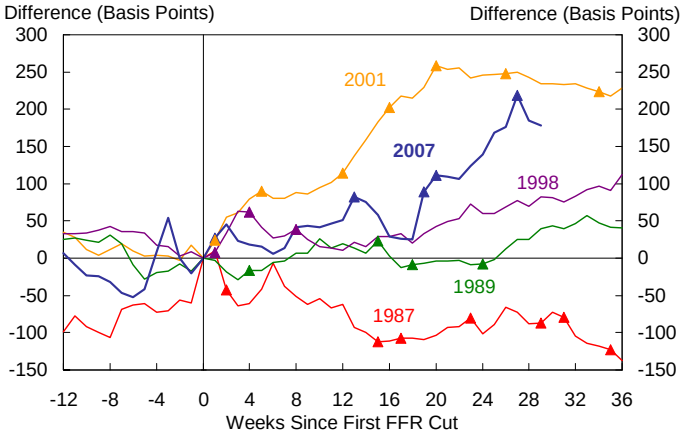


Source: Merrill Lynch

Note: Shading represents NBER recessions, unless otherwise noted.

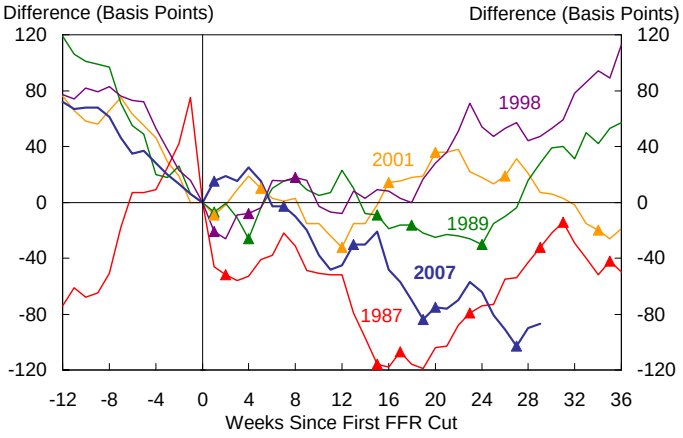
Financial Disturbances, ctd.

10-Year to 3-Month Treasury Spread



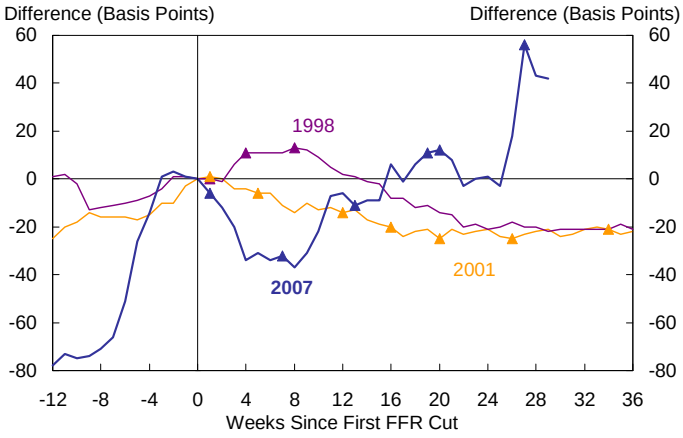
Source: Treasury

On-the-Run 10-Year Treasury Yield



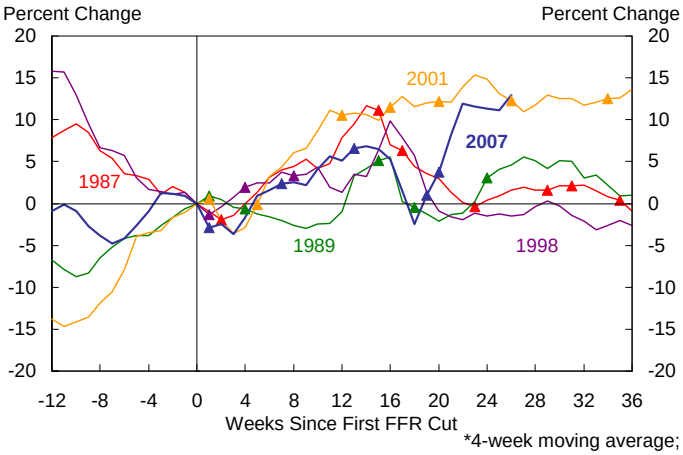
Source: Treasury

30-Year FRM Jumbo-Conforming Spread



Source: Treasury

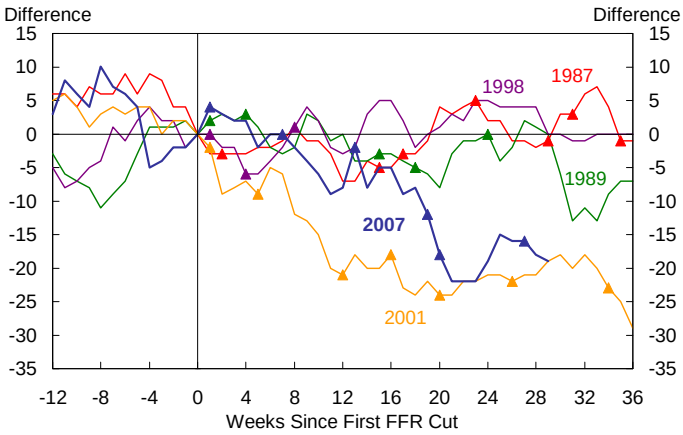
Initial Unemployment Claims*



*4-week moving average;
Normalized by insured employment.

Source: Department of Labor

ABC/Washington Post Consumer Comfort Index



Source: ABC News Washington Post

FOMC Target Rate Movements

Triangles mark the end of weeks during which the FOMC changed the FFR. Below is a list of the corresponding week-ending dates.

1987 Episode
- 11.4.87: FOMC lowers target 50 bp
- 2.3.88: FOMC lowers target 18 bp
- 2.17.88: FOMC lowers target 13 bp
- 3.30.88: FOMC *raises* target 25 bp
- 5.11.88: FOMC *raises* target 25 bp
- 5.25.88: FOMC *raises* target 25 bp
- 6.22.88: FOMC *raises* target 19 bp

1989 Episode
- 7.12.89: FOMC lowers target 25 bp
- 8.2.89: FOMC lowers target 25 bp
- 10.18.89: FOMC lowers target 25 bp
- 11.8.89: FOMC lowers target 25 bp
- 12.20.89: FOMC lowers target 25 bp

1998 Episode
- 9.30.98: FOMC lowers target 25 bp
- 10.21.98: FOMC lowers target 25 bp
- 11.18.98: FOMC lowers target 25 bp

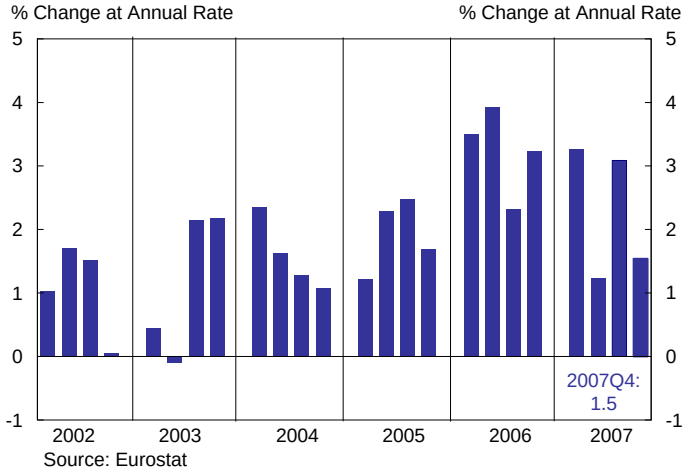
2001 Episode
- 1.3.01: FOMC lowers target 50 bp
- 1.31.01: FOMC lowers target 50 bp
- 3.21.01: FOMC lowers target 50 bp
- 4.18.01: FOMC lowers target 50 bp
- 5.16.01: FOMC lowers target 50 bp
- 6.27.01: FOMC lowers target 25 bp
- 8.22.01: FOMC lowers target 25 bp

2007 Episode
- 9.19.07: FOMC lowers target 50 bp
- 10.31.07: FOMC lowers target 25 bp
- 12.11.07: FOMC lowers target 25 bp
- 1.22.08: FOMC lowers target 75 bp
- 1.30.08: FOMC lowers target 50 bp
- 3.19.08: FOMC lowers target 75 bp

Note: Shading represents NBER recessions, unless otherwise noted.

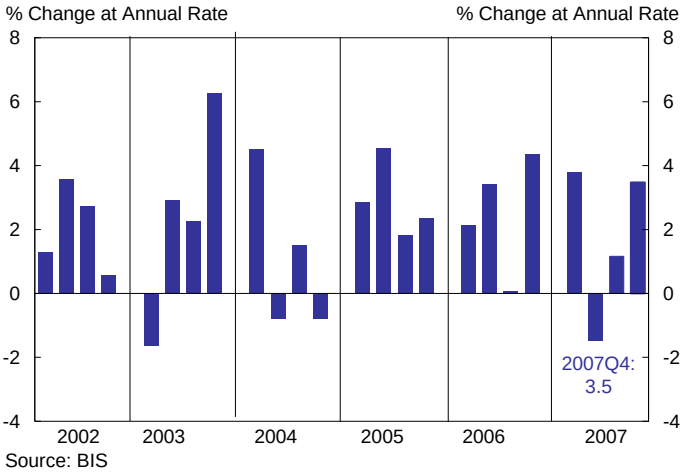
International Overview

Euro Area Real GDP Growth



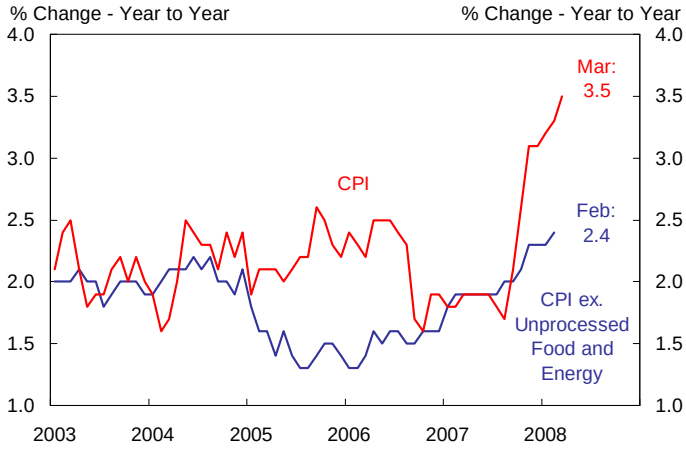
Source: Eurostat

Japan Real GDP Growth



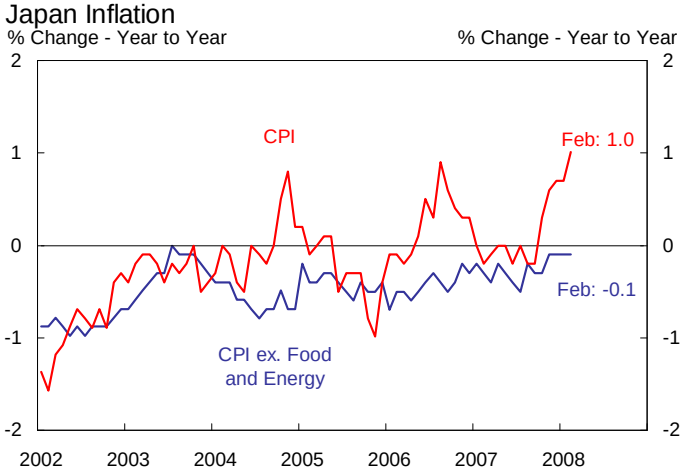
Source: BIS

Euro Area Inflation



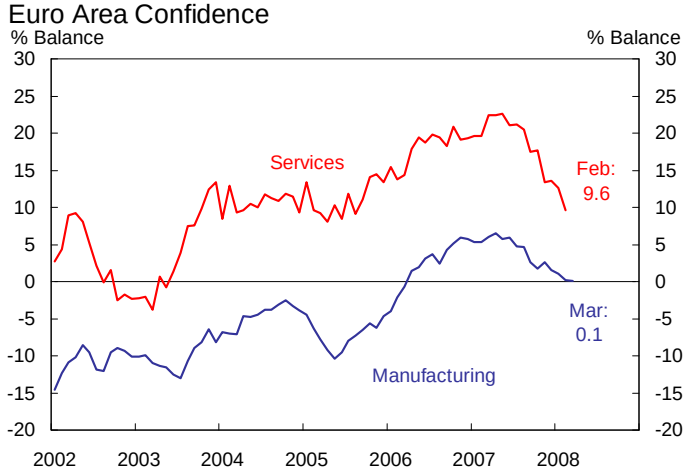
Source: BIS and Federal Reserve Board

Japan Inflation



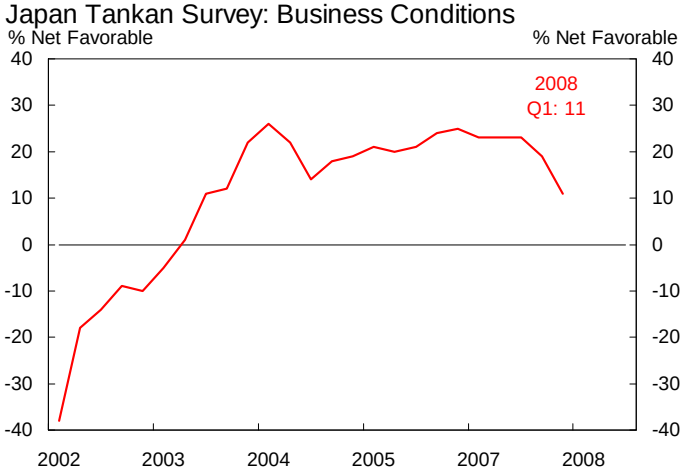
Source: BIS and Federal Reserve Board

Euro Area Confidence



Source: Eurostat

Japan Tankan Survey: Business Conditions

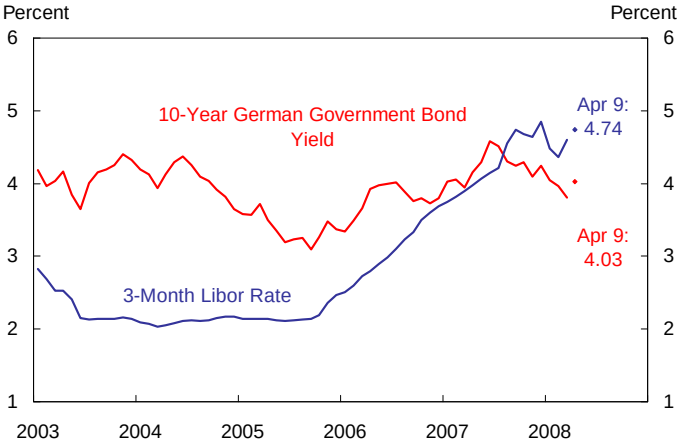


Source: National Sources

Note: Shading represents NBER recessions, unless otherwise noted.

International Overview, ctd.

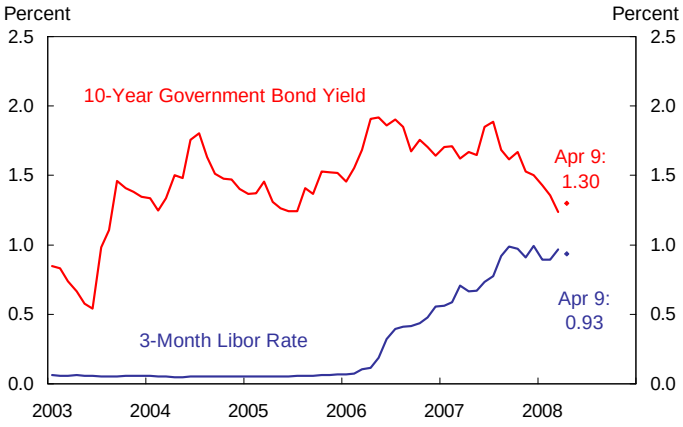
Euro Area Short- and Long-Term Interest Rates



Source: Bloomberg

Note: Data are monthly averages.

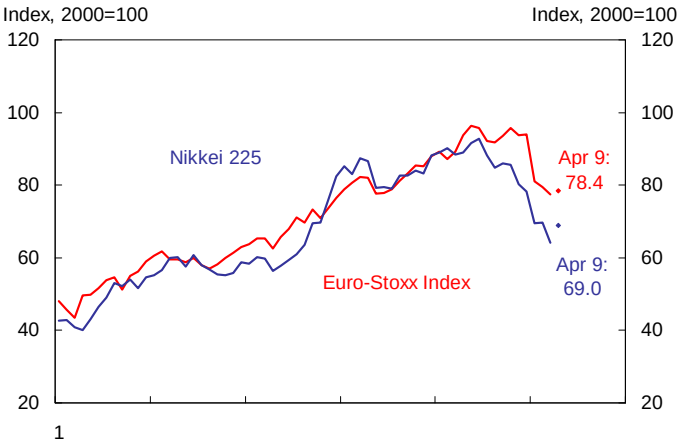
Japan Short- and Long-Term Interest Rates



Source: Bloomberg and Federal Reserve Board

Note: Data are monthly averages.

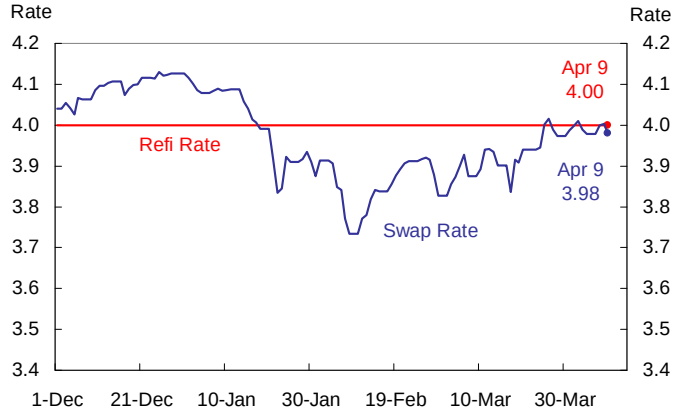
Euro Area and Japan Equity Indices



Source: BIS and Bloomberg

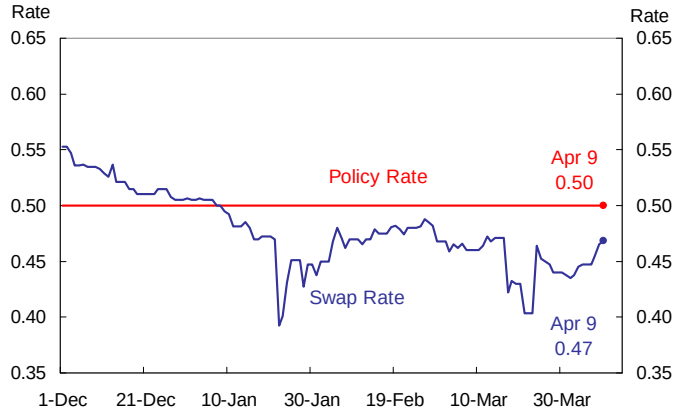
Note: Data are monthly averages.

Euro Area: Expected Average Overnight Rate Over the Next Six Months (Swap Rate)



Source: Bloomberg

Japan: Expected Average Overnight Rate Over the Next Six Months (Swap Rate)

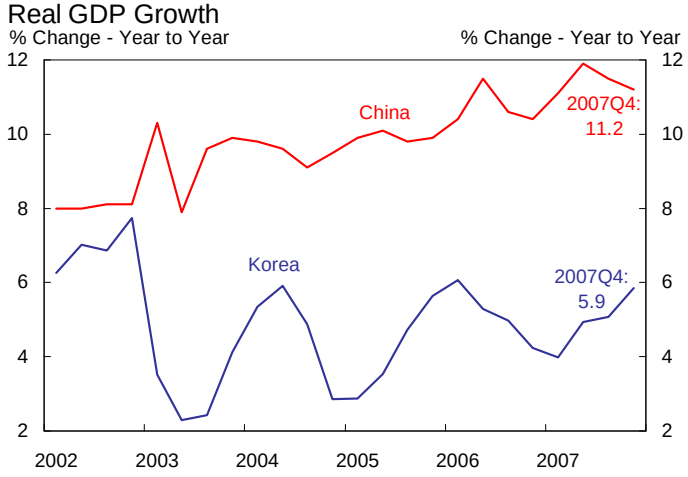


Source: Bloomberg

Note: Shading represents NBER recessions, unless otherwise noted.

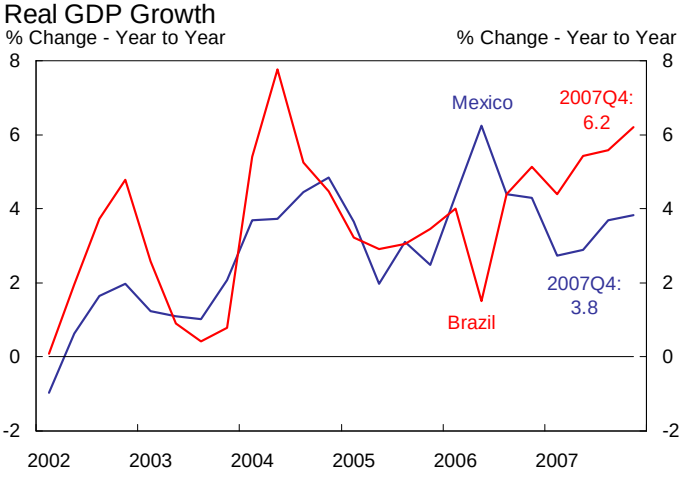
International Overview, ctd.

Real GDP Growth



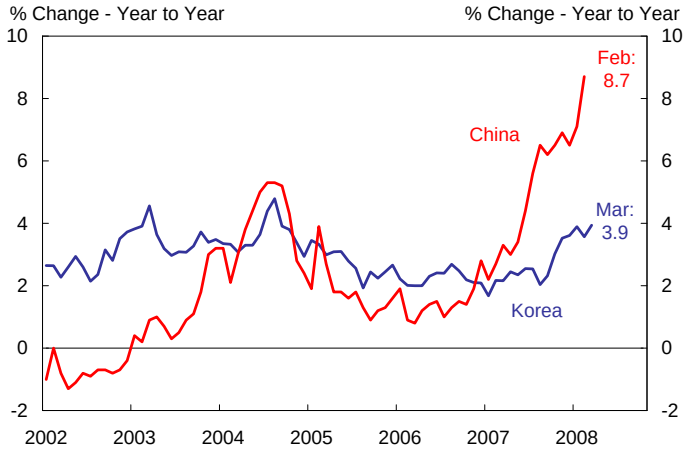
Source: China National Bureau of Statistics and Bank of Korea

Real GDP Growth



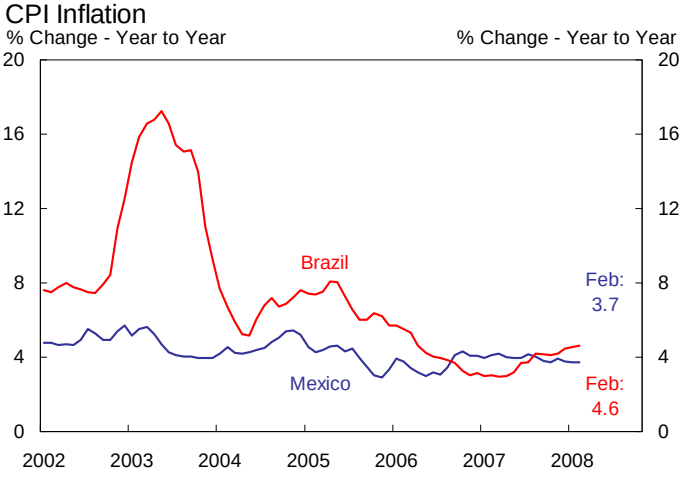
Source: National Sources

CPI Inflation



Source: China National Bureau of Statistics and Korea National Statistics

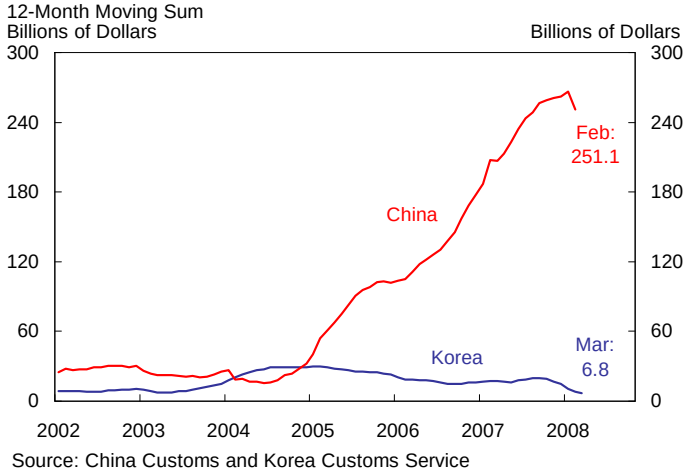
CPI Inflation



Source: National Sources

Merchandise Trade Balance

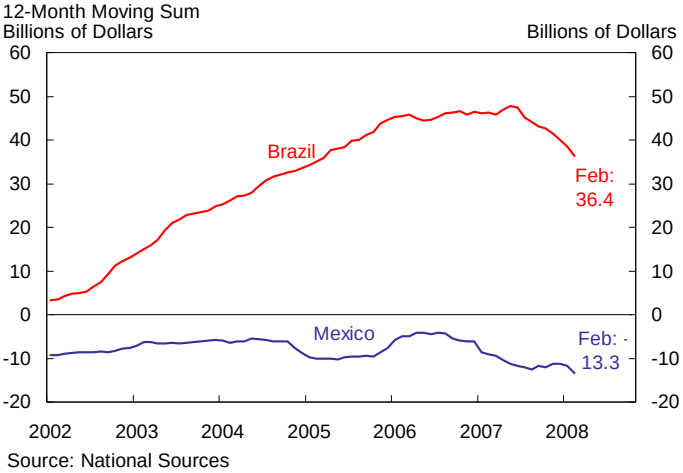
12-Month Moving Sum



Source: China Customs and Korea Customs Service

Merchandise Trade Balance

12-Month Moving Sum

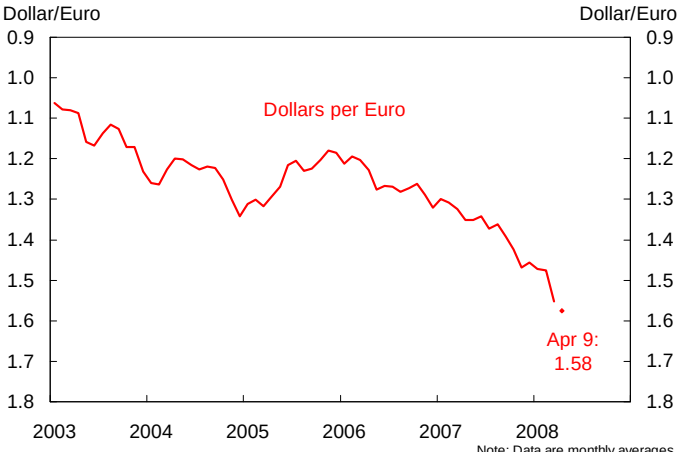


Source: National Sources

Note: Shading represents NBER recessions, unless otherwise noted.

International Overview, ctd.

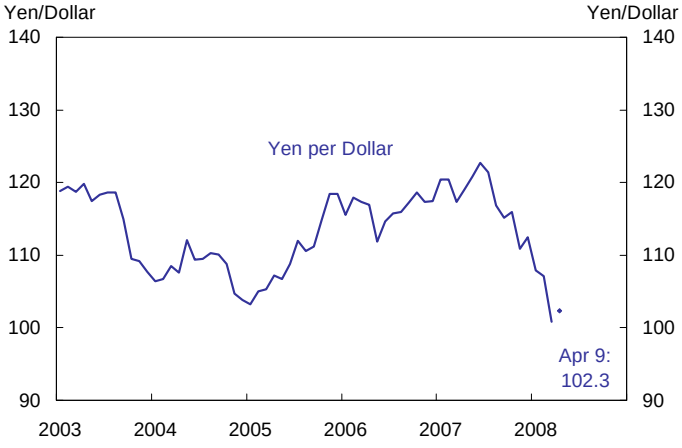
Dollar-Euro Exchange Rate



Source: Bloomberg

Note: Data are monthly averages.
Exchange rate scale is inverted.

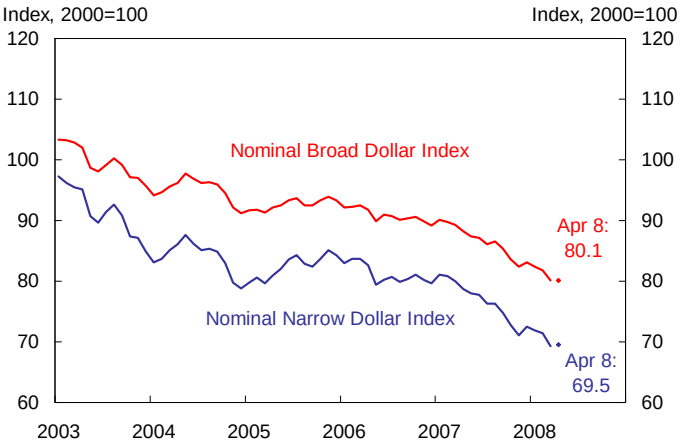
Yen-Dollar Exchange Rate



Source: Bloomberg

Note: Data are monthly averages.

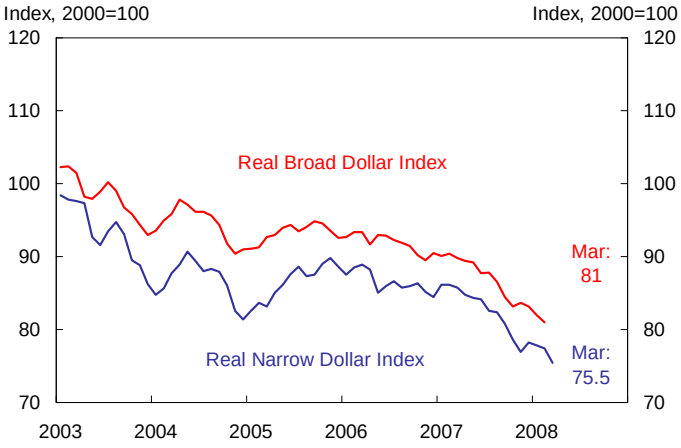
Nominal Effective Exchange Rates



Source: Federal Reserve Board

Note: Data are monthly averages.

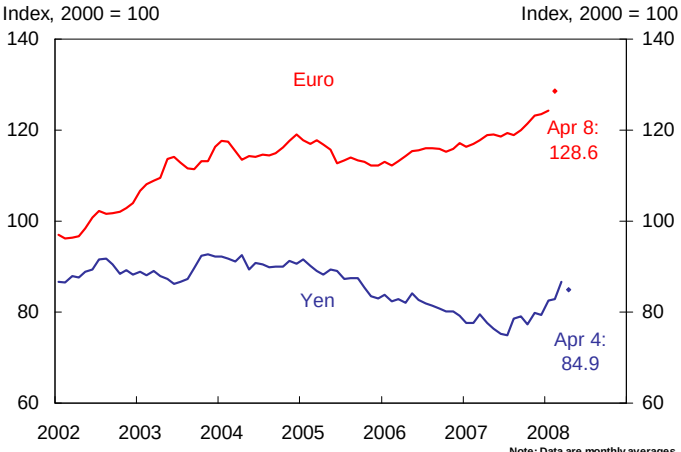
Real Effective Exchange Rates



Source: Federal Reserve Board

Note: Data are monthly averages.

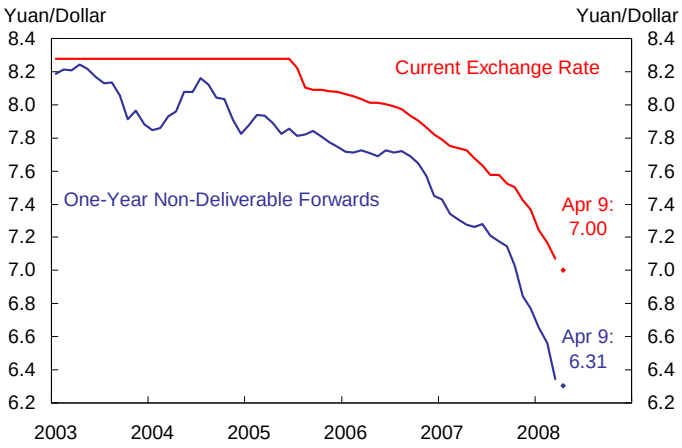
Euro Area and Japan Effective Exchange Rates



Source: BIS and ECB

Note: Data are monthly averages.
Yen weight has 27 currencies, Euro weight has 24

China Exchange Rates



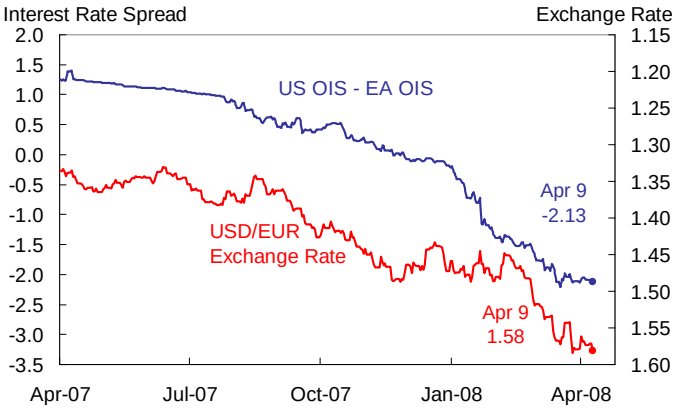
Source: Bloomberg

Note: Data are monthly averages.

Note: Shading represents NBER recessions, unless otherwise noted.

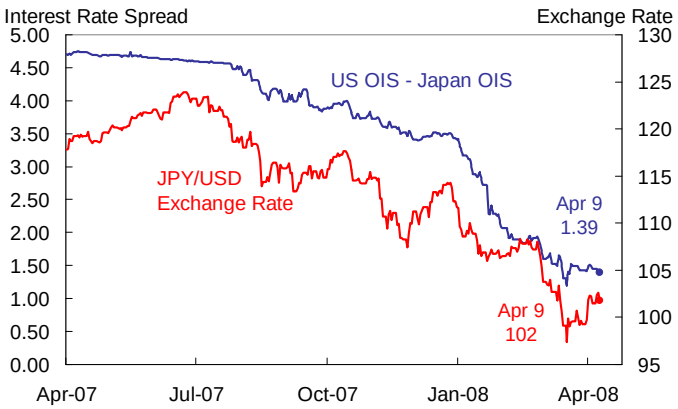
International Overview, ctd.

US vs. Euro Area
OIS Rate Differentials and Exchange Rates



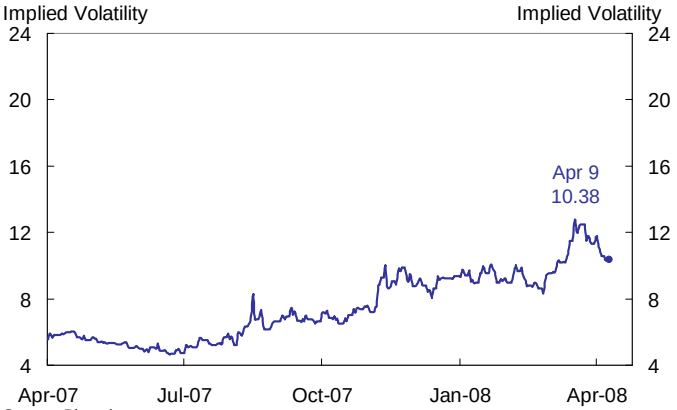
Source: Bloomberg
OIS: Overnight Index Swap Rates (6 mo). Exchange rate scale is inverted

US vs. Japan
OIS Rate Differentials and Exchange Rates



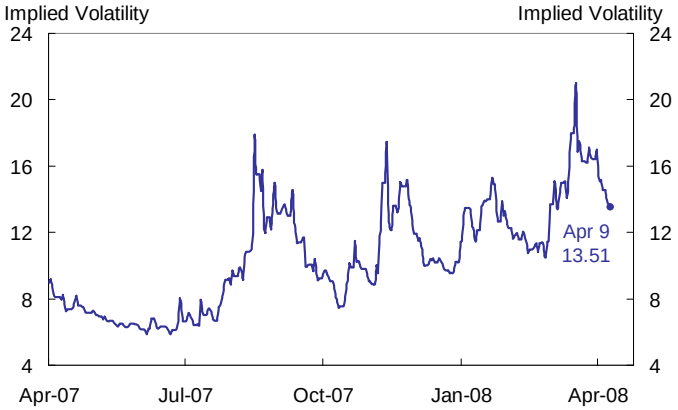
Source: Bloomberg
OIS: Overnight Index Swap Rates (6 mo). Exchange rate scale is

US vs. Euro Area
Implied Option Volatility (1-Month)



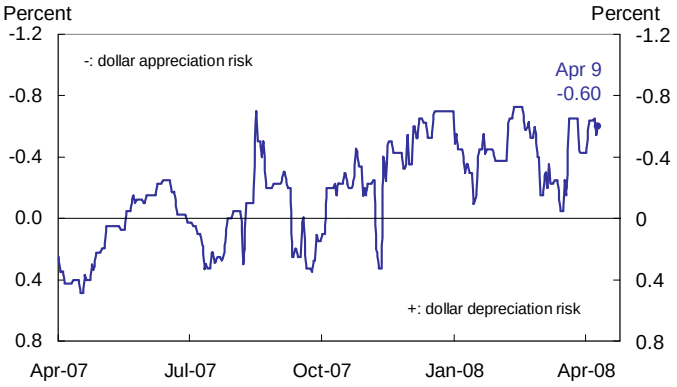
Source: Bloomberg

US vs. Japan
Implied Option Volatility (1-Month)



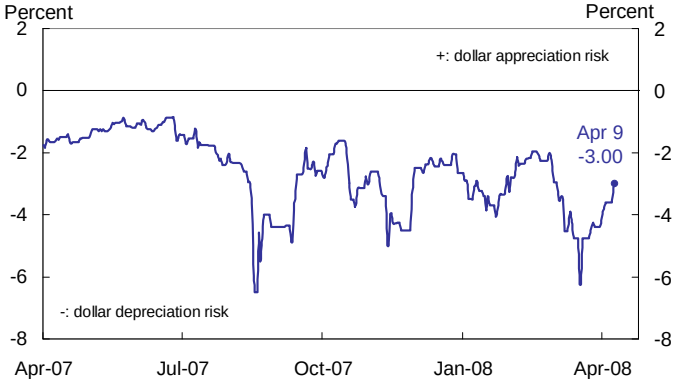
Source: Bloomberg

US vs. Euro Area
Risk Reversal (1-Month)



Source: Bloomberg. RR = Price of call option on euro minus price of put option. Scale is inverted
Positive (negative) risk reversal implies more risk that the dollar will depreciate (appreciate)

US vs. Japan
Risk Reversal (1-Month)



Source: Bloomberg. RR = Price of call option on dollar minus price of put option
Positive (negative) risk reversal implies more risk that the dollar will appreciate (depreciate)

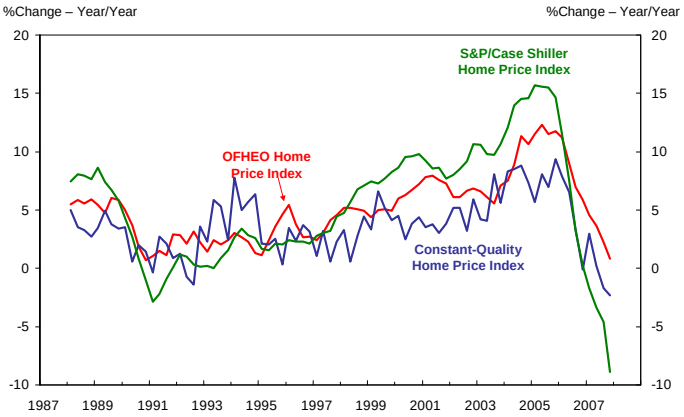
Note: Shading represents NBER recessions, unless otherwise noted.

Review of Home Price Indices

Overview of Home Price Indices

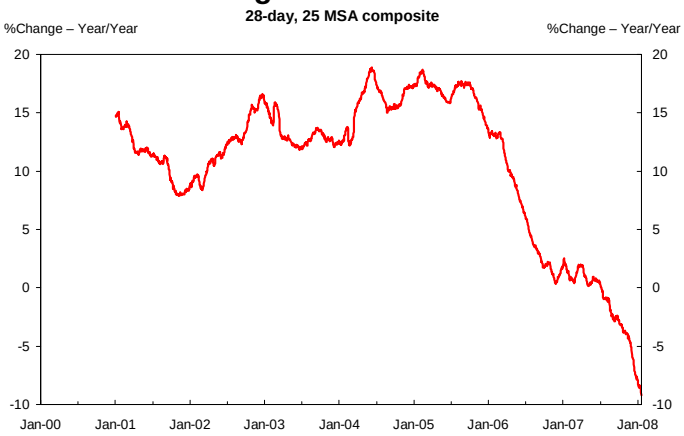
Index	Type	Coverage: Home types	Coverage: Areas	Regional Weights	Frequency
OFHEO	Repeat sales	SF homes with conforming mortgages	Entire US States, MSAs	Unit-weighted	Quarterly, monthly
S&P/Case-Shiller	Repeat sales	Existing SF homes with recorded sales	70% of US by 2000 value; 20 MSAs	Value-weighted	Quarterly, monthly
Census Constant-Quality New Home	Hedonic	All new SF homes sold	Entire US	Unit-weighted	Quarterly
Radar Logic	Median of est. $/sq ft distribution	All types of residences with recorded sales	25 MSAs	Value-weighted	Daily

Home Prices since 1987



Source: S&P, OFHEO, Census Bureau

Radar Logic Home Price Index

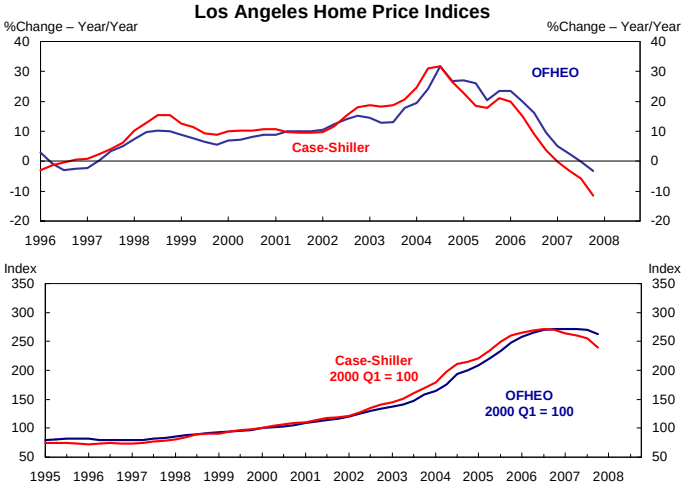


Source: Radar Logic

The Recent Difference between OFHEO and Case Shiller Indices

- The differences occur not just in the national index, but also in metro area indices.
- What implications may this difference have for the factors behind the decline in home prices?

Los Angeles Home Price Indices



Source: OFHEO, S&P, Fiserv, and MacroMarkets LLC

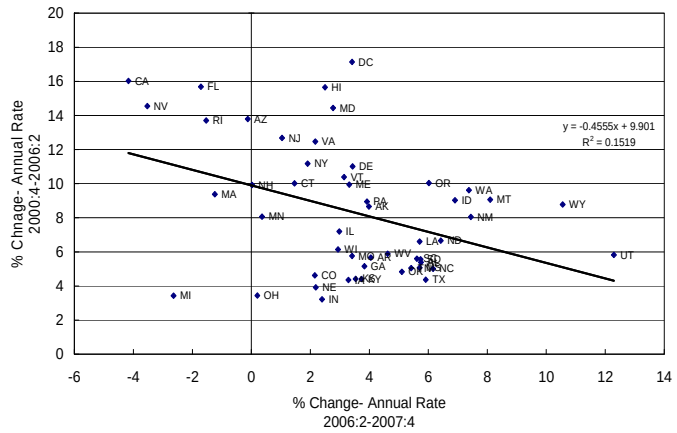
The Differences between the Metro Area OFHEO and Case-Shiller Indices

- OFHEO examined home price change from 2006Q3-2007Q3 for 10 metro areas.
- Introduced changes to OFHEO index one-by-one to make the methodology more similar to that of Case-Shiller.
- Identified three major factors behind the differences.
  1. Excluding appraisals.
  2. Less down-weighting of homes with long intervals between sales: this appears specific to this period.
  3. Adding lower-priced homes without conforming mortgages.
     - These homes appreciated more in boom.
     - Suggests the role of subprime mortgages in the latter part of the boom and in the subsequent bust.

Note: Shading represents NBER recessions, unless otherwise noted.

Review of Home Price Indices, ctd.

Home Price Change by State

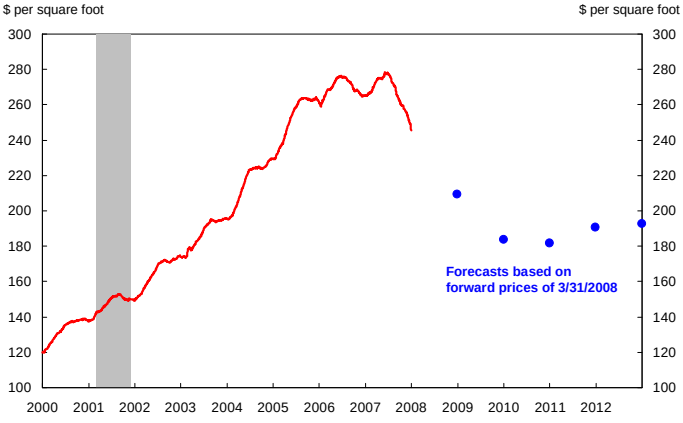


Source: Office of Federal Housing Enterprise Oversight

The Outlook for Home Prices

- Even with the declines so far, further declines are possible.
- Available financial market prices suggest substantial fall is possible.
- Downside risks:
  - Rent-price ratio is low by some measures.
  - Sizable inventory of homes on market.
  - Tighter mortgage credit reduces demand.
  - Possibility that expectations of declines leads to vicious circle.
- Mitigating factor:
  - Historically, much adjustment in housing market occurred on activity side.

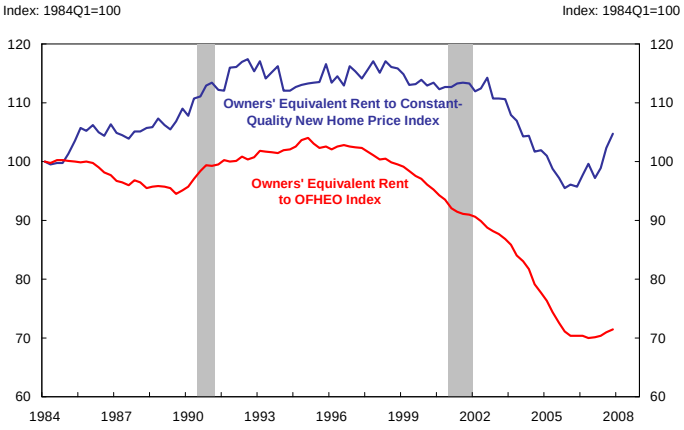
Radar Logic 28-Day House Price
25 MSA Composite



Source: Radar Logic, ICAP

Note: Shading represents NBER recessions.

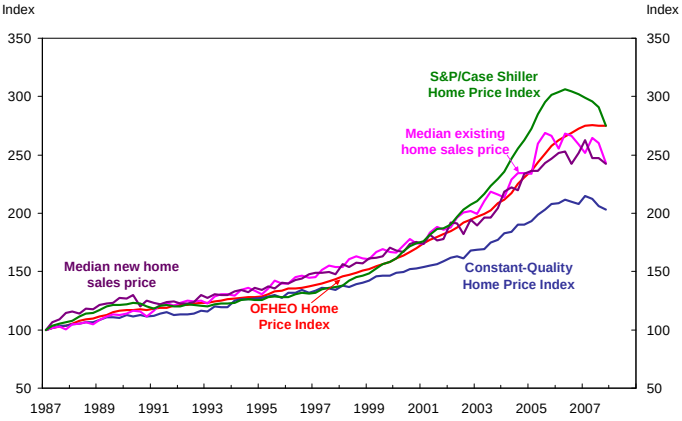
Ratio of Owners' Equivalent Rent to Alternative Price Indexes



Source: BEA, OFHEO, and Census Bureau

Note: Shading represents NBER recessions.

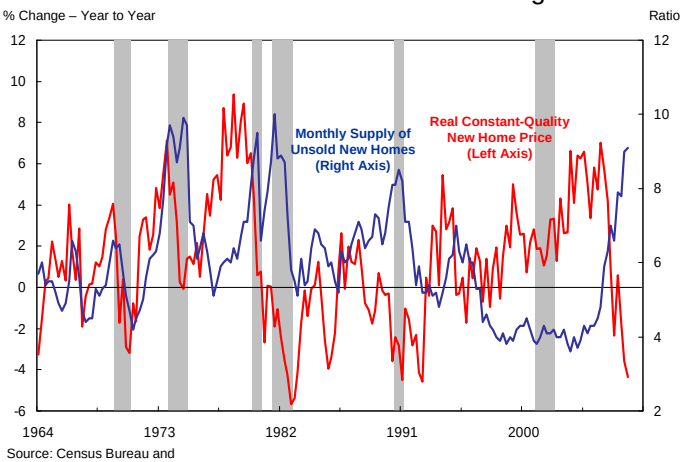
Home Prices since 1987



Source: S&P, Fiserv, MacroMarkets LLC, OFHEO, Census Bureau, and National Association Realtors

Note: 1987Q1 = 100

New Home Inventories and Real Price Change



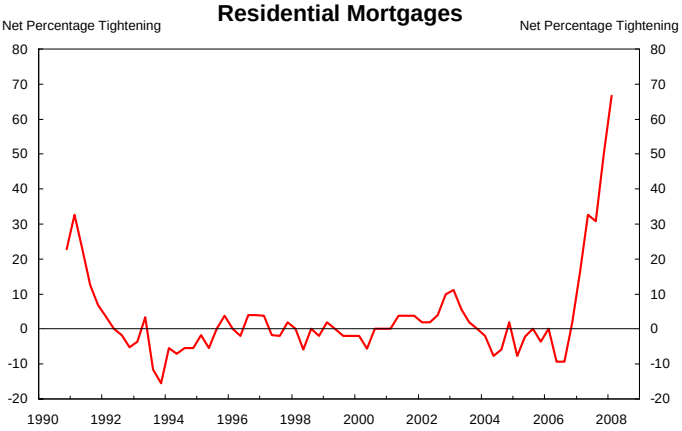
Source: Census Bureau and Bureau of Economic Analysis

Note: Shading represents NBER recessions.

Note: Shading represents NBER recessions, unless otherwise noted.

Review of Home Price Indices, ctd.

Senior Loan Officers Survey: Tightening Standards for Residential Mortgages



Source: Federal Reserve Board/Haver Analytics

Note: Data from 2007Q2 is weighted average for prime, subprime, and non-traditional loans

Final Thoughts

- Home price indices useful for different purposes.
  - OFHEO: price of "typical" home.
  - Case-Shiller: value of existing single-family housing stock.
  - Constant-quality: rent-price ratio.
  - Radar Logic: higher-frequency data for financial products.
- Most measures show notable weakening in home prices.
- Macroeconomic slowdown suggests prices could fall further.
  - Financial derivative prices also point to further decline.
  - A number of downside risks.

Final Thoughts

- All of the price indices are measures of central tendency of prices.
  - Foreclosures; delinquencies; pricing of MBS and associated derivatives: the tail of housing returns is important.
  - Higher moments (e.g., standard deviation, skewness) and shape of distribution are also important in this regard.
  - More analysis at the micro level.

Note: Shading represents NBER recessions, unless otherwise noted.

Economics of the Federal Reserve's New Lending Facilities

James McAndrews[1]
Federal Reserve Bank of New York
April 11, 2008

The Federal Reserve established three new lending facilities in recent months. Each of these facilities addresses funding needs of financial intermediaries and is intended to improve market efficiency in short-term money markets. This note outlines the key economic problem addressed by each facility.

The overall strategy for the new facilities, as well as the existing primary credit facility for deposit institutions (often simply called the "discount window"), are explained in the accompanying documents. These individual papers and notes provide more detailed descriptions and, in some cases, preliminary evaluations of each of the facilities. As stated in the document *Understanding Recent Changes to Federal Reserve Liquidity Provision*, "Although these changes were made incrementally in response to changing market conditions, they share the common objectives of reducing risks to financial stability and strengthening the effectiveness of monetary policy in addressing risks to the outlook for growth and inflation."[2]

Preliminary discussion

The Federal Open Market Committee determines monetary policy by setting an interest-rate target in its periodic meetings. This target is for the federal funds rate, which is the interest rate on unsecured overnight borrowing and lending among banks. The policy is implemented by the Open Market Desk when it transacts daily with primary dealers in open market operations, thereby adjusting the quantity of reserves in the U.S. banking system.

The interest rate through which monetary policy is transmitted is a market interest rate. Its level is affected by a number of factors: the quantity of reserves supplied by the Open Market Desk, their rate of remuneration at the Federal Reserve (currently zero), the rate at the primary credit program of the discount window, any penalties for running an overnight overdraft in a bank's reserve account, and the willingness of banks to lend to one another. The demand for borrowing reserves in the market and the willingness to lend depend on expectations of future rates and expectations of a bank's own ability to borrow funds in the future.

A bank's demand for funds in the market is usually presented in textbooks as a truncated demand curve. At high market rates of interest, a bank in sound financial

[1] The views expressed in this paper are those of the author and do not necessarily represent the views of the Federal Reserve Bank of New York or the Federal Reserve System.

[2] Geithner, Timothy F., "Actions by the New York Fed in Response to Liquidity Pressures in Financial Markets, Annex 1: Understanding the Recent Changes to Federal Reserve Liquidity Provision." Testimony before the U.S. Senate Committee on Banking, Housing and Urban Affairs, Washington D.C., April 3, 2008. http://www.newyorkfed.org/newsevents/speeches/2008/gei080403.html

condition with ample collateral would generally prefer to approach the primary credit program of the discount window and borrow funds at an interest rate that is set at a fixed premium to the target federal funds rate. In this line of thought, the discount window should meet any individual bank's demand for funds caused by some operational glitch or miscalculation.

The liquidity of the interbank market for both overnight and term lending can be thought of as the ease with which a bank can borrow or the willingness of banks to lend funds. Interruptions in banks' willingness to lend funds can cause an overall shortage of market-provided liquidity, which can be partly addressed by the Open Market Desk through an increase in the supply of reserves.

The seizure of term interbank markets in the second half of 2007, and the unusually wide spreads in markets for repurchase agreements ("repos") that have been observed more recently, has challenged conventional Federal Reserve open market operations and discount window programs to fully meet funding demands in these unsettled market conditions in a way that implements the monetary policy intended by the FOMC.

Before turning to the individual lending facilities, let me point out four general imperfections to the pre-existing set of tools of the Federal Reserve in implementing policy.

- First, borrowing from the discount window is perceived to be accompanied by a negative inference about the borrower's credit quality, known as a "stigma." While such borrowing is private information, the identity of borrowers is often known to market participants, such as interdealer brokers, and leaks out. This fact has prevented the discount window from serving as an effective source of backstop liquidity.
- Second, Federal Reserve open market operations lead to a situation in which the Federal Reserve holds a large portfolio of Treasury securities whose markets are highly liquid, while many market participants hold less liquid securities; the illiquid portfolio composition of financial intermediaries can impede their ability to borrow easily in both secured and unsecured markets.
- Third, various market imperfections in over-the-counter money markets, in particular in the repo market, make the transmission of monetary policy from Open Market Desk to primary dealer, and then on to the unsecured interbank market, problematic and subject to considerable risk.
- Finally, while the target rate is an overnight rate, the closely related term interbank rate also has important consequences for the transmission of the intent of the FOMC.

With that preamble, I now turn to each new lending facility and suggest how it might overcome one or more key economic problems, including those just listed.

Rather than describing the mechanics of each facility here, I refer the reader to the accompanying document, *Understanding Recent Changes to Federal Reserve Liquidity Provision*.

Term Auction Facility

The Term Auction Facility (or "TAF") aims to overcome the problem of discount window stigma. It is also designed to provide depository institutions better access to term funds and to facilitate their holding of a more liquid portfolio of assets.

Given the stigma at the discount window, banks face a pernicious strategic situation in case there is an overall shortage of liquidity. First, a shortage of liquidity in the term interbank market may not be fully addressed by open market operations that are aimed at influencing the overnight rate of interest. In part, this problem may be related to the fact that the rate of remuneration on deposit balances at the Federal Reserve is zero, so simply expanding excess reserves may not fully address a term funding shortage, as banks' willingness to hold reserves is very limited as a result of the costliness of holding reserves. For example, suppose that on a particular day, a depository institution faces a risk that a borrower will draw down a line of credit at some time in the next few weeks, and it faces an immediate reserve deficiency. In normal market conditions, the institution would prefer to borrow term funds, killing two birds with one stone, but if the term market is not functioning well, even if the Federal Reserve has supplied high levels of reserves, it will resort to overnight borrowing to cure the reserve deficiency, leaving it still facing the liquidity risk of the potential borrowing in coming weeks.

The primary conventional option for banks facing an illiquid market—a generalized unwillingness of banks to lend (in the case imagined here for a term such as one-month) is to approach the discount window and borrow funds. The Federal Reserve extended the term of primary credit program loans on August 17th, 2007 to encourage banks to address term funding needs at the discount window.

If a bank borrows funds at term through the discount window, it is likely to be more willing to lend funds in the market on subsequent days (or, alternatively, the counterparty to which the bank may have paid out its borrowing from the discount window will be more likely to lend funds). In any case, other banks in aggregate benefit nearly one-for-one from the additional willingness to lend funds occasioned by the discount window borrowing of the first bank. At the same time, only the first bank in the chain, the borrower from the discount window, faces a possible stigma from its actions.

The strategic situation is similar to what Eric Rasmussen has called the "Civic Duty Game."[3] In that game each of two parties observes a burglary. Each party, Smith and Jones, would prefer that the police are called. If Jones calls the police it adds 10 to Smith's payoff, but if Smith calls the police he adds only 7 to his payoff, as his effort costs 3. If both call they each receive 7, and if neither calls they each receive 0. There are three equilibria of this game: the two asymmetric equilibria in which only one of the

[3] Rasmusen, Eric. *Games and Information: an Introduction to Game Theory* Blackwell, 3rd Ed. 2001.

two calls the police, and a mixed strategy equilibrium in which there is a chance that no one calls the police. The key insight of this game is that as more people observe the crime, the probability that no one calls the police in the mixed strategy equilibrium rises (each now relies on one of many others to call the police).

The strategic situation banks find themselves in when there is an aggregate unwillingness to lend in the term interbank market is similar to the Civic Duty game: each bank would benefit from someone borrowing from the discount window, and subsequently lending at a premium interest rate. However, the presence of the stigma implies that each bank would prefer that some other bank approach the discount window. Furthermore, the term market may be affected by adverse selection in which the high posted term interest rates signal that only borrowers of lower quality borrow at term. In that case, the bank that borrowed through the discount window will rationally choose to lend funds in the overnight market, but that would not allow the bank to lend funds at a premium. In a mixed strategy equilibrium with many banks, there is a high probability that no one will borrow from the discount window and the illiquidity in the interbank market will persist.

The TAF overcomes that problem by incorporating features that together reduce the chance that winning banks' identities would be revealed (no brokers are involved in the auction procedures). If a borrower's identity were revealed, it also has several features that would reduce the sense that the borrower either is in great need of funds on the day that the borrowing takes place or that it can only borrow at a premium to market rates. First, the minimum bid rate in the TAF is set at the one-month overnight index swap rate, which is an approximation to the expected average overnight rate over the following month. Consequently, the bidders in the TAF do not face an exogenous premium to market rates. Second, the funds are delivered to winning bidders three days after the auction. Finally, the minimum bid rate and the uniform price nature of the auction should encourage participation by many banks.

Under normal market conditions, TAF auctions of a large size would be undersubscribed, and the auction rate of interest would be very close or equal to the minimum bid rate. These conditions would indicate that such auctions were of little added value, and the Federal Reserve could decide to hold the auctions only infrequently or for small amounts of funds.

The accompanying paper, McAndrews, Sarkar and Wang (2008), evaluates the effects of TAF and shows that its operations have had significant effects in reducing term spreads in interbank markets.[4]

The design of the TAF should improve the ability of the Federal Reserve to address liquidity needs of banks when there is an excess aggregate demand for funds. In this sense, it is an attempt to "perfect" the operation of the primary credit program of the discount window.

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[4] McAndrews, James, Sarkar, A., and Wang, Z. "Evaluation of the Term Auction Facility," April, 2008, Federal Reserve Bank of New York.

Term Securities Lending Facility

The Term Securities Lending Facility (the "TSLF") is designed to address various problems in markets for lending Treasury securities and in other securities lending markets. It does so by allowing primary dealers to bid at auction for a loan of general collateral Treasury securities. The loans of Treasury securities are secured by different types of collateral, including investment grade private-label mortgage-backed securities (MBS).

Recently, the general collateral Treasury repo rate ("GC repo" rate) fell to extraordinarily low levels, even falling to negative rates on some days. Such low rates are often said to reflect a flight to quality, and open up a large spread between GC repo rates and repo rates on other securities, such as MBS. A simple view is that GC repo rates falling to such low levels reflects a shortage of such securities (when GC repo rates are so low, the lender of money is sacrificing a large amount relative to the fed funds rate to obtain GC Treasury securities).

In addition to a large spread in financing rates, as explained by Fleming and Garbade (2005), when the GC repo rate falls to levels near zero, as occurred in March 2008, it is often accompanied by a high level of failures to deliver Treasury securities that are said to be on "special."[5] Certain Treasury securities such as benchmark on-the-run Treasuries are in specific demand, and repo rates on those securities fall below GC repo rates. As Fleming and Garbade (2005) explain, settlement fails can be self-perpetuating, leading to increased counterparty credit risk and a general pull-back in the Treasury market.

The high spread in the repo rates between GC Treasuries and MBS is anomalous. Under normal conditions, rates trade at a fairly constant spread between the two classes of securities. The rates are not intended to account for the market risk of the underlying instrument (such as the volatility of its price); instead the margin, or haircut, on the amount lent against the security is designed to protect the lender of funds against the

[5] "Episodes of fails can be self-perpetuating. If borrowing costs rise to near the GC rate and fails mount, some market participants that would otherwise lend securities may decide to step back from the market to avoid borrowers that might fail to return their securities. The reduced supply of securities available for lending exacerbates and prolongs the fails situation.
Because the benefit to avoiding a fail declines as the cost of borrowing securities rises toward the GC rate, an important factor in explaining fails is the general level of interest rates. When the fed funds rate, and hence the GC rate, are low, security borrowing costs can reach their upper limit more quickly. When the fed funds rate was only 1 percent in 2003 and 2004, for example, there was only a small margin before security borrowing costs reached the GC rate and the incentive to borrow securities became negligible." Fleming, Michael J., and Garbade, Kenneth D. "Explaining Settlement Fails," *Current Issues in Economics and Finance*, September 2005, Volume 11, Number 9.

market risk of the collateral. Consequently, the wide spread in rates is a reflection of market illiquidity.

The situation of wide spreads in rates can cause increased uncertainty in funding markets as dealers find it increasingly difficult to fund their portfolios of securities. At the same time, an increased level of settlement fails can cause general problems in the market for Treasury securities as well. Both of these problems can be addressed, at least in part, by an increase in the supply of Treasury securities.

The TSLF seeks to address those problems by auctioning a fixed supply of Treasury securities for one-month GC repos to be secured by various classes of alternative assets that are held by the Federal Reserve as collateral. It provides an increased amount of Treasury debt to the public (providing a greater supply of liquid securities) and adds an increased amount of an alternate, less liquid, class of securities to the Fed's balance sheet (increasing the demand of less liquid assets).

The TSLF auction has minimum bid rates for the asset classes that serve as collateral that slightly exceed an estimate of the typical market spreads in normal conditions. The haircuts on the collateral are determined by the Federal Reserve Bank of New York in a way that is consistent with those used in open market operations. Consequently, the program can be wound down when liquidity conditions in the particular asset classes involved have returned to normal, as measured, for example, by the spread between GC repo rates and the repo rates for that asset class.

The TSLF is intended to improve market conditions in repo markets, including the markets in which open market operations take place. As such, it is intended to perfect conditions in markets that are important to monetary policy transmission.

The accompanying note, Fleming and McAndrews (2008), provides preliminary support for the hypothesis that the operation of the first two TSLF auctions led to a significant increase in GC repo rates.[6]

Primary Dealer Credit Facility

The Primary Dealer Credit Facility (PDCF) was designed to meet an emergency situation that threatened the efficient functioning of the repo market. Announced on Sunday, March 16, 2008 for operation on Monday, March 17, it was intended to provide financing to primary dealers participating in repo markets. When it was revealed to the public that the broker-dealer Bear Stearns was near failure, investors were reluctant to lend to it in the repo market. Had Bear Stearns filed for bankruptcy (a possibility during the weekend of March 15-16) it is conceivable that investors would have been reluctant to lend to other dealers in the repo market. This possibility made manifest the lack of a backstop source of liquidity in the repo market.

[6] Fleming, M. and McAndrews, J. "Repo Market Effects of the TSLF," Federal Reserve Bank of New York, April, 2008.

The repo market is a large market in which broker-dealers obtain financing, much of it on overnight terms, for tradable assets on a collateralized basis. The repo market has grown rapidly in recent years, and is now the most important source of short-term financing for security broker-dealers: 38 percent of the liabilities of security broker and dealers are repos.[7] In contrast, the major source of short-term funding for U.S. commercial banks is deposits: 59 percent of commercial banks' liabilities are deposits, and only 11 percent are repos and fed funds obligations. The majority of the repo market borrowing is collateralized against Treasury securities, mortgage backed securities, agency securities, and corporate securities.

The most common repo contracts are tri-party repo contracts. In a tri-party repo agreement, the borrower puts collateral to a clearing bank and receives cash from a lender such as a money market mutual fund. The clearing bank assesses the value of the collateral, calculates a haircut, and manages margins. The haircut is determined in a way that reflects the riskiness of the security (for example, a corporate security is typically more risky than a Treasury bill), and it also depends on the counterparty credit risk of the borrower. Fleming and Garbade (2003) discuss the GCF Repo contract, which is a common form of tri-party repo contract in the inter-dealer market.[8]

The tri-party RP market suffers from a weakness similar to the one suffered by the commercial paper market prior to the Penn Central crisis of 1970. In particular, there is no market-based committed back-up source of credit. The PDCF fills this gap on a temporary basis. It provides an additional source of funding to the existing repo market among financial intermediaries. The PDCF offers a liquidity backstop facility for this central market by providing primary dealers with funding against a broad range of tradable collateral. The interest rate on the borrowing through the PDCF is set at the primary credit rate and the haircut on the collateral is set at 5 percent; the price of the collateral is set in the market by the clearing banks who organize the tri-party repo market.

The PDCF was designed to address an imperfection in an important money market, again, a market in which open market operations are conducted. It required the Board of Governors to find that "unusual and exigent" circumstances existed. Clearly the implementation of the PDCF raises many new challenges for the Federal Reserve. For example, the effort that is now devoted to monitoring the primary dealers is impressive and difficult.

By addressing imperfections in the repo market, the PDCF may well have reduced the systemic risk of other potential dealer failures that could have resulted from a broader retreat by repo market investors. In this regard, the PDCF was aimed at improving financial stability in an unsettled market environment. This action, while unusual, may have been effective and was similar to another historical episode of Federal Reserve provision of backstop liquidity facilities to financial intermediaries in uncertain

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[7] Computed from the Federal Reserve's Flow of Funds, as of 2007Q4.

[8] Fleming, Michael J., and Kenneth D. Garbade, 2003, "The Repurchase Agreement Refined: GCF Repo," *Current Issues in Economics and Finance* 9 (6) Federal Reserve Bank of New York.

conditions. Meltzer (2003) points out that at the time that banks were reopening following the bank holiday of 1933, "The president's announcement had assured the public that only sound banks would be reopened. Recognizing that the public would not distinguish between member and nonmember banks, Congress allowed state nonmember banks to borrow from Federal Reserve banks on acceptable collateral. This power expired after one year." [9]

Looking beyond the emergency nature of its implementation, the PDCF is aimed at repairing an imperfection in the repo market, and it acts to provide a backstop source of funding to a set of investment banks, a growing class of financial intermediaries in the U.S. It is an open question whether market-based sources of backstop funding can be designed for the repo market, as the commercial paper market designed a new institution, after the Penn Central debacle, to have commercial paper issues accompanied by bank-supplied back-up lines of credit.

The accompanying paper, Adrian and McAndrews (2008), provides a more thorough discussion of the PDCF.[10]

Concluding remarks

The new lending facilities of the Federal Reserve serve to overcome various frictions or imperfections that hinder the ability of the Open Market Desk to fully implement the monetary policy directive of the FOMC. Each facility raises new challenges in its operation, communication of strategy, and possible long-term usefulness or long-term exit. Continued evaluation and study of these facilities will provide both the Federal Reserve and the public with increased understanding of the effects of these facilities and insight into how they may be best employed.

[9] Meltzer, Allan, H. *A History of the Federal Reserve*, University of Chicago Press, 2003 pg. 424.
[10] Adrian, T. and McAndrews, J. "Economics of the Primary Dealer Credit Facility," Federal Reserve Bank of New York, 2008.

The Term Auction Facility

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Draft: April 10, 2008, preliminary and incomplete, please do not quote without permission.

[1] We thank many colleagues at the Federal Reserve Bank of New York and the Board of Governors of the Federal Reserve System for comments. The views expressed in the paper represent those of the authors and do not necessarily represent the views of the Federal Reserve Bank of New York or of the Federal Reserve System.

Introduction

In normal times, the Federal Reserve provides liquidity almost exclusively through domestic open market operations with a relatively small set of primary dealers. These operations primarily take the form of repurchase agreements against Treasury, agency and agency mortgage-backed securities, as well as outright purchases of Treasury securities. When the interbank markets function well, the liquidity is then redistributed to banks and to the broader economy in an efficient manner. The willingness of banks to lend to one another is based on their evaluations of the credit worthiness of their counterparties, as well as on their own ability to access funding markets.

That mechanism can cease to function during crisis periods when there is a sudden reduction in the ability or in the willingness of banks to distribute reserves through interbank transactions, thus disrupting funding markets and posing risks to financial stability. For example, banks of good credit quality may decide to lend less at term because they are less certain about either the credit worthiness of their counterparties, or their own ability to raise funds in the future. In these situations, banks may have limited access to term funds even if they are willing to pay high rates.

As further explained below, such a situation emerged in the late summer of 2007, following deteriorating performance in a narrow class of mortgage securities. In particular, term premiums on unsecured interbank term funding rose precipitously while the volume of term unsecured funding contracted. As a result, banks increasingly funded themselves at shorter maturities. The persistence of such high term rates is concerning as it may, in particular, affect interest rates on a wide variety of loans and securities (e.g. home mortgages and corporate loans). Moreover, an over-dependence on overnight loans can lead to higher volatility in overnight funding markets.

In response to the illiquidity in bank funding markets, the Federal Reserve made a number of changes in its Primary Credit program of the Discount Window. In addition, as these conditions persisted into the fall of 2007, the Federal Reserve then created a new lending facility, the Term Auction Facility (TAF). The purpose of the TAF is to provide longer-term funding to sound depository institutions on a collaterized basis through periodic auctions. The TAF is designed to support the goals of monetary policy by providing term funds when the market for term funding is impaired.

In this edition of *Current Issues*, we describe the genesis of the TAF and the Federal Reserve's objectives in introducing it, the design of the TAF, and a description of the results of several of the initial TAF auctions.[2] Two subsequent editions of *Current Issues* will assess the effectiveness of the TAF and discuss the behavior of TAF participants.

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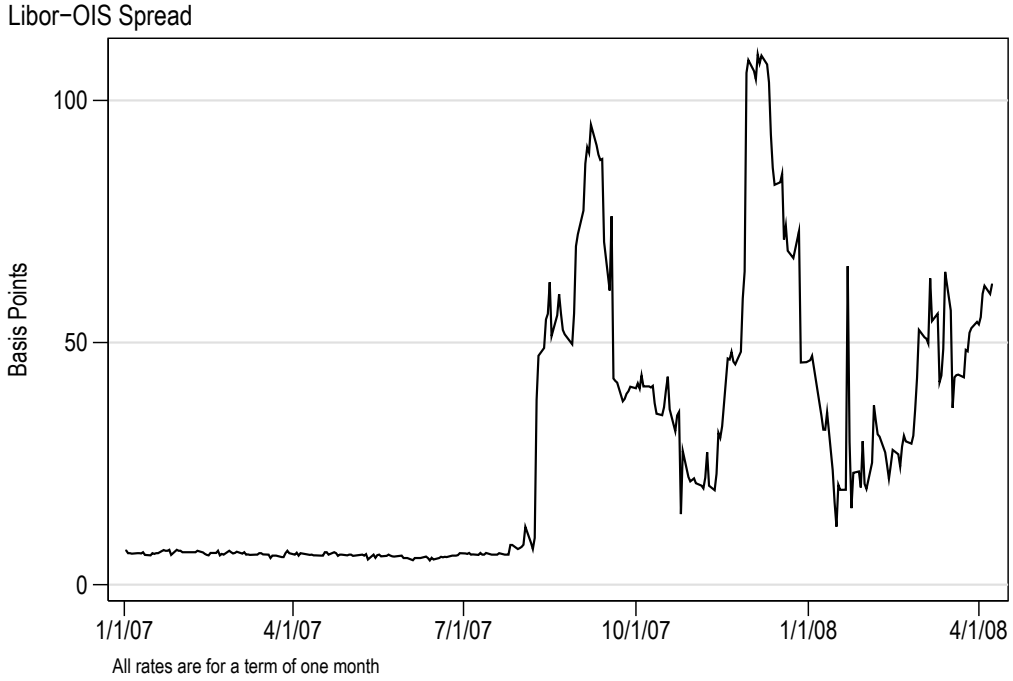
[2] In a related paper, McAndrews, Sarkar, and Wang (2008), the authors conduct an evaluation of the effectiveness of the TAF in reducing elevated term spreads in interbank money markets, and its effects on interest rate volatility in those markets.

Market Conditions Prior to the TAF

While problems in the mortgage and structured financial securities markets had surfaced earlier in 2007, money markets were seriously affected on August 9, 2007 when BNP Paribas announced that it could not value assets in three of its investment funds. Increased uncertainty about the true value of various structured financial securities appeared to have immediately affected the interbank money markets in Europe and the U.S. Figure 1 shows that there was a spike in the spread between the interest rate on one-month interbank loans, measured by the spread between the one-month Libor rate and the one-month Overnight Interbank Swap (OIS hereafter) rate.[3] The average spread jumped from 6.4 basis points to 55.4 basis points.[4] In addition, the implied volatility for the 3-month maturity Eurodollar option rose significantly after August 9, 2007. Interest rates of other maturities displayed a similar behavior of increased spreads and volatility.

Figure 1



[3] Quoting from the British Bankers Association, which publishes Libor rates, "Libor stands for the London Interbank Offered Rate and is the rate of interest at which banks borrow funds from each other, in marketable size, in the London interbank market."
http://www.bba.org.uk/bba/jsp/polopoly.jsp?d=225&a=1416

An overnight index swap (OIS) is a fixed for floating interest rate swap with the floating rate tied to a published index of a daily overnight reference rate. The two parties agree to exchange at maturity the difference between interest accrued at the agreed fixed rate and the interest accrued through geometric averaging of the floating index rate. As such, the market OIS rate is a market-based expectation of the daily average of overnight rates for the term of the swap (in the case of the TAF, the term is the one-month OIS rate).

[4] Bloomberg, OIS-LIBOR 1 month spreads for periods (1/1/07 – 8/8/07) and (8/9/07 – 12/31/07).

In Figure 1 we display the spread between the one-month Libor and the one-month OIS rate from January 1, 2007 to April 2008. Compared to its historical average, the Libor-OIS spread increased sharply in August 2007, to reach a peak on December 4 at 110 basis points. By January 15, this spread had fallen to 15 basis points, and it remained stable around 20 points until February 26. After this, following a sharp decline of the OIS rate, it has increased to 40-60 points.

Problems in the term money markets were linked to the structured finance products because commercial banks used off-balance sheet entities to invest in these products.[5] Banks provided implicit and explicit guarantees to these entities in case short term borrowing became impossible or too expensive.

As investors lost confidence in the value of the investments providing the stream of income from the securities in structured finance vehicles, they declined to invest further in them, causing a significant shrinkage in the issuance of asset-backed commercial paper (ABCP).[6] As the ABCP issuance fell, banks' liquidity and credit guarantees were called on, and banks then had to fund the underlying assets. Banks also faced large future contingent demand for funds as they expected the cycle to continue.

The market for newly issued securitized credit declined markedly during this period, which reduced a source of funding previously available to banks that originated large amounts of mortgages and other loans. Consequently, during this period banks had greater demands for funds arising from their prior commitments to supply funds and a decrease in their ability to sell loans in securitized markets. Banks faced a large increase in the expected future demand for bank funds without a comparable increase in the supply of bank funding.

Lenders became more concerned both about the credit risks associated with the commercial banks and about the risks of reduced liquidity in the market. The liquidity problem manifested itself in a large imbalance between the supply of and the demand for longer-term loans. This imbalance was possibly caused by "credit uncertainty" rather than credit risk, as market participants realized that the perceived value of the structured finance products had been overestimated. It is not clear that the rise in the term spread reflected increased default risk of counterparties. In fact, several studies find that heightened default risks explain only a small portion of the increase in the three-month LIBOR rate in the last two quarters of 2007.[7]

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[5] Examples of such entities are structured investment vehicles (SIVs), collateralized debt obligations (CDOs), and conduits.

[6] Commercial Paper Rates and Outstanding, Federal Reserve Board. http://www.federalreserve.gov/releases/cp/

[7] "An indicative decomposition of Libor spreads" *Quarterly Bulletin*, December 2007 pp. 498-9, Bank of England. http://www.bankofengland.co.uk/publications/quarterlybulletin/qb0704.pdf Michaud, François-Louis, and Christian Upper, 2008, "What Drives Interbank Rates? Evidence from the *117* LIBOR Panel,"

One hypothesis that is consistent with an increase in credit uncertainty relates to an increase in monitoring costs, as opposed to default risks. An unexpected increase in monitoring costs may have occurred because: (a) securitization of mortgage loans did not solve monitoring problems nearly as well as was expected; (b) the very complexity of the structures increased the difficulty of evaluating precisely what assets were referenced by the securities in a specific off-balance-sheet entity; and (c) the increased uncertainty about valuations also raised monitoring costs. The additional monitoring costs could be caused by a recognition that the distribution of borrowers as a whole was less safe and that there was more uncertainty in the evaluation of any given borrower, for any given level of monitoring effort.

The initial set of concerns about counterparty risk and ability to access future funding in turn exacerbated conditions in the term money markets. Term premia on unsecured inter-bank funding markets increased and volume decreased; funding terms became progressively shortened.[8] Banks with excess funds did not step in with lower rates for term loans. Instead, banks resorted to overnight markets to meet their funding needs. This resulted in higher volatility in overnight rates, and with a greater maturity risk than they would have normally chosen.

We next turn to a description of the Federal Reserve's action designed to improve liquidity conditions in the term money markets.

The Federal Reserve's Response to Conditions in the Money Markets

In response to the crisis, the Federal Reserve made several changes in the terms of its primary credit program of the discount window on August 17, 2007.[9] In particular, the premium on the primary credit rate was reduced from 100 to 50 basis points over the target Fed Funds rate. In addition, to address directly the tensions on the term funding markets, discount window borrowers were allowed to take renewable loans for a period of up to 30 days.

This change in policy, however, generated little additional borrowing from the discount window. This may be explained in part by the fact that the interbank market rate remained lower than the discount rate, making it less attractive for banks to borrow from the discount window.[10] Another commonly accepted explanation is the presence of a

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Bank for International Settlements Quarterly Review (March), pp. 47–57, and McAndrews, Sarkar, Wang (2008).

[8] "What drives interbank rates? Evidence from the Libor panel" Michaud, Francois-Louis, Christian Upper, *Quarterly Review*, March 2008 pp.47-58, Bank for International Settlements. http://www.bis.org/publ/qtrpdf/r_qt0803.pdf

[9] http://www.Federal reserve.gov/newsevents/press/monetary/20070817a.htm

[10] For example, the one-month U.S. dollar LIBOR rate was 5.5 percent on August 17, 2007, less than the

possible "stigma" that may be attached to borrowing at the discount window.[11] Indeed, there are good reasons to believe that potential borrowers tend to shy away from the discount window as they fear that the market could interpret such borrowings as a sign that they may have credit issues and face reduced ability to borrow in the market. In these times of high uncertainty about credit worthiness, these fears may have been greatly enhanced thereby explaining the lack of discount window borrowing despite the Federal Reserve encouragements.

An additional possible explanation for the lack of borrowing at the discount window is that Federal Home Loan Bank (FHLB) system may have been used as an alternative source of term funding. Indeed, for thousands of U.S. banks that had at least 10 percent of assets in mortgage related lending, the FHLB system could provide lending against a wide variety of assets as collateral, under terms that were usually more favorable than those in the primary credit program. The FHLB system increased its lending to banks by approximately $200 billion in the third and fourth quarters of 2007, providing significant amounts of term funding to the U.S. banking system.

The combination of several factors, including decreases in the target federal funds rate, the decrease in the spread of the primary credit rate to the target funds rate, and the availability of term funding at the FHLB system all led in October 2007 to more stable funding conditions in interbank markets. In late November and early December of 2007, however, market conditions worsened again.[12] In part, that could have been correspondent with banks' regular increased year-end funding pressures related to seasonally higher economic activity, and to banks' regulatory and tax-related desires to "clean up" their balance sheets. Banks therefore typically demand higher levels of reserves at year-end. This heightened banks' reluctance to lend at term in late November and early December even more so than in recent years. Many market participants reported extremely tight money market conditions as indicated by a jump in the spread at this time (see Figure 1).

Genesis of the Term Auction Facility

As it was perceived that encouraging banks to borrow at the discount window may not be sufficiently effective, alternatives measures were then considered to address the credit crisis. In particular, the Federal Reserve reexamined the idea of auctioning funds to the market first proposed in 2002 in response to concerns that the entire publicly held Federal debt would be paid off within a decade and the Federal Reserve would need to find other methods to implement monetary policy besides intervening in the Treasury

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discount rate of 5.75 percent on that date.

[11] Furfine, Craig. "*Standing facilities and interbank borrowing : evidence from the Federal Reserve's new discount window"* International Finance, Vol. 6, No. 3, pp. 329-348, 2003

[12] [12] "Markets and operations" *Quarterly Bulletin*, December 2007 pp. 490, Bank of England. http://www.bankofengland.co.uk/publications/quarterlybulletin/qb0704.pdf

debt market.[13] In reexamining the idea of fund auctions in 2007, the focus had shifted from monetary policy implementation to addressing illiquid conditions in the inter-bank market.[14]

The Federal Reserve, compared to a traditional bank, has three potential advantages in making loans in the midst of a liquidity crunch: access to a wider set of collateral, a more informative, but coarse, signal about creditworthiness, and less funding risk for itself.[15] The Federal Reserve holds a large pool of collateral as a result of banks' pledges to the Federal Reserve's discount window. Most of these assets are difficult to borrow against (most consisting of bank loans) in private markets, because of the absence of supporting market conventions and pricing services, making the collateral difficult to use as security for private loans.[16]

The second potential advantage is that the Federal Reserve must systematically monitor banks' financial health as part of its normal supervisory duties. The Federal Reserve, for example, examines banks, and is informed of the "CAMEL" ratings of prospective borrower banks.[17] By limiting lending to banks with CAMEL ratings of 1 to 3, which represent banks with the highest credit quality and the least supervisory concerns, it could be reasonably confident that borrowers would have the wherewithal to

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[13] "Alternative Instruments for Open Market and Discount Window Operations" Federal Reserve System, Board of Governors of the Federal Reserve System, December 2002. http://www.Federal reserve.gov/boarddocs/surveys/soma/alt_instrmnts.pdf

[14] The Federal Reserve, when it lends to a bank through the discount window, typically *sterilizes* the borrowing; in other words the Federal Reserve conducts a parallel open market operation to offset the injection of reserves that it makes when it lends at the discount window. After a bank borrows at the discount window, therefore, banks in total have the same amount of reserves as before the borrowing took place, but additional holdings of government securities (the next most liquid instrument). So the sum of money plus government securities held by the public rises. In contrast, when the Federal Reserve conducts a typical operation to increase reserves, it leaves the sum of these two financial assets unchanged.

[15] In contrast, it is not clear that in normal times the Federal Reserve could add value in making loans directly to banks because the Federal Reserve does not have as much knowledge as the private sector about the financial intermediaries. In addition, the Federal Reserve's "shareholders" are effectively the taxpayers and claimants on government revenues, who are typically more risk-averse than capital market investors. As Holmstrom and Tirole (1996) point out, private provision of liquidity is preferred unless the private market information becomes very uninformative. Holmstrom, Bengt and Jean Tirole, 1996, "Private and Public Supply of Liquidity" *Journal of Political Economy,* 1998, vol. 106, no. 1.

[16] Using these assets to make collateralized loans shifts risk away from those loans and towards the remaining uncollateralized creditors of the bank (or the residual claimants to the bank, including the FDIC, a public sector entity) --- there is no overall reduction in risk. If it is moderately expensive (because of the need for legal services, supporting infrastructure to manage the collateral, and pricing services) to collateralize lending, then as a practical matter it might be more economical for private parties to lend on an unsecured basis.

[17] CAMEL refers to the five components of a bank's condition that are assessed: Capital adequacy, Asset quality, Management, Earnings, and Liquidity. (A sixth component, reflecting a bank's sensitivity to market risk, was added in 1997.). A bank's CAMEL rating is highly confidential and known only by its senior management and the appropriate supervisory staff.

repay.[18] In fact, "fresh" CAMELS ratings have been shown to be a useful predictor of defaults.[19] In normal times, the supervisory information possessed by the Federal Reserve may be a coarser signal of a firm's condition than is the information possessed by private counterparties of a firm. However, in a crisis, knowledge of a bank's supervisory rating may be more informative about basic creditworthiness than knowledge possessed by the market.

Finally, the Federal Reserve has a third potential advantage in lending during a crisis. In a crisis, banks are reluctant to loan funds because they may not know either their future need for liquidity (such as how large draw-downs on the lines of credit the bank has outstanding will be) or whether they will be able to borrow in the future, given the unsettled conditions in funding markets. The Federal Reserve is much less affected by these problems by its power to create reserves, and therefore suffers less liquidity risk.

Auction Design

An auction approach was perceived to have four particularly attractive features compared to the discount window and open market operations. First, in contrast with the discount window, an auction would enable the Federal Reserve to control precisely how much liquidity would be injected in the system. Indeed, since the demand for funds is not perfectly known, successive reductions in the discount window rate could have resulted (at some interest rate low enough to overcome any perceived stigma of use of the window) in a very high demand for funds. Such an event could result in increased difficulty in maintaining the effective federal funds rate close to the target rate. As a result, the auction of a set amount of funds is easier to integrate with the regular monetary policy operations of the Federal Reserve.

Second, in an auction the rate at which the funds are allocated is determined endogenously by the bidder as a function of their demand for the funds. In contrast, the discount window rate is set at a fixed premium to the target rate by the Federal Reserve. Because borrowing at a set premium could contribute to the perceived stigma of borrowing from the primary credit program, the auction-determined rate might be less subject to the perception of a stigma.

Third, unlike open market operations, in which the Federal Reserve deals with a

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[18] Examiners assign a rating for each component of CAMEL on a scale from 1 to 5, with 1 representing the highest rating, as well as a composite rating for the bank's overall condition and performance. Banks with composite CAMEL ratings of 1 or 2 are considered to present few supervisory concerns, while banks with ratings of 3 or more present moderate to extreme degrees of supervisory concern. The Federal Reserve lends to borrowers with a 1, 2, or 3 rating through the primary credit program of the discount window, and to banks with a rating of 4 or 5 through its secondary credit program. The Federal Reserve also has a third window for seasonal borrowing by e.g. agricultural banks. When a bank borrows from the discount window it is not revealed whether they have borrowed as a primary or secondary credit.

[19] The largest financial institutions are monitored continuously by the Federal Reserve. For the smallest banks, a CAMEL score might be updated as infrequently as once every 18 months. The older a score the less reliable it is as a predictor of a bank's likelihood of being able to repay borrowings.

small set of primary dealers, an auction would enable the Federal Reserve to allocate directly to banks which need funds the most. As the interbank funding markets were impaired, this is a desirable feature of the auction format.

Finally, a competitive and well functioning auction for term credit was perceived as a possible way to circumvent the "stigma" attached to the discount window. In particular, an auction requires banks to submit bids simultaneously, while banks may not approach the discount window as rate decisions are made unilaterally.

Once the idea of an auction was adopted, some of its features were selected in an effort to reduce further the possibility of a "stigma" and to improve the possibility that it would distribute funding widely and to banks with high demands for funds. In particular, to promote participation, the Federal Reserve decided to set a competitive market-based minimum rate at which bids could be submitted.[20] Likewise, the Federal Reserve chose a uniform-price (or single price) auction rather than a discriminatory (or pay-your-bid) auction, which may provide good incentives to encourage bidders, and in particular small or less informed bidders, to participate.[21] Finally, the Federal Reserve imposed a cap on the amount of funds for which a bidder could bid corresponding to 10 percent of the total amount allocated. Because there would be a least ten winners, it was believed that it would be more difficult for the market to identify which bidder was allocated funds and that funding would be distributed relatively widely.[22]

Two additional important rules were imposed. First, given the Federal Reserve experience in its option auctions in 1999[23] (Drossos and Hilton, 2000) where bidders, when allowed to submit two price-quantity pairs, often submitted significantly different

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[20] In practice, the minimum rate was set at the 30-day OIS rate; it is a fixed rate instrument whose rate is set and if the Federal funds rate differs from that rate the party that holds the floating-rate side of the contract either pays or collects funds from the other party. That is, banks would not be able to borrow at a rate that was lower than what they were likely to have to pay rolling over one-day loans but there would be no minimum premium over that rate for the benefits of obtaining longer-term funds. This relatively low rate was likely both to encourage participation and to reduce any stigma associated with receiving funds in the auction (indirectly encouraging participation), if somehow the market were able to deduce who had participated.

[21] In addition, as the uniform price structure has been used in Treasury auctions in recent years it was believed that banks would have a higher level of comfort if the same design were used in the TAF auctions. In particular, such a design could reduce the "learning period" for banks.

[22] So for a $20 billion auction, a bank could submit up to $2 billion worth of bids. If less than $20 billion of bids were submitted then all bids would be serviced at the minimum rate. This would mean that if only, say, $5 billion in bids were submitted there might be an individual bank that would receive 40 percent of the funds. On the other hand, the rate would be sufficiently favorable that it would be difficult to attribute the banks having bid in the auction as a signal of desperation rather than simply taking advantage of a good deal.

[23] Drossos, Evangeline Sophia and Spence Hilton, 2000, "The Federal Reserve's Contingency Financing Plan for the Century Date Change" *Current Issues in Economics and Finance* (Vol. 6 Num. 15).

prices and quantities for their two bids, it seemed that there was high value in allowing bidders to make more than one rate-amount offer. At the same time, considerations of operational costs, and in the interests of providing a simple auction design, it was decided that bidders would be allowed to make a maximum of two bids. Second, to ensure that TAF bidders retain some capacity to borrow under the primary credit facility to meet any unexpected overnight funding needs, bidders were required to maintain collateral beyond that necessary to secure TAF credit (banks were required to hold a minimum of $2 in assets in collateral for every dollar borrowed from the Federal Reserve through the TAF).

The Federal Reserve announced the establishment of the TAF on December 12, 2007, together with a series of coordinated actions by other central banks.[24] The reader is referred to the TAF Frequently Asked Questions page for detailed information on the exact implementation of the TAF.[25] The first auction was held on December 18, and there have been nine auctions at the date of this writing. The auctions generally occur every two weeks. The Federal Reserve stated on December 21, 2007 that it will continue to hold these auctions "for as long as necessary to address elevated pressures in short-term funding markets."[26] On March 7, 2008, the Federal Reserve announced that it "will continue to conduct TAF auctions for at least the next six months unless evolving market conditions clearly indicate that such auctions are no longer necessary."[27] To date, the auctions appear to have been a success in terms of auction participation, and have helped mitigate the difficulties in the financial markets.[28]

Descriptive Statistics of Initial Auctions

Between December 17, 2007 and March 24, 2008, the Federal Reserve conducted eight TAF auctions. In this section we briefly describe the outcomes of these auctions.

As shown in Table 1, the total amount allocated by the Fed in each of the first two TAF auctions was $20 billion. To address a perceived increase in demand for funds, the amount allocated has been subsequently raised to $30 billion in the next four auctions, and to $50 billion in the last two. Despite these successive increases, the bid-to-cover ratio (defined here as the total amount bid in an auction divided by the total amount allocated), remained essentially stable around 2, after initially declining slightly. As a general rule of thumb, practitioners tend to interpret a bid-to-cover ratio of 2 as a sign of a "healthy" multi-unit auction. In other words, the first eight TAF auctions may be

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[24] http://www.federalreserve.gov/newsevents/press/monetary/20071212a.htm

[25] The TAF Frequently Asked Questions page is found at: http://www.federalreserve.gov/monetarypolicy/taffaq.htm

[26] http://www.federalreserve.gov/newsevents/press/monetary/20071221b.htm

[27] http://www.federalreserve.gov/newsevents/press/monetary/20080307a.htm

[28] http://www.Federal reserve.gov/monetarypolicy/taf.htm At the Federal Reserve Board's website on the TAF, one can read details of the auction results.

generally considered successful, as the credit for sale was in high demand. The stability of the bid-to-cover ratio also attests to the ability of the Fed to allocate appropriate amounts in the various TAF auctions.

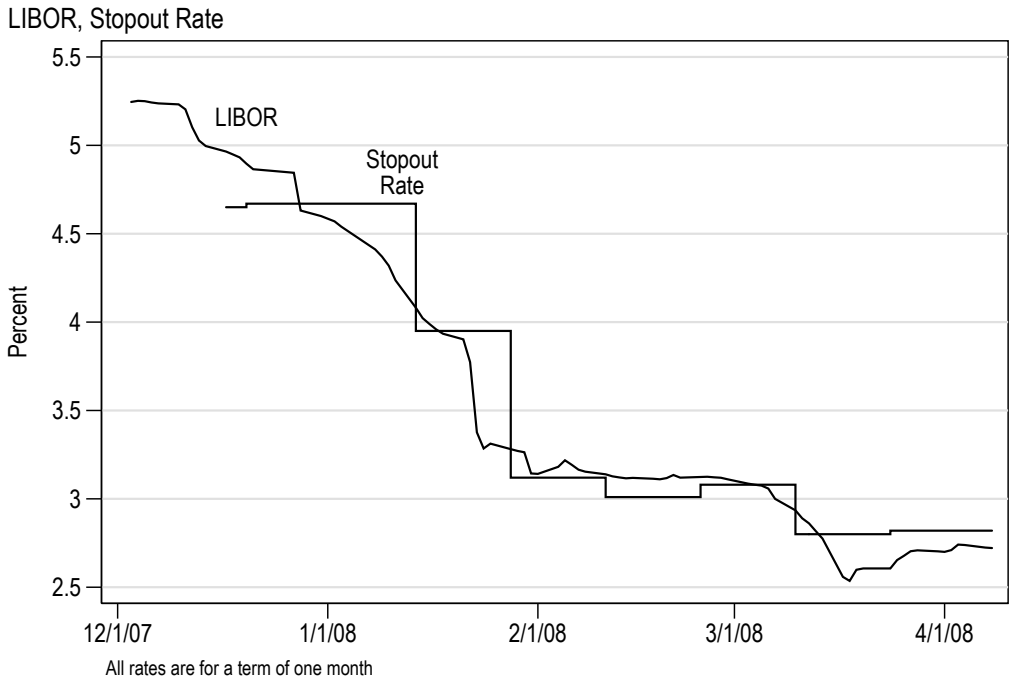
Participation in the TAF auctions has varied from one auction to the next, but has always included more than 50 bidders in the auctions to date. Such a large number of bidders indicate that many depository institutions have found these auctions potentially valuable. Indeed, as indicated in Table 1, participation at the TAF, after an initial decline in the first four auctions (from 94 to 52 participants), steadily increased to reach 88 participants in the last auction.

Table 1 also indicates that during the three months between the first and the eighth TAF auctions both the minimum bid rate (i.e. the OIS rate the day prior to the auction) and the stop-out-rate declined. As for the spread between stop-out-rate and the expected discount rate (i.e., the OIS rate the day prior to the auction plus the spread of the primary credit rate over the target rate, which stood at 50 basis points until March 11, 2008, when the Federal Reserve Board lowered it to 25 basis points), is close to zero except in auctions 3 to 6, and it is almost always negative. However, at the eighth auction, on March 24, 2008, the stop-out rate, 2.61 percent, exceeded the expected discount rate by 18 basis points (it was also positive in the second auction). This result may provide evidence supporting the presence of a "stigma" attached to borrowing from the discount window. In other words, in most but not all of the auctions, banks were able to borrow funds for 28 days at the TAF at a slightly lower rate than what they could expect from the discount window. The stop-out rate also has tended to settle at a rate close to the one-month Libor rate, as can be seen in the two panels of Figure 1 (the left panel displays the information over a longer time period than the right panel). This result suggests that the TAF has tended to allocate funds at a rate that is close to the market-based substitute for bidders.

Table 1
Auction Results

	Auction 1	Auction 2	Auction 3	Auction 4	Auction 5	Auction 6	Auction 7	Auction 8
Date	12/17/08	12/20/07	01/14/08	01/28/08	2/11/08	2/25/08	3/10/08	3/24/08
Amount Allocated (in $ Billions)	20	20	30	30	30	30	50	50
Minimum Bid (OIS) Rate (in %)	4.1665	4.1005	3.85	3.048	2.8665	2.81	2.376	2.178
Stop-out-Rate (in %)	4.65	4.67	3.95	3.12	3.01	3.08	2.8	2.61
Spread between Stop-out-Rate and Expected Discount Rate (in Basis Points)	-2	+7	-40	-43	-36	-23	-8	18
Total Amount Bid (in $ Millions)	61,553.4	57,664	55,526	37,452	58400	67950	92595	88869
Bid-to-Cover Ratio	3.0	2.8	1.8	1.2	1.9	2.3	1.9	1.8
Number of Bidders	94	73	57	52	67	72	83	88

Figure 2



In Figure 2 we display the one-month Libor rate from December 1, 2007 to April 2008. In addition, the stop-out rate for the TAF auction is displayed as well. The two rates are quite close to one another. The consistency between TAF auction rates and market rates indicates that the Federal Reserve is allocating funds through TAF with little subsidy to the private sector. In addition the competitive pricing in the TAF auctions suggest that the auctions are allocating funds efficiently and are not subject to a stigma.

Conclusion

This paper described the establishment of the Term Auction Facility. It is a supplementary tool that can be of use to the Federal Reserve in meeting its monetary policy and financial stability objectives in circumstances when there is a breakdown in liquidity conditions in the uncollateralized interbank term funding markets. The Term Auction Facility combines features of both open market operations and primary credit loans, by providing term funding directly to banks on a collateralized basis, at a rate and allocation of quantities determined by an auction. It is designed to be useful in conditions when the provision of reserves through open market operations and regular discount window lending programs has little impact beyond the overnight federal funds rate, and when appetite for even a term discount window program is limited, because of some combination of stigma and price. In such a circumstance, the TAF, by satisfying at least some of the demand for term funds that is not being supplied by the market, may be able to improve conditions in term funding markets, reducing constraints on banks in their allocation of credit. The next paper in this series of *Current Issues* provides an evaluation of the performance of the Term Auction Facility.

Box on Description of TAF

The Federal Reserve has generally conducted TAF auctions of term funding of 28-day maturity. The interval between auctions has been biweekly, except for periods around holidays. The TAF is a discount window program. Depository institutions that are eligible for primary credit—those determined to be in generally sound financial condition by their respective Reserve Banks—are eligible for the TAF program. Borrowing would be fully collateralized using assets that are eligible to pledge at the discount window. Standard discount window haircuts are employed in valuing any collateral pledged. In addition, the maximum TAF funding for which an institution can bid is not permitted to exceed 50 percent of available pledged collateral. Individual of propositions per bidder at any auction are limited to a maximum of two. To promote a relatively large number of winning bids, the maximum award to any individual institution at an auction is limited to 10 percent of the announced auction quantity. The minimum bid size was initially set at $10 million, and was later reduced to $5 million, to permit smaller institutions to participate competitively. The TAF auction itself follows the single-price format utilized in Treasury auctions; the single-price auction format should encourage auction participation.

Repo Market Effects of the TSLF*

Michael Fleming and Jamie McAndrews

April 9, 2008

We assess the effects of the Term Securities Lending Facility (TSLF) on the overnight and one-month financing markets for Treasury, agency, and MBS collateral. To do this, we relate repo rates and spreads to both the quantities of securities made available to the market and to the quantities of securities financed by the Fed.[1] While our primary focus is the TSLF, we also analyze the effects of outright SOMA sales, single-tranche operations, and Treasury bill issuance and redemptions for control and comparison purposes.

Our strongest finding is that changes in the quantity of Treasury securities made available to the market via the TSLF and other actions significantly affect GC Treasury rates, with additions to supply leading to higher rates. In contrast, there is limited evidence of these actions affecting agency and MBS GC rates. It follows that the TSLF and other operations tend to cause agency and MBS repo spreads to narrow via their effect on GC Treasury rates.

Treasury Repo Rate Effects

We first assess the effects of the TSLF and other operations on Treasury repo rates by regressing the daily changes in repo rates on the quantity of Treasury securities made available to (or withdrawn from) the market that day. In examining supply changes, we focus on settlement days, so that in the case of the TSLF, we relate the rate change from operation day Thursday to settlement day Friday to the quantity of securities made available to the market that Friday.

We find that the Treasury supply consequences of the TSLF and other operations have a significant effect on both overnight and one-month Treasury repo rates (see Table 1). Moreover, the effects are of roughly similar magnitude for the various operations, suggesting that each additional $1 billion of Treasury supply causes overnight GC Treasury rates to rise by about 2 bp and term rates to rise by just under 1 bp.[2] Further tests suggest that the previous day's level of the GC rate is not related to the supply effects and that the effects are little changed when one controls for changes in the fed funds rate.

Agency/MBS Repo Rate and Spread Effects

The effects of the TSLF and other operations on other repo rates are less straightforward. To the extent that agency and MBS collateral are substitutes for Treasury collateral, one

* We are thankful to Michal Lementowski and Clara Sheets for their excellent assistance.

[1] Results presented here use repo rate data from Bloomberg and are based on the February 29 to April 4, 2008 period.

[2] We use operation par amounts in this initial analysis.

might expect their repo rates to rise with additions to Treasury supply. In contrast, to the extent that agency and MBS collateral are financed by the Fed, one might expect their repo rates to decline with Fed operations. While we can try to disentangle these effects by examining both effects simultaneously, our results are especially limited in this regard by our small sample.[3] Perhaps as a consequence, we generally find little effect of the TSLF or other operations on agency or MBS rates (results not shown).

The repo spread effects of the TSLF and other operations follow from their effects on the individual rates. That is, increases in Treasury supply cause the agency and MBS repo spreads to narrow via their effect on the Treasury general collateral rate.

Table 1: Effects of TSLF on GC Treasury Repo Rates

Independent Variables	Dependent Variables: Daily Change in:	
Change in Treasuries available to market due to:	Overnight GC Treasury Repo Rate	One-Month GC Treasury Repo Rate
TSLF	1.9***	0.6***
	(0.4)	(0.1)
Bill issuance & redemptions	2.1***	0.8
	(0.4)	(0.5)
Outright sales	1.7	-0.3
	(1.1)	(1.0)
(Constant)	-18.6*	-2.5
	(9.9)	(4.1)
Adjusted R^2	47.1%	29.9%

The table reports the results of regressions of daily changes in the GC Treasury repo rate on changes in the supply of Treasury securities available to the market due to the TSLF, issuance and redemptions of CMBs and 4-week bills, and outright SOMA sales. Supply changes are in billions of dollars and repo rate changes are in basis points. The period of analysis is February 29 to April 4, 2008. Coefficients are reported with heteroskedasticity-consistent standard errors in parentheses. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

[3] The analysis of the effects of collateral financed by the Fed is further complicated by the disparate classes of collateral accepted (i.e., Schedule 1 vs. Schedule 2 in the TSLF).

Empirical Evaluation of the Term Auction Facility

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PRELIMINARY: PLEASE DO NOT QUOTE

The international money markets for trading in short-term securities ran into serious trouble on August 9 2007. The interest rate on overnight loans between banks increased to unusually high levels. In addition, the rates on term inter-bank loans (i.e. loans for maturities of one month or more) rose substantially and transactions in the market declined to the extent that borrowers often could not get money at the posted rates.

In response to the crisis, the Federal Reserve (the Fed) injected large amounts of reserves in order to maintain the effective federal funds rate (i.e. the interest rate on overnight loans between banks) close to its target rate. The Fed succeeded in its objective as the overnight rate came down sharply. However, the term loan rates continued to move up, perhaps reflecting a continued reluctance of banks to lend to each other on a longer term basis. Since they affect interest rates on a wide variety of loans and securities (e.g. home mortgages and corporate loans), unusually high term rates can have disruptive effects on the economy. Moreover, an over-dependence on shorter-term loans can lead to volatility in overnight funding markets. Therefore, the Fed has tried a number of ways to reduce the term rates, in particular by encouraging discount window borrowing.

In this edition of *Current Issues*, we focus on an entirely new way for banks and other financial institutions to borrow from the Fed through the Term Auction Facility (TAF). The TAF provides a pre-specified quantity of longer-term funding (i.e. longer than overnight) to banks and other eligible financial institutions on a collaterized basis at an interest rate determined through auctions. It is designed to provide term funds when the market is not doing so and when the Fed's regular instruments (i.e. open market operations and the discount window) are having little impact on term rates.[1] We describe the genesis of the TAF and the Fed's objectives in introducing it. In order to assess whether the TAF met the Fed's objectives, we examine the impact of the TAF on the term money markets. We conclude with an assessment of the role of the TAF in monetary policy.

Our empirical evidence suggests that money markets benefited significantly from the TAF. In particular, we find that the announcement of the TAF and the subsequent auctions generally reduced the difference between the 3-month LIBOR rate and the overnight-indexed interest rate swap (OIS). The average reduction is more than 7 percent of the average daily spread level in the latter half of 2007, an economically significant amount. Since the LIBOR-OIS spread (simply called "the spread" from now on) is an indicator of lending risk in the term money markets, our results indicate that the TAF mitigated stress in these markets.

We further show that the TAF primarily affected the "liquidity risk" component of the spread rather than its "credit risk" component. This result is intuitive since by distributing liquidity to precisely those banks with the greatest funding needs, the TAF

[1] According to the Fed's announcement, "By allowing the Federal Reserve to inject term funds through a broader range of counterparties and against a broader range of collateral than open market operations, this facility could help ensure that liquidity provisions can be disseminated efficiently even when the unsecured inter-bank markets are under stress." See http://www.federalreserve.gov/monetarypolicy/taffaq.htm.

program enables a more efficient allocation of liquidity in the market. Indeed, the spread reduction from the TAF auctions increases with demand and participation in the auctions. In contrast, increased borrowing from the Fed is unlikely to affect the risk that a bank is unable to honor its financial commitments to other banks (i.e. counterparty credit risk). Finally, we find that publication of the auctions results is associated with significant changes in liquidity risk. Thus, the auctions provide the additional function of revealing useful information about the underlying demand for and supply of funds to market participants.

Consistent with the idea that the TAF auctions generate new information, we find that the interest rate volatility increases temporarily on announcement and in two of the subsequent four auctions. We suggest that the increased short-term volatility may be an outcome of a temporary increase in aggregate funding uncertainty as some auction participants are unable to meet their funding requirements at the auctions (having bid a rate that is too low). Alternatively, the Fed's actions may generate additional trading in the money markets, resulting in greater volatility.

In addition to examining the Fed's actions, we further examine the TAF auctions of the European Central Bank (ECB). While the ECB auctions also resulted in spread reductions, there are some differences with the US experience. In Europe, spread reductions occurred later than in the US, with the strongest effect in the more recent auctions.

Credit and Liquidity Risk in Money Markets during the Second Half of 2007

While problems in the mortgage markets had surfaced earlier in 2007, things came to a head on August 9 2007 when the French investment bank BNP Paribas announced that it could not value assets that were backed by risky mortgages in three of its investment funds. The news immediately impacted the inter-bank money markets in Europe and the U.S as the spread and the interest rate volatility spiked on August 9 2007. In the 3-month maturity, for example, the average spread jumped from about 8.50 basis points before August 9 2007 to more than 70 basis points afterwards, while the average volatility increased from 55 to 185, between in the same period (Figure 1). These numbers pertain to rates denominated in US dollars, but other G-10 currencies show similar behavior.

Problems with structured finance products (such as those backed by mortgages) spread to the money markets as commercial banks used off-balance sheet entities to invest in these products. Banks provided standby letters of credit and other implicit or explicit guarantees to the entities in case the latter required short term borrowing on an emergency basis. As the structured finance markets unwound in the fall of 2007, banks lost what had been a consistent source of funding. Further, banks expected that their lines of credit to the off-balance-sheet entities would likely be drawn down. Thus, there was likely to be a large increase in the expected future demand for bank funds without a comparable increase in the supply of funding. The large imbalance between the supply of and the demand for longer-term loans resulted in a liquidity problem.

In addition to these increased funding or liquidity risks, banks suffered the risks of low-quality assets being brought onto their balance sheets. Therefore, generalized concerns about counterparty credit risks increased dramatically. Thus, lenders became more concerned both about the risks of reduced liquidity in the market and about the credit risks associated with the commercial banks.

The initial set of concerns about counterparty risk and ability to access future funding in turn exacerbated conditions in the term money markets. Term premia on unsecured inter-bank funding markets increased and volume decreased; funding terms became progressively shortened. Banks with excess funds did not step in with lower rates as a result of the credit and liquidity concerns. In addition, banks typically demand higher levels of reserves at year-end as they face increased funding pressures.[2] This heightened banks' reluctance to lend at term during late November and early December of 2007 even more so than in recent years. Many market participants reported extremely tight money market conditions as indicated by elevated spread levels at the turn of the year (Figure 1).

It appears that the problems that surfaced in the summer of 2007, and continue as of writing, may have partly increased credit risk, and partly liquidity risk. We decompose the spread into a credit risk and a liquidity risk component in order to separately examine the behavior of each component (see appendix A, where we describe this decomposition). The credit risk component is estimated from 2-year CDS prices for 21 large banks. The liquidity risk premium is the residual (i.e. the total spread minus the credit risk premia). In 2007, the liquidity risk component increased from about 25 percent of the spread (2 of 8 basis points) to more than 60 percent (26 of 70 basis points) after August 9 (Table 1). This shows the increased prominence of liquidity risk, relative to credit risk, for the period August 9 to December 31 2007. There was a dramatic change in 2008 as a large part of the spread became credit risk alone.

The correlation matrix of the spread and its components further shows the increased prominence of the liquidity component of the spread since August 9 (Table 2). In particular, prior to August 9, the overall spread moved mainly in line with its credit risk component (correlation of 0.77). However, this correlation drops to 0.47 for August 9 to December 31 2007. In contrast, the correlation between the spread and its liquidity component increased from -0.49 before August 9 to 0.88 afterwards. Moreover, the correlation between the credit and liquidity premia drops from -0.93 before August 9 to essentially zero for the rest of 2007.

Our result is in broad agreement with a recent study (see Bank of England [2007]) that finds heightened credit risks to have been only a small portion of the increase in the three-month LIBOR rate in the last two quarters of 2007. The IMF also comes to a similar conclusion in its Global Financial Stability Report (see IMF [2008]). Therefore, the evidence suggests that the majority of the increase in spreads was attributable to an increase in liquidity risk, rather than an increase in default risk.

[2] The increased funding pressures relate to seasonally higher economic activity, and to banks' regulatory and tax-related desires to "clean up" their balance sheets.

We next turn to a description of the Fed's action designed to improve liquidity conditions in the term money markets. In particular, we describe the implementation of the Term Auction Facility (TAF).

The Term Auction Facility, and its Anticipated Market Impact

In normal times, the Fed provides reserves almost exclusively through domestic open market operations with a relatively small set of primary dealers. The latter distribute the reserves to the broader economy provided the money markets function well. The willingness of banks to lend to one another is based on their decisions about the credit worthiness of their counterparties, as well as on their own ability to access funding markets. The "normal" mechanism can cease to work during crisis periods with a sudden reduction in the ability or willingness of banks to distribute reserves through inter-bank transactions, thus disrupting funding markets and posing risks to financial stability. For example, banks of good credit quality may decide to lend less at term because they are less certain about their ability to raise funds in the future. Consequently, banks may have limited access to term funds even if they are willing to pay high rates.

The Fed may be particularly suited to provide liquidity in crisis situations. Banks are reluctant to lend at such times due to their inability to know their own funding needs. In contrast, the Fed knows its own funding needs to a greater degree of precision.[3] Accordingly, the Fed implemented a new tool, the TAF, to directly provide financially healthy banks the opportunity to borrow term funds in an auction against a broad range of collateral instruments. Under a TAF, loans to eligible depository institutions are arranged through the discount window in an aggregate amount set by the Fed, but distributed across institutions at quantities and rates determined through an auction process.

To the extent that it is successful in attracting participation, the TAF has the potential to mitigate banks' funding risks from tight liquidity conditions in the term money markets. If banks obtain funds more readily, the need to sell assets quickly in distressed conditions is reduced. If the Fed is willing to lend to banks against broad collateral, the financial markets might also be more comfortable with the quality of bank assets as collateral.

Anticipated Market Impact of the Term Auction Facility

The TAF is expected to increase banks' ability and willingness to provide term credit to others in three ways: by directly providing term funds to banks with the greatest needs; by encouraging banks to avail of the funding; and by providing liquid collaterals.[4]

The Fed has allocated funds by holding nine auctions as of writing, with the most recent auction occurring on April 8, 2008. To date there have been nine auctions--- two $20

[3] This is partly because the Fed's liabilities (such as bank reserves) are statutorily determined. Moreover, its assets are liquid.

[4] This discussion does not consider any broader impact that use of the TAF might have on banks' perception on the availability of liquidity coming from the Federal Reserve.

billion auctions, four $30 billion auctions and three $50 billion auctions. In this paper, we consider the first five auctions. The Fed has stated that it will continue to hold these auctions "for as long as necessary to address elevated pressures in short-term funding markets."

It is worth noting that the Fed did not act alone but in coordination with other central banks such as the ECB and the Swiss National Bank. The coordinated auction of dollars likely benefited US financial institutions by alleviating the demand for dollars by foreign financial institutions.

The Fed's objectives in running its auctions are to increase the supply of longer-term funds directly available to banks and to help precisely those banks in greatest need, but without the Fed taking on significant credit risk.[5] Banks with the highest default risk need not be those with the greatest funding needs since some banks mostly borrow in the market (i.e. they typically generate more loans than deposits) while others mostly lend. A firm that typically borrows might be financially sound yet suffer greater stress from the crisis. The Fed's hope is that the auctions will prove particularly beneficial to those banks who typically borrow in the wholesale funds markets.

The market-determined rate and the auction format are designed to overcome the stigma of the traditional discount window format and encourage banks to participate in the auctions. Partly because the discount rate is higher than the money market rates, the market tends to attach a "stigma" to discount window borrowers (i.e. they are perceived to have credit issues and reduced ability to borrow through normal market channels). The "stigma" discourages participation and reduces the effectiveness of the Fed's actions. By setting an attractively low minimum rate in the auction the Fed hopes to generate a reasonably high level of participation. In addition, the auction format makes it easier to hide participant identities compared to discount window borrowing. Since funds at auctions are released to winning bidders simultaneously, the stigma of going first would be removed.

The acceptance of a broad range of collateral permits banks to retain a more liquid balance sheet than otherwise. Banks borrow directly from the Fed, using the assets they hold at the Fed as collateral. These assets, while often difficult to value,[6] represent a total amount of collateral worth roughly $1 *trillion*. By contrast, loans outstanding from the Fed are typically $400 *million* or so. To offset the impact of the TAF on its balance sheet, the Fed increases the supply of Treasury securities, and possibly agency and agency mortgage-backed securities, held by the private sector, the types of assets in greatest demand during times of financial turmoil. This should foster more liquid conditions for a broader range of institutions than just primary dealers and banks.

[5] The Fed is required to systematically monitor banks' financial health as part of its normal regulatory duties. It may also be better able to evaluate the creditworthiness of banks compared to the private market because it has exclusive knowledge of the so-called CAMELS ratings that measure banks' credit quality and general financial health. Finally, the Fed knows the types of collaterals that banks hold with it.

[6] 70 percent of the assets are commercial loans; there are also AAA rated mortgage-backed securities. The nature of these securities may make them difficult to use as collateral for private loans.

It is important to note that total liquidity (i.e. reserves) in the system is unchanged since the Fed offsets or sterilizes the injection of funds at auctions. However, the *allocation* of liquidity among banks is made more efficient by the auctions. As discussed above, banks with the greatest funding needs should be the most aggressive participants in the auctions. Since resources move to institutions with the greatest needs, we expect the marginal cost of funding in the term markets to be lower.

In contrast to the effect of TAF on liquidity, we do not expect it to have a major effect on counterparty risk since the latter is primarily determined by the value and risk of banks' assets. In the current situation, much of the change in asset value is likely determined by valuation in the mortgage and structured finance markets. In general, therefore, we expect the TAF to mostly impact the liquidity rather than the credit component of the spread.

Unlike spreads, the predicted effect of the TAF auctions on interest rate volatility is ambiguous. On the one hand, we might expect the volatility to decrease to the extent that the auctions result in greater funding certainty. However, the auctions may actually lead to a decrease in funding certainty, at least in the short run. This is because the auctions make funds available for the auction winners but not for the auction losers. If many participants are unable to meet their short-term funding requirements through the auctions, uncertainty is created with near-term funding imbalance in the market.[7] Further, the Fed's actions may induce greater trading in the money markets, resulting in greater volatility. Finally, the announcement of the TAF program itself may reveal information about the economy. If investors disagree on the interpretation of the news, greater aggregate uncertainty may be observed.

To summarize, the operation of the TAF could ease strains in the term inter-bank market in the following ways:

- by providing funding to banks with the greatest needs
- by enabling a large number of credit-worthy banks to avail of the funding
- by reducing the relative scarcity of liquid collateral in the financial system, and
- By reducing banks' uncertainty about their ability to access funding in the future. However, the auctions themselves may generate greater short-term volatility.

Effect of TAF on Libor-OIS Spreads and Interest Rate Volatility

The TAF program was implemented to mitigate stresses in the short term inter-bank funding market. To determine whether the program succeeded in relieving the funding pressures, we assess the effects of TAF on changes in the 3-month LIBOR-OIS spread.[8]

[7] However, it is also possible that banks that bid low in the auctions (and so do not receive funds) had no need for funds in the first place. Instead, they were bidding strategically to obtain lower cost financing than they could obtain elsewhere.

[8] We do not use the level of the spread since the latter is highly persistent. Formally, we cannot reject the hypothesis of unit roots in the spread levels at the 1% level of significance. Thus, the use of levels may lead to spurious results.

The LIBOR is meant to capture rates paid on unsecured inter-bank deposits at large, international banks; these rates reflect counterparty credit risk as well as liquidity factors. The OIS rate reflects the average overnight inter-bank rate expected over that maturity but is perceived to have lower credit and liquidity risks compared to LIBOR.[9] Thus, the difference between the two rates is taken to be a measure of credit and liquidity risks in the money markets.

A change in the spread may occur for reasons unrelated to the TAF---e.g. due to positive macroeconomic news. Therefore, in examining the effects of TAF on the spread, we take into account the volatility of interest rates which is a measure of aggregate uncertainty.[10] The spread and volatility have become more strongly correlated since August 9, 2007 (see Figure 2) reflecting investors' heightened sensitivity to risk in the short term funding market during the recent period.

If the TAF relieves funding stress, then we expect the spread to decline as a result of the TAF auctions. If investors anticipate such a benefit, then some reduction may occur on December 12 2007, the day the TAF program was announced (the "announcement day"). We regress the change in the spread on the change in volatility and dummy variables for the TAF announcement day and auction dates.

We find that TAF is associated with an average decline of about 5 basis points in the overall LIBOR-OIS spread. However, the effect has varied considerably across the different auctions (Figure 3).[11] The strongest effect was on the auction of January 14 2008 when the spread fell by almost 20 basis points and on the announcement day when the spread fell by about 7.5 basis points. Spreads fell by 1.40 basis points on the December 20 2007 auction and by 2.50 basis points on the February 11 2008 auction. In contrast, there was no statistically significant effect on spreads for auctions held on December 17 2007 (the very first auction) and January 28 2008. The weak effect from the first auction may derive from the fact that much of the impact had already occurred on announcement day.

Next, we examine the effects of the TAF separately on the credit and liquidity components of the spread. As discussed previously, we expect the main effect of the TAF to be on the liquidity component of the spread. The results bear out our expectations (Figure 4). On the announcement day, the liquidity and credit premium dropped 4.70 and 2.80 basis points, respectively. On the auction dates, virtually the entire reduction in spreads is on account of its liquidity premium. For example, on December 20 2007, there is no statistically significant change in the credit risk premium but the

[9] The OIS rate reflects lower counterparty risk because swaps do not involve exchange of principal and they are backed by collateral. OIS contracts involve no initial cash flows and thus are expected to have low liquidity risk. See Michaud and Upper (2008) for further discussions.

[10] The volatility is calculated using options on the 3-month Eurodollar interest rate futures contract.

[11] Whenever we mention a specific change in the variable (e.g. "the spread fell by 2 basis points"), the change is estimated to be statistically significant at the 1% or 5% levels.

liquidity premium drops 1.60 basis points. On January 14 2008, there is a substantial reduction of 18.5 basis points in the liquidity premia while the credit risk premium drops by less than one basis point.

Does the TAF have any effect on funding uncertainty? To address this issue, we study its impact on the interest rate volatility.

Effect of TAF on Interest Rate Volatility

We repeat the previous analysis for the Eurodollar implied volatility by regressing volatility on spreads and the TAF auction and announcement dates. On average, there is an increase in volatility on days of TAF announcement and auctions. However, the effect varies from auction to auction, perhaps because the aggregate funding risk also changes over time (Figure 5). There is a substantial increase in volatility on the day of the TAF announcement, consistent with investors viewing it as a negative signal for the economy. Volatility is also significantly higher on the January 14 2008 auction date and (by smaller amounts) on the December 20 2007 and February 11 2008 auction dates. In contrast, the December 17 2007 and January 28 2008 auctions are associated with a decrease in volatility.

Considering the spread and volatility results together, days with large spread reductions also appear to be associated with the most increase in volatility. The auctions may increase funding uncertainty since losing bidders are unable to obtain funding at the auction and need to seek out alternative funding sources in the future. In the next section, we examine the auction results in detail in order to shed more light on this topic.

Effects of Auction Characteristics

The Board publishes auction results on its web site at 10 a. m. on the notification date, which is typically the day after the auction.[12] We find that the liquidity component of the spread is lower by almost 4 basis points on the notification date.

The published results contain data on various parameters of the auction: the total propositions submitted, the stop-out rate, the bid/cover ratio, and the number of bidders. A higher stop-out rate, relative to the 1-month OIS rate, indicates that banks are willing to pay more for funding at the auctions, likely because the availability of funds from normal channels is lower. Consequently, the auctions are likely to be more beneficial to banks and the spread is likely to be lower. Consistent with this idea, we find that every basis point increase in the stop-out rate, relative to the OIS rate, results in a reduction of 8 basis points in the liquidity premium. There is no effect on the credit component of the spread. Similar to the stop-out rate, a *higher* amount submitted may indicate that banks have greater need for funds. Indeed, we find that a higher amount submitted is associated

[12] We exclude days when there is a second monetary policy announcement by the Fed. The first auction of December 17 2007 was an exception whereby the notification date was two days later on December 19 2007.

with a lower liquidity premium on the notification date, while there is no significant effect on the credit risk premia.[13]

Next, we consider the auction bid parameters: the bid/cover ratio and the number of bidders. A higher bid/cover ratio or an increased number of bidders are evidence of broader participation in the auctions. As more banks avail of funding, the positive impact on the spread is likely to be greater. Our results support this idea: we find that the bid parameters have a negative effect on the liquidity premia. Thus, strong demand at auctions may signal a lowering of liquidity-related risk.

Generally speaking, the details of the auctions results appear to be highly informative of the spread and volatility. Greater participation in the auctions and indications of high demand tend to have a positive impact on the liquidity component of the spread. There is no effect on the credit risk premia or on volatility. Thus, the auctions provide the additional function of revealing useful information about the underlying demand for and supply of funds to market participants.

Effects of Auction Announcement and Settlement Days

We examine the effect of individual auction dates on the spread and volatility. Details of the individual auctions are typically announced on the Friday before the Monday auction date.[14] We do not find that the auction announcement dates have an effect on either the credit or liquidity components of spreads. However, we find that volatility increases on the announcement day which may be due to the increased uncertainty from auction outcomes (i.e. the availability of fund for auction winners, and the lack thereof for auction losers). Since a greater amount offered (revealed by the Fed along with the auction date) decreases the likelihood that participants are unable to meet their short-term funding requirements through the auctions, an increased offering amount is expected to have a negative effect on volatility. The results are consistent with this intuition: volatility on announcement day is negatively related to the amount of funding offered at auctions.

Finally, the auctions are settled on the Thursdays following the Monday auction, and we check for a settlement date effect on the spread and volatility. We find none.

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[13] Since the offered amount changed over time (from $20 billion to $30 billion), we also define PACC=Offered amount/Total propositions accepted. We find no relation between the proportion accepted and the spread or volatility.

[14] Dates and offered amounts for the first four auctions were announced on December 12 2007. However, other details (such as the minimum bid rate) were announced one weekday before. The exception is the December 20 2007 auction which was conducted on a Thursday with an announcement date on Wednesday. We omit the announcement date for the December 20 2007 auction as it was also the notification date for the December 17 2007 auction. Announcements are on http://www.federalreserve.gov/newsevents/press/monetary/2007monetary.htm

Are the Effects due to TAF or Are They Spurious?

We provide some further analysis in order to ascertain whether the identified effects on the spread and volatility are associated with the TAF auctions or with factors unrelated to the TAF auctions. One possibility is that spreads may typically fall and volatility increase on days with regular open market operations (OMOs). Thus, we include dates of regular and permanent OMOs and reverse repurchase (repo) programs. We witness a decrease in volatility on reverse repo days but otherwise find that regular or permanent OMOs are not associated with significant changes in spread and volatility. Thus, the market impact of TAF cannot be explained by systemic "OMO effects."

A second possibility is that spread and volatility changes are due to systematic macroeconomic or financial factors and the TAF dates are correlated with changes in these omitted systematic factors. Note, however, that we include the implied volatility of interest rates in our regressions and this should soak up the effect of systematic factors to some degree. Of course, the interest rate volatility may not fully incorporate the systemic changes. To further address this issue, we use two additional systematic factors: changes in VIX, the implied equity market volatility; and a currency-based systematic factor extracted from Libor rates denominated in different currencies.

Since changes in systematic factors are likely to be reflected in VIX, we include the change in VIX in the regressions. For the spread results, we find that inclusion of the VIX variable reduces the significance of those auction dates when there was a marginal effect on the spread. However, we continue to find strong and highly significant impacts on the other dates (in particular, the December 12 2007, January 14 2008 and February 11 2008 auction dates). For the volatility regression, we find that VIX and interest rate volatility are strongly correlated, as may be expected. However, the impact of the TAF dates remains highly significant.

The level of the spread has been declining since December 2007 primarily as a result of a decline in the Libor. This decline occurred not just for the US dollar Libor but for many other currencies as well. We extract the systematic factor from the common movements in the Libor curve denominated in different currencies.[15] For the period since August 9 2007, we find that the first three principal components (PC) explain about 94% of the total variance, with the first PC explaining 78% and the second PC an additional 10% of the total variance. The first PC is a roughly-equal linear combination of all the different Libor series; thus, it may be viewed as a global systematic factor. The remaining PCs appear to be country or region specific factors; for example, the third PC loads positively on the yen and the Danish kroner and negatively on other currencies.

We re-estimate our regressions after including the first three PC and find that the second PC is significant. After inclusion of the PCs, the effect on the liquidity risk premia is no longer significant for the December 20 2007 and the February 11 2008 auctions whereas they were negative and highly significant earlier. For the announcement date and the

[15] In addition to the US dollar Libor, we include the 3-month Libor series in the following currencies: Canadian dollar, British pound, euro, yen, Swiss franc and Danish kroner.

January 14 2008 auction, the effect remains negative and highly significant, although the magnitude of the impact is reduced by one basis point. We repeat the exercise for the credit risk premia and find that the effect of auctions is now negative and significant for the January 14 2008 and January 28 2008 auctions whereas the effect was not significant earlier. Overall, the effect of including the PCs is to mitigate the reduction in liquidity premia but enhance the reduction in credit risk premia associated with the auctions.

As observed earlier, the level of the spread (and in particular its liquidity component) has been declining recently. However, since we explain spread changes and not its level, this should not be a matter of concern. Nevertheless, we include a time trend for 2008 in the liquidity premia regression and find that it is negative but not significant. However, after inclusion of the trend, the effect on the spread is no longer significant for the February 11 2008 auction whereas it was negative and highly significant earlier. For the January 28 2008 auction, the effect remains negative and highly significant, although the magnitude of the impact is reduced from 18 to 17 basis points. Results for credit risk are converse of those for liquidity. The trend in 2008 is for the credit risk premia to increase significantly. Moreover, the January 28 2008 auction is now estimated to have a negative and significant effect on credit risk in contrast to the insignificant effect earlier. The magnitude of the (negative) effect of the January 14 2008 auction increases from 0.20 to 1.06 basis points. In general, these results are consistent with the PC-based analysis.

In summary, the robustness checks generally result in a reduced impact of the TAF on the liquidity premia but a greater reduction in credit risk premia associated with the auctions. However, we continue to observe a significant association between TAF auctions, the Libor-OIS spread and interest rate volatility.

Effect of TAF in Europe

We repeat our analyses for the euro. We use the spread relevant for the euro but we continue to use the Eurodollar implied volatility. The results are somewhat different from the U.S. case (Figure 6). The announcement day effect on the spread is *positive*; so is the effect on the first auction. However, there are strong negative effects from the second auction onwards. Moreover, the strongest effect has been in the January 28 2008 auction.

The explanation may lie in differences in perceptions of the credit crisis in the two continents. In particular, market participants in Europe may have been more skeptical of the need for such large auctions in the initial stages. Subsequently, as the crisis worsened, the market may have revised its views. In addition, differences in auction parameters may also have played a role. For example, in the early auctions, the ECB imposed an additional 17 percent haircut to collateral to offset exchange rate risk, which may have persuaded some banks to participate in the Fed or the Swiss National Bank auctions instead. Finally, there may be a measurement issue in that we are not using the right volatility measure for the euro.

Concluding Remarks

We perform tests of the effects of TAF on the LIBOR-OIS spread in both US Dollars and in Euros. Furthermore, we decompose the Dollar LIBOR-OIS spread into a credit risk component and a liquidity risk component. We find the following:

- The extraordinary increases in the LIBOR-OIS spread following August 9 2007 were not explained by increases in credit risk; we therefore consider these primarily liquidity events. Indeed, virtually all of the spread reduction on auction dates is on account of a decrease in its liquidity risk component.
- Controlling for volatility, the announcement of TAF and the subsequent auctions have substantial and negative effects on the LIBOR-OIS spread. The average spread reduction is 5 basis points, but there is wide variation across auctions ranging from a high of almost 20 basis points on January 14 2008 and (statistically) zero on December 17 2007.
- Interest rate volatility increases on announcement and in two of the subsequent four auctions. The increase in volatility appears to be an outcome of an increase in aggregate funding uncertainty as some auction participants are unable to meet their funding requirements.
- Publication of the auctions results is associated with significant changes in the liquidity component of the spread. Thus, the auctions provide the additional function of revealing useful information about the underlying demand for and supply of funds to market participants.
- The US and European experiences have been somewhat different. In Europe, spread reductions occurred later than in the US, with the strongest effect in the most recent auctions.

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Box A
Decomposition of the LIBOR-OIS spread into a credit-risk premium and a residual

The LIBOR-OIS measures the interest rate premium that a (bank) lender receives to lend funds for the duration of the loan. In the figure below we display the LIBOR-OIS spread for one-month terms in blue. As is clear, the spread widened considerably in late 2007.

Here we attempt to decompose the LIBOR-OIS spread into a credit risk premium and a remainder. In other words, we assume that everything in the spread that is not explained by increased credit risk is considered liquidity risk.

In the late summer of 2007, banks were uncertain of the value of certain securities in other banks portfolios, uncertain of the extent to which and the timing at which both they and other banks would need to bring assets onto their balance sheets (as a result of previous extensions of lines and letters of credit) and faced increased monitoring costs in evaluating collateral. For these reasons, market liquidity was impaired in the inter-bank market.

In addition to the market liquidity problems, credit risks were likely rising as well in the late summer of 2007, as some assets and some banks were known to hold observably riskier positions than they had previously, and their default was judged to be more likely. We wish to measure the extent to which credit risks explain the rapid rise in the LIBOR-OIS spread.

To measure the credit risk premium we use data on prices on credit default swaps (CDS) on 22 large banks. These CDS are of two-year duration, and we use those prices to calculate a default-risk premium for the average of those 22 banking firms for one-month durations for every day from January 1, 2007 to date through January 2008. We believe this set of banks forms a good approximation for the credit risk that underlies a typical one-month Eurodollar loan, as these banks are some of the largest participants in that market. This method follows a similar exercise performed by the Bank of England and reported in their Quarterly Bulletin in December, 2007.[16]

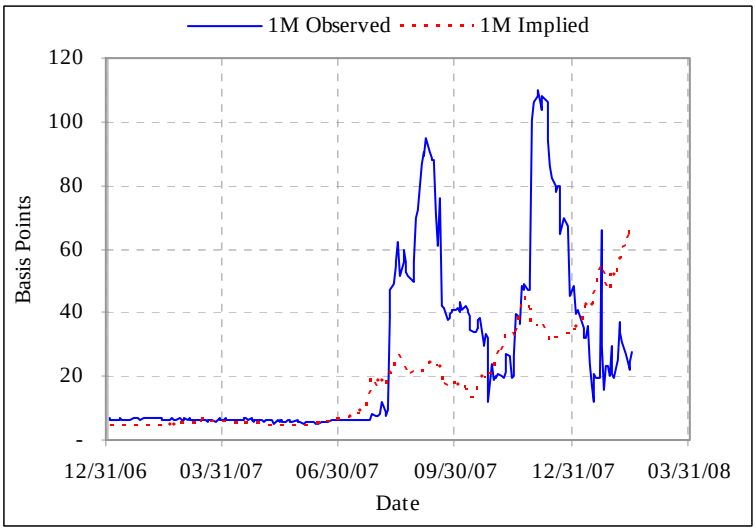
There are a number of assumptions that underlie this decomposition. First, we assume that CDS prices reflect the default probability of the reference entity, the loss given default and some compensation for uncertainty about these factors. Furthermore, we assume that investors recover 40 percent of their deposit in the event of default (however, we have found that the assumption about the recovery rate does not affect the calculated default premium because of the interaction between recovery rate and its effect on the implied default probability). We assume that there are no liquidity premia in the CDS markets. With those assumptions one can calculate an implied (risk-neutral) probability of default for the underlying security by positing a no-arbitrage relationship. This probability is then used to infer a credit spread (above the risk-free rate) that must prevail

[16] "An indicative decomposition of Libor spreads," *Quarterly Bulletin*, December 2007, pp. 498-9, Bank of England. http://www.bankofengland.co.uk/publications/quarterlybulletin/qb0704.pdf

such that a risk-neutral investor is indifferent between investing in a risk-free bond and a risky bank deposit. The overnight index swap (OIS) rate is used to proxy for the risk-free rate.

We show the one-month U.S. dollar LIBOR-OIS swap in the figure below, in blue, and the credit spread in the dashed red line. The difference between these two rates forms our estimate of the liquidity premium in the Eurodollar market, as it is the part of the spread that is not explained by our estimate of credit risk.

The picture that emerges from this exercise is that in August 2007 liquidity risks increased significantly in the Eurodollar market, causing the LIBOR-OIS spread to rise even though credit risks were not perceived to have increased markedly. The second chart below displays our measure of the liquidity premium, shown in the red dashed line. The liquidity premium (and the LIBOR-OIS spread) fell rapidly in late September and October, but reemerged in December. Finally, credit risk premia increased in December and again in January as the LIBOR-OIS spread fell.



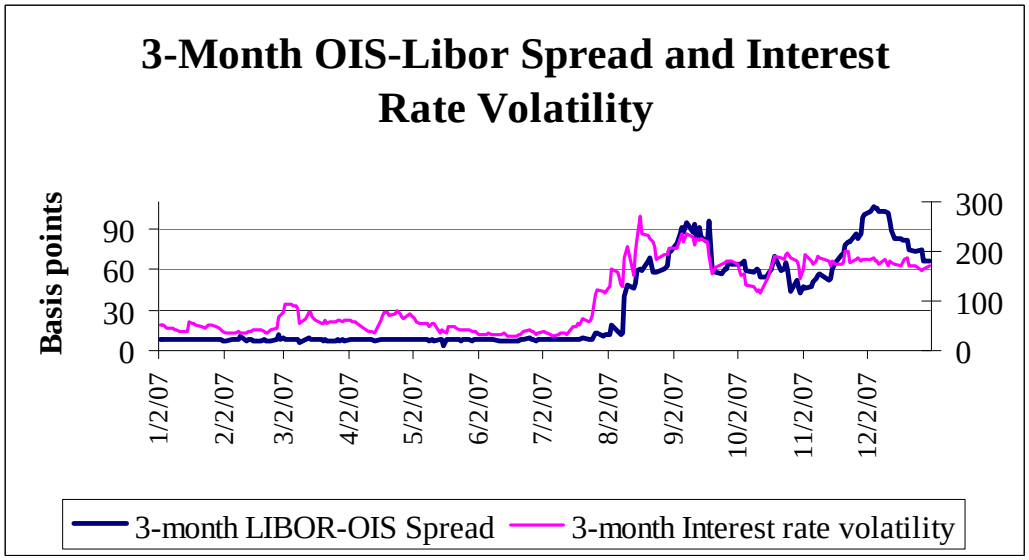


Figure 1: The 3-month OIS-LIBOR spread and the 3-month interest rate volatility.
Note: The 3-month LIBOR data is from Bloomberg. The interest rate volatility is calculated based on the 3-month Eurodollar options.

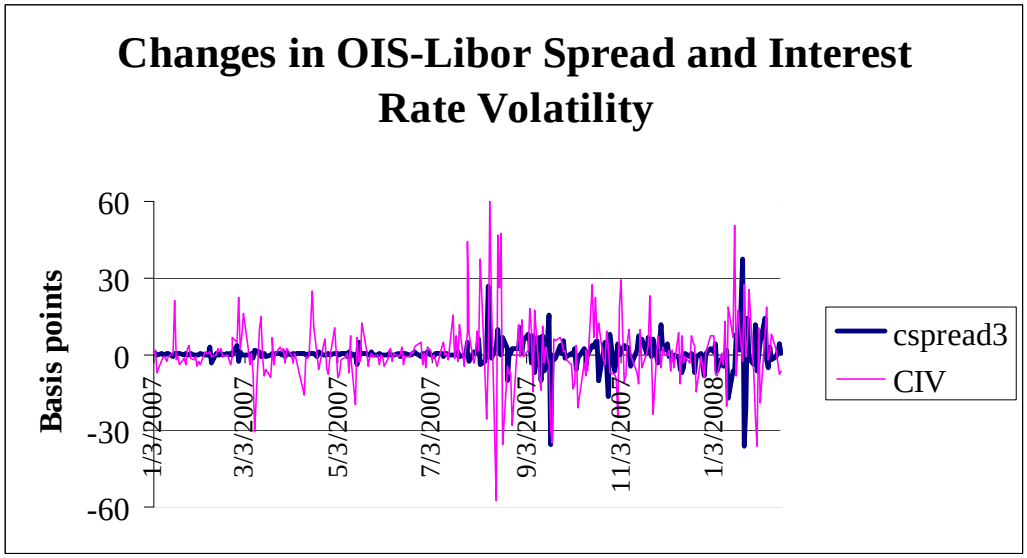


Figure 2: Changes in the 3-month OIS-LIBOR spread and the 3-month interest rate volatility.
Note: Cspread3=change in OIS-LIBOR 3-month spread. CIV=change in the 3-month Eurodollar implied volatility. The 3-month LIBOR data is from Bloomberg. The interest rate volatility is calculated based on the 3-month Eurodollar options.

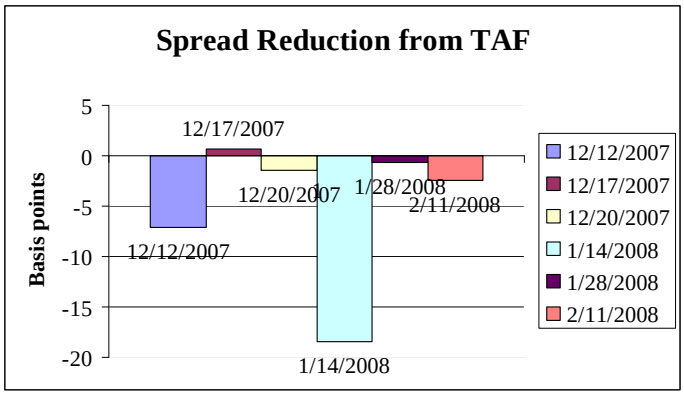


Figure 3: Changes in the 3-month OIS-LIBOR spread on TAF auction dates.
Note: 12/12/2007=TAF announcement date. The remaining dates are the auction dates.

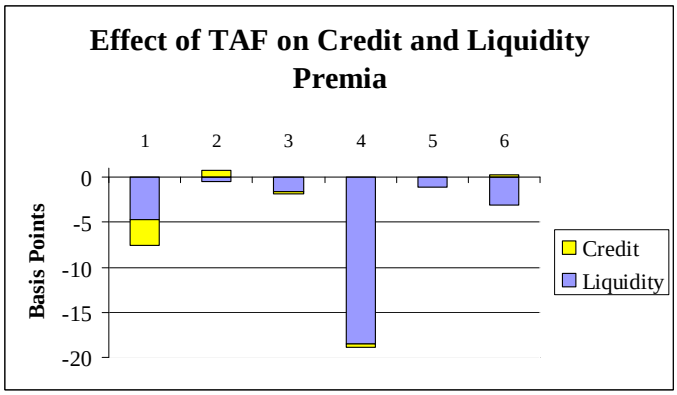


Figure 4: Changes in the credit risk and liquidity risk premia components of the 3-month OIS-LIBOR spread on TAF auction dates.
Note: 1=12/12: TAF announcement date. 2-6 are TAF auction dates. 2=12/17/2007; 3=12/20/2007; 4=1/14/2008; 5=1/28/2008; 6=2/11/2008.

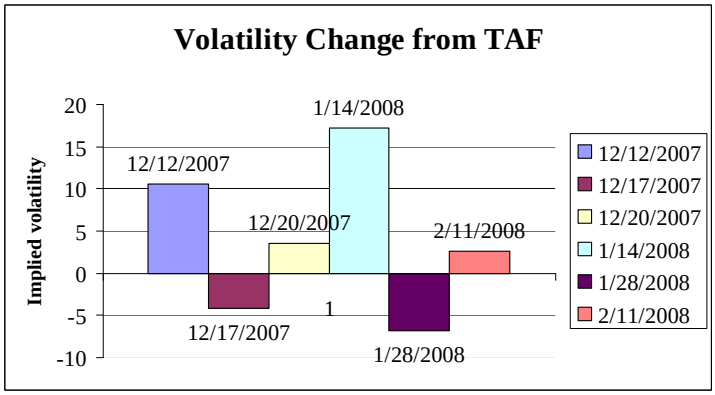


Figure 5: Changes in interest volatility on TAF auction dates.

Note: 12/12=TAF announcement date. The remaining dates are auction dates.

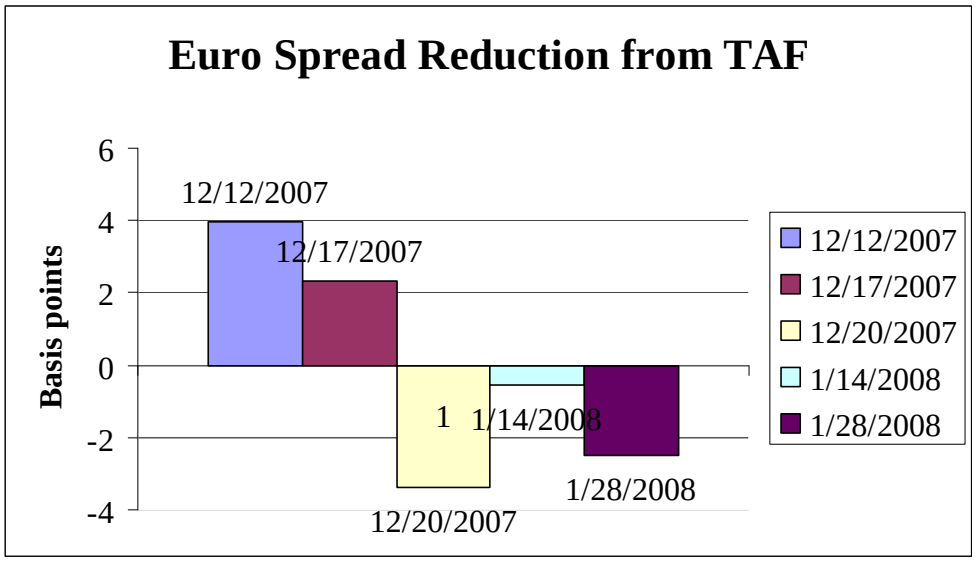


Figure 6: Changes in the 3-month OIS-Euro LIBOR spread on TAF auction dates.
Note: 12/12/2007=TAF announcement date. The remaining dates are the auction dates.

	S	S_liq	S_credit
Pre-Aug 9	8.33	2.03	6.30
Aug 9-Dec 31 2007	70.06	43.93	26.13
Jan 1-Feb 15 2008	49.82	-0.17	49.99

Table 1: Averages of the Libor-OIS Spread and its Credit and Liquidity Risk Components

Note: S=OIS-LIBOR 3-month spread. S_liq=change in liquidity risk component of spread. S_credit=change in credit risk component of spread.

	S	S_liq	S_credit
S			
Pre-Aug 9	1		
Aug 9-Dec 31 2007	1		
Jan 1-Feb 15 2008	1		
S_liq			
Pre-Aug 9	-0.49	1	
Aug 9-Dec 31 2007	0.88	1	
Jan 1-Feb 15 2008	0.87	1	
S_credit			
Pre-Aug 9	0.77	-0.93	1
Aug 9-Dec 31 2007	0.47	-0.01	1
Jan 1-Feb 15 2008	-0.24	-0.70	1

Table 2: Correlation: LIBOR-OIS Spread, its Credit and Liquidity Risk Components

Note: CS=change in OIS-LIBOR 3-month spread. CS_liq=change in liquidity risk component of spread. CS_credit=change in credit risk component of spread.