

## How Did a Domestic Housing Slump Turn into a Global Financial Crisis?

Steven B. Kamin and Laurie Pounder

**Abstract:** The global financial crisis clearly started with problems in the U.S. subprime sector and spread across the world from there. But was the direct exposure of foreigners to the U.S. financial system a key driver of the crisis, or did other factors account for its rapid contagion across the world? To answer this question, we assessed whether countries that held large amounts of U.S. mortgage-backed securities (MBS) and were highly dependent on dollar funding experienced a greater degree of financial distress during the crisis. We found little evidence of such “direct contagion” from the United States to abroad. Although CDS spreads generally rose higher and bank stocks generally fell lower in countries with more exposure to U.S. MBS and greater dollar funding needs, these correlations were not robust, and they fail to explain the lion’s share of the deterioration in asset prices that took place during the crisis. Accordingly, channels of “indirect contagion” may have played a more important role in the global spread of the crisis: a generalized run on global financial institutions, given the opacity of their balance sheets; excessive dependence on short-term funding; vicious cycles of mark-to-market losses driving fire sales of MBS; the realization that financial firms around the world were pursuing similar (flawed) business models; and global swings in risk aversion. The U.S. subprime crisis, rather than being a fundamental driver of the global crisis, may have been merely a trigger for a global bank run and for disillusionment with a risky business model that already had spread around the world.

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\*The authors are economists in the International Finance Division of the Federal Reserve Board. They can be reached at [steven.kamin@frb.gov](mailto:steven.kamin@frb.gov) and [laurie.pounder@frb.gov](mailto:laurie.pounder@frb.gov). The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System. We would like to thank Daniel Beltran, Carol Bertaut, Mark Carey, Marcel Fratzscher, Larry Schembri, Charles Thomas, Frank Warnock, and participants in the International Finance Workshop and Dallas Fed conference, “Capital Flows, International Financial Markets and Financial Crises,” for useful comments and advice. Daniel Silver and Grant Long provided superb research assistance.

## **I. Introduction**

By the spring of 2007, it was clear to all observers that a housing bubble had burst and delinquencies on U.S. mortgages, especially subprime, would be expanding substantially. But there was little recognition that this would seriously threaten the U.S. financial system more generally. And there was even less recognition that the financial crisis would spread, and become just as intense, in the United Kingdom, continental Europe, and beyond.

What led the financial crisis to spread so much more virulently around the globe than most onlookers had anticipated? The simple answer is: the financial system was even more globalized and more interdependent than most of us realized. But what were the transmission channels leading from the United States to the rest of the world?

This paper attempts to address that question. We start by noting that, although the current crisis appears to be the deepest and broadest since the Great Depression, it follows a number of prior international financial crises: the so-called Tequila crisis of 1994-95, the Asian crisis of 1997-98, and the Russian/LTCM crisis of later in 1998. These crises prompted the emergence of a large literature on financial “contagion”, that is, the spread of financial volatility and turmoil in one national market to others.

The contagion literature identified two broad categories of (or, rationales for) contagion (Claessens, Dornbusch, and Park, 2001; Karolyi, 2003). One type, which we would call “direct contagion,” involves co-movements in asset prices and other financial developments that reflect tangible and direct real and financial linkages. Such linkages might involve common shocks (e.g., a surge in oil prices), a recession in one economy that spreads difficulties to other economies via trade relationships, or a major bankruptcy in one country that creates large losses for investors in other countries. In the case of the current financial crisis, such linkages might

include, among others, foreign holdings of toxic U.S. assets and the dependence of foreign financial institutions on dollar funding.

A second type of contagion identified by analysts, which might be called “indirect contagion,” is more of a residual category and comprises all those transmission channels for financial volatility that do not involve the direct real and financial linkages described above. Irrational panics and herding behavior would qualify for this category, and, arguably, such phenomena might have become more likely in an age of instantaneous communication and convergent economic cultures. But as Karolyi (2003) and others point out, there are a host of other transmission channels for financial crisis that, although not associated with direct real or financial linkages, are entirely rational. For example, a crisis in one economy might lead investors to flee other economies with similar characteristics and hence similar potential for losses. This “wake-up call” hypothesis has frequently been cited in the rapid spread of the Asian financial crisis (Goldstein, 1998). Alternatively, a run on the liabilities of financial institutions in one country might generate concerns about the liquidity positions of, and thus runs on, institutions in other countries, even if no adverse information about their fundamental solvency came to light. (Hendricks, Kambhu, and Mosser, 2006) All of these considerations may have been at work in the current crisis.

The relative importance of the transmission channels of financial turmoil is of more than merely academic interest. A wide range of international political bodies are encouraging reforms to financial supervision and regulation, including a heightened emphasis on identifying vulnerabilities and systemic risk in the global financial system. How such risks are identified must depend, in part, on which channels of contagion are most important. For example, if direct financial channels are considered most important, a high priority should be accorded to identifying domestic and cross-border financial exposures, as was recently advocated by Otmar

Issing and Jan Krahen (Financial Times, 2009). Conversely, if the current crisis is believed to more importantly reflect a meltdown in confidence around the world, as investors awoke to the similar vulnerabilities in other countries, crisis identification and prevention might place a greater weight on leverage and liquidity positions, risk management, and market infrastructure.

To date, we are aware of no research that attempts to assess whether direct or indirect channels of contagion have been more important in transmitting the U.S. subprime crisis abroad, but some recent papers have attempted to explain the global incidence of the crisis. IMF (2009) focuses on the transmission of financial stress from advanced to emerging market economies and compares the current crisis to past episodes. Ehrmann, Fratzscher, and Mehl (2009) show that in a sample of emerging market and industrial economies during the crisis, equity prices fell more in those countries with higher “betas” vis-à-vis the United States and weaker macroeconomic fundamentals. Fratzscher (2009) analyzes movements in exchange rates during the crisis and finds that the currencies of countries with weak macro fundamentals and large financial liabilities to the United States experienced larger depreciations. Rose and Spiegel (2009) also study the incidence of the crisis across a broad range of industrial and emerging market economies, but find that few economic, financial, or regulatory characteristics of these economies help explain why some countries were hit harder than others. Eichengreen et.al. (2009) study the evolution of CDS spreads for 45 global banks and find that common factors became more important with the advent of the crisis.

Several other papers also shed light on the international aspects of the crisis. Beltran, Pounder, and Thomas (2008) develop measures of foreign holdings of U.S. asset-backed securities, which were at the core of the crisis. Bertaut and Pounder (2009) describe the effects of the crisis on U.S. cross-border financial flows. Both Bowman and Covitz (2008) and Coffey, Hrung, Nguyen, and Sarkar (2009) document the breakdowns in money market functioning –

including deviations from covered interest parity – that emerged during the crisis and relate them to concerns about credit and liquidity risk. McGuire and von Peter (2009) use BIS banking statistics to identify the evolution of dollar funding needs among international banks.

This paper evaluates the extent to which the “direct channel” of contagion may have played a role in the international transmission of the financial crisis. It differs from some of the research described above in three key respects. First, its primary focus is on the direct financial linkages tying the foreign economies to the U.S. economy and whether the intensity of those linkages explains the extent of financial distress in those economies.

Second, our analysis focuses exclusively on the transmission of the U.S. crisis to the foreign industrial economies. Narrowing the scope in this way is important because until late in the summer of 2008, the crisis was concentrated in industrial countries, with emerging market economies appearing largely unscathed. Additionally, as will be discussed further below, the emerging market economies held relatively little U.S. ABS, thus taking off the table a key direct channel through which the U.S. sub-prime crisis might have spread abroad. Finally, many of the emerging market economies hardest hit by the crisis appeared to be those with large current account and budget deficits (Eastern Europe) or those with the greatest exposure to international trade (East Asia). Our sense is that the determinants of distress in emerging markets might differ significantly from those in industrial economies, a hypothesis we hope to address in future research.

Third, our research focuses squarely on performance within the financial sectors of the countries within our sample—movements of stock prices and CDS spreads for financial institutions—as this is where the crisis first emerged within the industrial economies. Moreover, focusing on the performance of financial sectors may give us a cleaner read on the initial transmission of the U.S. subprime crisis abroad. Movements in broader national equity indexes,

exchange rates, and economic activity likely reflected not only the proximate consequences of the subprime crisis, but also their knock-on effects on trade, sentiment, and wealth as the crisis reverberated throughout the world.

The plan of the paper is as follows. Section II describes estimates of two linkages that are candidates for having been most important in spreading the U.S. crisis abroad: foreign investments in U.S. mortgage-backed securities, and the dependence of foreign financial institutions on U.S. dollar funding. Section III assesses the extent to which these linkages can explain the transmission of U.S. financial turmoil abroad. It evaluates whether countries with greater holdings of U.S. MBS and greater dollar funding needs also experienced sharper deteriorations in the stock prices and CDS spreads of financial firms. Section IV discusses the likely role of indirect channels of causation. Section V considers the implications of our findings for future work on identifying vulnerabilities in the international financial system.

To summarize our key findings, we found scant evidence of a direct channel of contagion spreading the U.S. subprime crisis abroad. True, a year into the crisis, CDS spreads generally rose higher and bank stocks generally fell lower in countries with more exposure to U.S. MBS and greater dollar funding needs. But, with the prominent exception of the relationship between CDS spreads and dollar funding needs, these correlations were not statistically significant and robust. And, more importantly, these relationships failed to explain the lion's share of the deterioration in bank stock prices and CDS spreads that took place during the crisis.<sup>1</sup> This result, surprising as it may seem at first pass, becomes somewhat easier to understand when one considers that, of the \$1.3 trillion in losses taken by foreigners on their holdings of U.S. assets since the crisis began, only \$160 billion in losses stemmed from asset-backed securities.

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<sup>1</sup> Furthermore, it is possible that dollar funding needs should not even be characterized as a "direct channel" of contagion. Insofar as some dollar funding came from non-U.S. sources, it did not always represent liabilities to the U.S. financial system itself. And insofar as dollar funding was part of an overall business model that was overly reliant on short-term funding, it might have been associated with general vulnerabilities rather than direct exposure to U.S. financial problems.

Our findings on the role U.S. MBS holdings and dollar funding needs in the spread of the crisis are not definitive, as much of the available data—especially those on the geographical distribution of U.S. MBS holdings—are less accurate and reliable than we would like. However, we did attempt to correct the data on U.S. MBS holdings for likely sources of inaccuracy, and the adjusted data generally still failed to explain the cross-country pattern of deterioration in bank asset prices. Moreover, even if holdings of U.S. toxic assets and exposure to dollar funding were more important than we were able to document, we still believe that a number of indirect channels stressed in the growing stock of commentary on this crisis were relevant as well: (1) a generalized run on global financial institutions, given lack of information as to who actually held toxic assets and how much; (2) the dependence of many financial systems on short-term funding (both in dollars and in other currencies); (3) a vicious cycle of mark-to-market losses driving fire sales of ABS, which in turn triggered further losses; (4) the realization that financial firms around the world were pursuing similar (flawed) business models and were subject to similar risks; and (5) global swings in risk aversion supported by instantaneous worldwide communications and a shared business culture. At an extreme, the U.S. subprime crisis, rather than being a fundamental driver of the global crisis, may have been more of trigger for a global bank run and for disillusionment with a risky business model that already had spread around the world.

## **II. Direct Exposures of Foreign Economies to the U.S. Crisis**

Over the past decade, there has been a tremendous increase in cross-border financial flows, assets, and liabilities. Figure 1 describes the evolution of the U.S. international investment position. Both gross U.S. claims on foreigners, the blue area, and gross foreign claims on the United States, the red area, have substantially expanded as a share of U.S. GDP. Accordingly,

all else equal, a shock to the U.S. financial system would likely have a greater effect on the rest of the world now than it would have a decade ago.

#### *Foreign exposure to U.S. assets*

In considering the channels that spread the U.S. subprime crisis abroad, we begin by focusing on foreign claims on the United States. Figure 2 shows the diversity of these claims. Had foreign investments been concentrated exclusively in U.S. treasuries, the sub-prime crisis might well have had a more muted effect on foreign markets. But foreigners were buying all kinds of assets, including U.S. corporate bond debt, shown as the brown area, which totaled over \$3 trillion by 2007. And much of that debt represented the asset-backed securities (ABS) which have been at the heart of the current crisis.

The exact size of the exposure of foreigners to U.S. ABS is difficult to determine, in part owing to the complexity of the securitization process, which frequently was multi-staged and often crossed national borders. Table 1 summarizes estimates of foreign exposure as of June 2007, immediately before the financial crisis erupted in force, compiled by Beltran, Pounder, and Thomas (2008). Gross foreign exposure, line 1, represents the total dollar value of foreign holdings of ABS, both those issued in the U.S. and those issued abroad, that are backed by at least some U.S. loans – all together, this represents roughly 2½ trillion dollars, a very substantial sum representing 60 percent of the value of U.S. ABS and 17 percent of total foreign claims on the United States.<sup>2</sup>

Of course, the gross foreign exposure figure exaggerates the ultimate foreign exposure to U.S. ABS. As suggested above, it was common for a given set of loans or ABS to be repackaged into other ABS. In particular, foreign financial institutions frequently purchased U.S. ABS and then repackaged them for further sale. Accordingly, in addition to holding original U.S. ABS,

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<sup>2</sup> In this presentation, foreign exposure to U.S. ABS excludes mortgage-backed securities issued by Agencies (Fannie May and Freddie Mac), which were considered by investors to be quite safe until the spring of 2008.



foreigners often held foreign-issued ABS backed by at least some U.S. ABS. Netting out this foreign repackaging, foreign holdings of U.S. ABS, line 2, are estimated at \$1.2 trillion.

Finally, some of the foreign repackaged ABS was sold back to U.S. residents. Subtracting claims that U.S. residents held on foreigners involving U.S. ABS, net foreign exposure is estimated at \$835 billion, much less than gross foreign exposure but still substantial.

Figure 3 provides a rough cut at the global distribution of foreign holdings of U.S. ABS, focusing on the gross holdings definition shown in line 2 of Table 1. The industrial economies account for the vast preponderance of these holdings, especially Europe. By contrast, emerging market economies held only 7% percent of total foreign ABS claims, with the majority of that held by the offshore centers of Hong Kong and Singapore.

The exposure to U.S. ABS described in Table 1 meant that foreigners would be exposed to losses as the subprime crisis evolved. Depending on the time frame and accounting method, different definitions of exposures are relevant to the determination of these losses. Thus, ultimate losses on U.S. ABS by foreigners, netting out multiple repackagings as well as the claims of U.S. residents on foreigners, would be most closely linked to the \$835 billion in net foreign exposure shown in line 3. Conversely, the gross foreign exposure of \$2.6 trillion shown in line 1 was probably most relevant to the mark-to-market losses subsequently declared by foreign financial institutions, as these losses were based on the fall in asset prices on all holdings, whether repackaged or not.

Table 3 shows that for the largest foreign banks, these writedowns amounted to some \$300 billion by the end of 2008. Although not all these writedowns reflected holdings of U.S. ABS, clearly some of them did, and the concern about the health of foreign financial institutions engendered by these losses obviously contributed to the spreading of the financial crisis beyond U.S. borders.

All that said, the role in the financial crisis of foreign exposure to U.S. ABS should not be exaggerated. Table 2 shows that, if we apply a rather large loss factor of 30 percent to the estimated gross exposure of foreigners to U.S. ABS shown in Table 1, we calculate losses of \$770 billion – this is, of course, a lot of money, but it is still less than 2 percent of foreign bond market capitalization outstanding or foreign equity capitalization, and only about a fifth of the bank capital of the major non-U.S. economies. Applying the 30 percent loss factor to either gross foreign holdings (line 2) or net foreign exposure (line 3) yields much smaller losses still. Accordingly, it is not clear that direct exposure to bad U.S. assets was, by itself, enough to turn the U.S. subprime crisis into a global financial crisis.

In fact, it is ironic that, although the global financial crisis appeared to originate in the U.S. sub-prime sector, losses on U.S. ABS accounted for only a small part of the total losses taken by foreigners on their holdings of U.S. assets. As indicated in Table 4, foreigners experienced some \$1.3 trillion in losses on their portfolio holdings in the United States, but only \$160 billion of those losses were linked to ABS. By far the greatest losses were on their holdings of U.S. common stock.<sup>3</sup>

Below, we take a closer look at this issue by examining the correlation between countries' exposure to U.S. ABS and movements in their financial-sector asset prices.

#### *Foreign exposure to U.S. dollar funding*

Although many foreign policymakers appear to have been surprised by the extent of their institutions' exposure to bad U.S. assets, certainly knowledgeable observers understood that large foreign banks had been heavy purchasers of U.S. ABS, and they were not surprised when foreigners started sharing in the resultant losses. Perhaps more surprising was the exposure of

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<sup>3</sup> We are indebted to Daniel Beltran, Federal Reserve Board, for these calculations, which are based on the TIC surveys of U.S. cross-border liabilities for June 2007 and June 2008.

foreigners to the U.S. sub-prime crisis, not through their claims on the United States, but rather through their dollar-denominated liabilities.

One of the first manifestations of the financial crisis was the seizing up of interbank and other short-term money markets. This is clearly indicated in Figure 4 by the jump in spreads of Libor over OIS rates starting in August 2007. Especially novel and significant was the fact that much of the heightened demand for funding in dollars appeared to be coming not so much from U.S. banks but from foreign banks and other institutions. Aside from considerable anecdotal evidence, a number of market indicators also pointed to these dollar funding pressures, as will be discussed further below. These dollar funding pressures likely not only boosted Libor-OIS rates in dollars but also spilled over into Libor rates in other currencies, as shown in Figure 4. Dollar funding pressures were also associated with a deterioration of functionality in the foreign exchange swap market and deviations from covered interest parity, as discussed by Coffey, Hrung, Nguyen, and Sarkar (2009) and Bowman and Covitz (2008).

Why did foreign institutions have such a strong need for dollar funding? As indicated by the green area in Figure 5, foreign banks had substantially increased their cross-border dollar liabilities in recent years, in part to finance their purchases of dollar assets such as U.S. ABS.<sup>4</sup> Once credit markets seized up, rolling over those liabilities became quite difficult, and because they were in dollars, often with short maturities, foreign central banks had limited scope to improve funding conditions.

Large foreign banks with U.S. subsidiaries were able to respond by tapping U.S. money markets. Figure 6, drawn from Bertaut and Pounder (forthcoming), shows the cumulative changes to cross-border positions of foreign-owned bank subsidiaries in the United States since 2004. This chart is constructed by aggregating confidential micro-data that underlies the U.S.

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<sup>4</sup> See McGuire and von Peter (2009) for a detailed analysis of the data on the dollar-denominated assets and liabilities of foreign banks.

Treasury International Capital (TIC) database. The red line represents the cross-border assets of these entities. After mid-2007, they rose substantially relative to cross-border liabilities, the blue line, presumably as the foreign subsidiaries borrowed in the New York market and on-lent the funds to their parents.

However, smaller regional banks abroad had less access to the U.S. markets and were forced to pay higher rates for funding. As indicated in Figure 7, drawn from Bowman and Covitz (2008), this tiering or market segregation led to increases in spreads between rates in the offshore Eurodollar market and rates in the onshore fed funds market.

It was in response to the pronounced shortage of dollar funding abroad that the Fed and foreign central banks arranged currency swaps designed to permit the foreign central banks to lend dollars into their domestic markets. The amounts outstanding under these swaps ballooned in the fall of 2008, when the intensification of the crisis after the bankruptcy of Lehman Brothers boosted the demand for dollar funding, and the retraction of limits on the swaps for several central bank counterparties boosted the available supply. The provision of dollar funding through this channel appears to have helped ease liquidity conditions in money markets, as evidenced by sharp decline in dollar Libor-OIS spreads shown in Figure 4. It also apparently reduced the need for European banks to raise funding in the U.S. market, as evidenced by the narrowing of the gap between the cross-border assets and liabilities of European subsidiaries in the United States (Figure 6).

### **III. Do Direct Exposures Explain the Contagion?**

As shown in the preceding pages, the strengthening of financial interdependencies, as evident in the expansion of cross-border balance sheets, appears to have contributed to spreading the crisis beyond the United States. Not only were foreign financial institutions exposed to losses on

U.S. sub-prime and other ABS, but their financing of these assets with short-term dollar liabilities exposed them to additional stress as funding markets dried up.

But were these cross-border balance sheet positions the most important factor spreading the U.S. housing crisis abroad? To address this question, we assess whether those countries with the most pronounced exposures to the U.S. sub-prime crisis, in terms of their holdings of U.S. ABS or their dependence on dollar funding, were also those countries whose financial institutions experienced the greatest distress. We first describe the data used in this exercise and present an initial look at relevant correlations. We then outline the results of a more comprehensive econometric analysis.

#### *Data description and basic correlations*

Measures of financial distress To gauge the distress of financial institutions, we focused on two measures: CDS premia and stock prices. For each country, a sample of firms classified as “financials” was drawn from the Markit (a financial information services company) database. Quotes on CDS premia and stock prices were drawn from Markit and Bloomberg, respectively, and, for each country, were averaged across the financial firms, weighted by those firms’ total assets. (Additional details are provided in the appendix.)

Figures 8 and 9 provide an overview of the evolution of CDS premia and stock prices for the financial sectors of the 19 industrial economies in our sample. The impact of the crisis is especially evident in the behavior of CDS premia, which were both very low and tightly clustered prior to August 2007, and which progressively rose and became less well-clustered thereafter. Even so, these spreads exhibited considerable co-movement over the course of the crisis, as did the stock prices for financial firms shown in Figure 9.

Exposure to U.S. ABS To what extent are increases in CDS premia and declines in stock prices among different countries associated with their holdings of U.S. ABS? To measure foreign

exposure to U.S. ABS, we used measures of foreign holdings corresponding to line 2 in Table 1; these are readily available from the U.S. Treasury International Capital (TIC) database, whereas it is more difficult to compile data on gross foreign exposure on a disaggregated national basis. We also focused on foreign exposure to a particular subset of U.S. ABS, mortgage-backed securities (MBS), as these were considered the riskiest assets by investors, especially before the financial crisis started to affect the real economy. (However, the results were not significantly altered when we used data on overall ABS holdings rather than MBS alone.) Finally, to make holdings of U.S. MBS comparable across countries, each country's holdings were scaled by the dollar value of equity capital in that country's banking sector.<sup>5</sup> We discuss below an extension that also examines foreign banks' exposure to U.S. ABS through their sponsorship of ABCP vehicles.

Figures 10 and 11 look at the correlation between holdings of MBS and movements in CDS premia and stock prices, respectively, at two points in time: end-September 2007, soon after the initial eruption of the crisis, and end-September 2008, which followed on the much sharper intensification of the crisis after the failure of Lehman Brothers.<sup>6</sup> Every observation in the scatterplot represents a country. The x-axis measures the country's holdings of U.S. MBS as a ratio to bank capital. The y-axis measures the cumulative change in the average CDS spread (or average stock price) of the country's financial firms since mid-2007.

Three findings are suggested by the exhibits. First, during the initial phase of the crisis, between mid-2007 and end-September, there was no apparent relationship between a country's exposure to U.S. MBS and movements in financial-sector stock prices or CDS premia, as evidenced by the nearly flat bivariate regression lines. Second, over the longer period between

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<sup>5</sup> The results described in this paper were broadly unchanged when MBS holdings were scaled by banking sector assets rather than capital.

<sup>6</sup> Looking at other periods of the crisis, including the period from mid-2007 through the end of 2008, does not change the general findings.

mid-2007 and end-September 2008, more of a relationship is evident: Countries with greater holdings of U.S. MBS experienced larger increases in CDS spreads and larger declines in stock prices, although the relationship is by no means very tight. But, third, holdings of U.S. MBS clearly were not the only factor boosting spreads since the emergence of the financial crisis. Even countries with negligible holdings of U.S. MBS experienced large increases in CDS spreads and reductions in stock prices.

Dependence on dollar funding To what extent were increases in CDS premia and declines in stock prices during the crisis associated with exposure to dollar funding problems? To measure a financial sector's dependence on dollar funding, for each country we computed the banking sector's dollar-denominated cross-border liabilities, divided by the dollar-value of total bank assets.

Figures 12 and 13 present cross-country correlations between this gauge of dollar funding and measures of financial distress. The results are very similar to those shown for exposure to U.S. MBS in Figures 10 and 11: For the initial period through September 2007, there is little apparent correlation between dollar funding and financial distress. For the longer period through September 2008, a greater dependence on dollar funding is associated with larger increases in CDS premia and greater declines in stock prices. But, again, the dollar share of cross-border liabilities clearly was not the only factor weighing on financial institutions, as even those with very low dollar shares were hit hard by the fall of 2008.

An additional measure of financial stress: Libor-OIS spreads As noted above, the financial crisis was marked in its earliest stages by the swift widening of Libor-OIS spreads. There is no consensus on whether this widening reflected increases in perceived credit risk, in liquidity risk, or in capital constraints. (See Bowman and Covitz, 2008.) But in any event, it seems reasonable to assess whether increases in these spreads in different countries might be correlated with those

countries' exposure to U.S. MBS or to dollar funding needs. These correlations are shown in Figures 14 and 15.

Unfortunately, as there is only a single Libor quote for each currency (all euro-area countries share the same quote for euribor) the number of observations is quite small. No relationship between Libor-OIS spreads and measures of foreign exposure to U.S. MBS or to dollar funding needs is apparent, but this may reflect the paucity of observations.

#### *Multivariate analysis*

In order to distinguish the role of U.S. ABS holdings from that of dollar funding needs, and in order to gauge their effects on measures of financial distress more precisely, we estimated some simple OLS regressions. In the equations shown in Tables 5 and 6, the dependent variable is the change in CDS premia for financial firms over the same two periods as shown in the scatterplots in Figures 10-11: end-June to end-September 2007, and end-June 2007 to end-September 2008, respectively. For Tables 7 and 8, the dependent variable is the percent change in stock prices. The explanatory variables include the two variables shown in the scatterplots—the ratio of U.S. MBS holdings to bank capital and the dollar share in cross-border bank liabilities—as well as a number of control variables, described below. We would caution that these equations are not intended to represent full models of CDS spreads or stock prices, but rather are intended as a means to better test the correlations of these measures with variables of interest.

As in the scatterplots, each observation represents data from a separate country, drawn from a specified time period. Because those scatterplots suggested that the relationship between the explanatory variables and the measures of financial distress might be different in the June-September 2007 period than in the longer June 2007-September 2008 period, we decided not to



pool the data into a single panel data set, but rather merely to estimate separate cross-sectional regressions for each period.

The control variables, drawn from the IMF's Global Financial Stability Report and International Financial Statistics, are intended to help explain some of the variation in financial distress across countries, so as to allow us to focus on the residual variation associated with direct linkages to the U.S. financial system. In principle, for a given shock emanating from the U.S. subprime crisis, we would expect stronger financial institutions to experience less distress than weaker ones. Our control variables measure financial strength as follows:

- A higher *ratio of loans/deposits* leaves banks less dependent on volatile wholesale funding, and this should reduce the response to adverse shocks.
- Greater growth in the *loan/GDP ratio* may reflect a credit boom and weakened balance sheets, increasing vulnerability to adverse shocks.
- A higher *share of non-performing loans* (NPLs) in total loans should also weaken balance sheets and raise vulnerability.
- Higher *ratios of bank regulatory capital to risk-weighted assets* and *total capital/assets* should reflect greater strength and lower vulnerability.
- *Bank returns on assets and on equity* may have ambiguous effects; they could imply stronger balance sheets, or they could reflect riskier prior investment decisions.

Table 5 presents the equations for the change in CDS premia during the June-September 2007 period. Consistent with the scatterplots described above, the coefficients on neither MBS holdings nor the dollar funding variable are statistically significant. Accordingly, the rise in CDS premia during this period is unexplained, with the constant having a significant positive coefficient. Owing to the small number of observations, the control variables were entered singly in separate regressions rather than all at once. Notably, only the change in the loans/GDP ratio enters significantly, suggesting that countries experiencing lending booms experienced larger increases in CDS premia. Even so, this variable does not explain the generalized rise in

these premia from before the crisis, as the coefficient on the constant in that regression is little changed.

Table 7 presents the analogous equation for changes in the stock prices of financial firms during the June-September 2007 period. Again, neither MBS holdings nor dollar funding needs are significant explainers of stock prices during this period, and none of the control variables are significant, either.

Tables 6 and 8 focus on the longer June 2007-September 2008 period. Table 6 indicates that, taken separately, both MBS holdings and dollar funding needs are marginally significant explainers of CDS premia during this period. When considered jointly, it is clearly the dollar funding variable that is doing the explaining. The coefficient on the dollar funding variable is statistically significant in most of the equations, and the adjusted R<sup>2</sup> approaches nearly 60 percent or so. Even so, the coefficient on the constant remains large and statistically significant, indicating that most of the rise in CDS premia through September 2008 remains unexplained. The same result applies to the equations for the change in stock prices shown in Table 8, where none of the explanatory variables are statistically significant, so that the fall in stock prices during the crisis is explained exclusively by the constant term.

Finally, we extend the analysis with one additional variable: banks' exposure to U.S. ABS through their sponsorship of asset-backed commercial paper (ABCP) vehicles. Although the majority of ABS were held in the advanced economies, a substantial portion were held in offshore centers. Since many European banks sponsored offshore financing vehicles that held U.S. ABS and issued ABCP to finance those holdings, those banks faced additional exposure to U.S. ABS through their ABCP vehicles. Additionally, sponsorship of ABCP vehicles may have put sponsoring banks at risk of liquidity shortfalls in the event the ABCP could not be rolled over. Therefore, we supplement the regressions with an additional explanatory variable

measuring ABCP issuance by vehicles, aggregated by the home country of the vehicles' sponsors.<sup>7</sup> Similar to MBS, this variable is scaled by the country's banking sector capital. Tables 9 and 10 show the same two dependent variables (bank stocks and CDS spreads) for the period through September 2008. In the bivariate regressions shown in the first column of each table, higher sponsorship of ABCP vehicles is correlated with lower bank stocks and higher CDS spreads, but neither relationship is statistically significant. Including other covariates reduces the significance of the effect further and, in many cases, changes its sign.

### *Summary of results*

Based on our analysis, we would highlight a number of broad findings. First, during the initial eruption of the financial crisis in the June-September 2007 period, we found scant evidence that holdings of U.S. MBS, dependence on dollar funding, or even measures of financial-sector strength helped explain differences in the extent of financial distress experienced by different countries. For reasons that will be discussed in Section IV, below, it appears that in the initial phases of the crisis, financial institutions around the world were tarred with much the same brush.

Second, focusing on the longer period from June 2007 through September 2008 (which includes the intensification of the crisis after the failure of Lehman Brothers in mid-September), countries with greater exposure to U.S. MBS and greater dependence on dollar funding appear to have experienced larger increases in financial-sector CDS premia and larger declines in stock prices. This is consistent with the view that greater exposure to the U.S. sub-prime crisis led to greater financial distress abroad. However, only the linkage between the dollar funding variable and the change in CDS premia was statistically significant.<sup>8</sup> Moreover, most of the deterioration

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<sup>7</sup> The data linking ABCP vehicles to bank sponsors was taken from Arteta, Carey, Correa, and Kotter (2009) and we are indebted to Mark Carey for the idea of applying these data to our analysis.

<sup>8</sup> In these regressions, cross-border dollar liabilities are measured using the BIS locational by residence data: liabilities of banks' foreign subsidiaries are counted in the country where they are located rather than in the country

in both CDS premia and stock quotes was unexplained by the explanatory variables. Thus, as during the initial June-September 2007 period, it is difficult to pin the spread of the financial crisis abroad to direct exposures of foreign financial sectors to the U.S. financial system.

### *Caveats and Robustness Checks*

The results described above tend to undercut the view that direct channels of contagion helped spread the U.S. subprime crisis abroad. Below we describe some important caveats to our findings that are related to certain misleading aspects of the data we use. We then describe adjustments to the data implemented to address some of these shortcomings and assess the robustness of our findings to those adjustments.

First, the dependent variables in our estimated equations—CDS premia and stock prices—are based on available data for selected financial firms in each of the sample countries. However, the data on the key explanatory variables—MBS holdings and dollar share of cross-border liabilities—are only available on an aggregate country-wide basis. Therefore, there could be slippage between movements in the asset prices for our selected subsample of financial firms and those for a country’s aggregate financial sector. In future research, we hope to address this concern by identifying firm-level data on key determinants of financial performance.

Second, our data on foreign holdings of U.S. MBS may not be a reliable proxy for the genuine exposure of foreign financial firms to U.S. MBS: Some of these securities may be held by investors outside the financial sector. Some of the U.S. securities holdings attributed to a particular country in the TIC data may actually be held in custody for investors in other countries; as a consequence of this “custodial bias”, the distribution of U.S. MBS holdings across countries identified by our data may be an inaccurate—and potentially misleading—

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of their parent bank. We also ran regressions in which cross-border dollar liabilities are measured using the BIS locational by nationality data, in which all cross-border liabilities of foreign subsidiaries are attributed to the parent bank. This definition is more consistent with the definition of the dependent variables—CDS spreads and stock prices of the parent banks—but the results are similar and in some cases even show a weaker relationship between dollar liabilities and measures of stress.

measure of the actual distribution.<sup>9</sup> By the same token, the significant holdings of U.S. MBS in offshore centers undoubtedly include exposures of U.S. and European financial firms that cannot be properly attributed. Finally, securities held by foreign subsidiaries of financial firms are attributed to the country where they are held rather than the country of the parent firm. This also creates slippage between the stress measures for a country's firms and the total MBS exposure of those firms across all of their subsidiaries.

At this time there are no alternative sources of data on foreign holdings of U.S. MBS *per se*. However, there is an alternative source of data on foreign holdings of *overall* U.S. long-term securities: the 2007 Coordinated Portfolio Investment Survey (CPIS). Unlike the TIC data, which are drawn from a survey of the external *liabilities* of U.S. residents, the CPIS represents a survey where countries report the external *claims* of their residents. CPIS data should not suffer from custodial bias because countries are typically capable of reporting what securities their residents own, regardless of where they are held in custody. On the other hand, the CPIS does not include disaggregated categories such as ABS or MBS.

Using the CPIS data, we made a number of adjustments to our measures of foreign holdings of U.S. MBS to assess whether the statistical problems discussed above might account for the failure of U.S. MBS holdings to explain the pattern of asset price declines during the crisis. First, because much of U.S. MBS held by foreigners is held in the Cayman Islands and has been re-securitized into instruments subsequently purchased by other foreigners, we added a certain fraction of each foreign country's holdings of Cayman Islands securities (as measured by the CPIS) to their TIC-based holdings of U.S. MBS. Second, to account for the custodial bias problem in the TIC data, we adjusted each country's TIC-based holdings of U.S. MBS by the

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<sup>9</sup> See Bertaut, Grier, and Tryon (2006) for a detailed discussion of issues associated with interpreting the TIC data.

discrepancy between that country's TIC- and CPIS-based holdings of overall U.S. long-term securities. These adjustments are described in detail in Data Appendix 2.

Table A1 in Data Appendix 2 compares the original estimates of foreign holdings of U.S. MBS with the adjusted estimates. For some countries, the adjustment is quite substantial. Even so, the adjusted estimates of U.S. MBS holdings generally are no better able to explain the pattern of asset declines across national banking systems than the original estimates. The first two columns of Table A2 in Data Appendix 2 reproduce the regressions result already presented in Tables 5-8, relating changes in CDS spreads and stock prices to the original measures of U.S. MBS holdings and dollar-funding shares. (The regressions including measures of financial-sector strength are excluded, as these variables generally were not significant.) The next two columns show results for regressions using the MBS holdings data adjusted for claims on the Cayman Islands, while the final two columns are based on MBS data adjusted both for Cayman Islands claims and custodial bias. With the exception of the equations for bank stock prices in the June-September 2007 period, where the adjusted MBS variable becomes weakly significant, the coefficients on the adjusted U.S. MBS variables remain insignificant and often of the wrong sign.

#### **IV. Indirect Channels of Contagion**

In Section III, we found little evidence that direct financial linkages—both foreign exposures to bad U.S. assets and foreign vulnerability to dollar funding pressures—can by themselves explain the transmission of the U.S. financial crisis around the world. Although this finding may in part reflect shortcomings in the available data, notwithstanding our attempt to correct for some of those shortcomings, it is plausible that a number of indirect channels of contagion may have played an important role in turning the U.S. housing slump into a global financial crisis. Without purporting to come up with a definitive list, the following inter-related factors have been cited in

the voluminous and growing number of commentaries on the crisis. Although their focus has generally been the financial market within a country, the close integration of global financial markets suggests these factors were likely important in transmitting financial turmoil across borders as well. <sup>10</sup>

First, although, as noted above, direct exposure to U.S. subprime was not great relative to the scale of the financial system, the complexity and opacity of the new structured investment instruments, including the multiple repackagings of U.S. ABS, made it difficult to identify counterparties' exposure to subprime (Gorton, 2008). This led to a generalized retreat from lending and risk, which in turn engendered a pervasive breakdown of markets.

Second, amid heightened demands for liquidity, financial institutions that depended heavily on short-term funding were subject to runs (Bowman and Covitz, 2008, Gorton, 2009). Following Banque Paribas' announcement on August 9, 2007 that it was no longer redeeming shares in a number of its off-balance-sheet vehicles, for example, the asset-backed commercial paper (ABCP) market seized up overnight as investors feared other such vehicles would follow. Similarly, the demise of Bear Stearns and then Lehman Brothers prompted investors to try to exit while they could. These developments represented clear manifestations of the contagious bank run scenario discussed in the introduction.

Third, in an environment of mark-to-market accounting, initial losses experienced by financial institutions prompted fire sales of ABS, which led to further price declines and amplified losses (Adrian and Shin, 2008a, Caballero and Simsek, 2009). As argued by Beltran, Pounder, and Thomas (2008), mark-to-market losses likely far exceeded ultimate losses on ABS. But financial volatility became increasingly driven by mark-to-market losses, this further attenuating the link between direct exposure to bad U.S. assets and financial turmoil.

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<sup>10</sup> Analyses of the domestic aspects of the crisis, including theoretical papers exploring its fundamental underpinnings, include, among many others, Adrian and Shin (2008a, 200b), Bowman and Covitz (2008), Brunnermeier and Pedersen (2008), Caballero and Simsek (2009), Gorton (2008, 2009), and Lo (2008).

Fourth, it is likely that the “wake-up call” scenario was also an operative channel of contagion. Ultimately, financial paralysis overtook nearly all markets in the industrial world, whether or not they had invested heavily in U.S. ABS. Why? Because the business practices of banks and other financial market participants around the world had become very similar, and aside from investing in U.S. ABS, many aspects of these practices increased vulnerability to risk: excessive leverage, excessive dependence on short-term funding sources, complex and opaque financial instruments, excessive dependence on credit ratings, inadequate (and often ignored) risk management, and lax oversight by supervisory authorities.

Finally, changes in the degree of risk aversion were undoubtedly important in the gyrations of the crisis. In an environment of instantaneous global communications and a shared business culture, the international transmission of movements in investor sentiment likely reinforced the channels of contagion described above. Looking at the evolution of CDS spreads and bank stocks in Figures 8 and 9, the high-frequency correlations seem to reflect more than either common shocks or the transmission of country-specific shocks through direct cross-border linkages. Consistent with this view, Kim, Loretan, and Remolona (2009) attribute the rise in Asian CDS spreads during the crisis more to the repricing of risk than to changes in expected default.

All told, these indirect channels of contagion from the United State to the rest of the world may have been much stronger than the direct channels. In fact, to take this line of thinking still further, it is possible that in today’s globalized financial system, the entire notion of contagion has become irrelevant. The financial markets of the advanced economies have become so integrated that, for all intents and purposes, they form a single market, with shocks to one country—i.e., the United States—seamlessly transmitted throughout the rest of the global market.



The considerations noted above also make clear that vulnerabilities were well entrenched in the financial systems of many advanced economies, rendering them highly sensitive to any number of shocks. From this perspective, some might argue that the U.S. housing slump, far from being a fundamental cause of the global crisis, was more akin to a trigger. This would make its role similar to that of Thailand in 1997, whose devaluation sparked the Asian financial crisis, but could not be construed to have caused that crisis in a more fundamental sense.

## **V. Implications for Future Analysis**

As noted in the introduction, the financial crisis has led to a renewed emphasis on the identification and prevention of systemic risk in the global financial system. There is no consensus on how that task is to be performed. One approach to assessing systemic risk that has attracted attention of late has been the analysis of “interconnectedness” or “network effects”. (See Lo, 2008, and Wells, 2002.) This approach entails looking at linkages among financial institutions to assess the likely effects on the financial system of shocks to one or more participants. It is thus an attempt to operationalize the analysis of direct contagion discussed above.

Although the evidence we have looked at in this paper cast doubt on the importance of direct linkages as a mechanism of contagion in the current crisis, we can think of several aspects of cross-border financial interdependencies that remain quite relevant at present. For example, shocks affecting large, globally connected institutions obviously will have knock-on effects throughout the world’s financial system. Broader questions of financial interdependence also remain relevant. How exposed are Western European banks to financial conditions in the central European economies? Or how dependent are emerging market banks and corporations on continued financing from industrial country financial institutions? McGuire and Tarashev (2008) show how BIS international banking statistics can be used to address such issues.

Questions of international interdependence are particularly germane when applied to emerging market economies, because neither their financial systems nor their relationship to world capital markets have fully matured. But it is not clear whether, in analyzing contagion between major industrial economies, measures of interconnectedness are as relevant. It might be reasonable to assume that the financial systems of the major advanced economies are already highly interdependent, or even that they already comprise a single market. If so, perhaps the relevant question is not whether financial challenges in one major system will spread to others – because they certainly will – but rather, are these other systems sufficiently resilient to maintain their stability in the face of those challenges? Answering this question will not be easy, and will require a greater understanding of the dynamics of confidence and market behavior than we now possess.

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Table 1

## Foreign Exposure to U.S. Asset-Backed Securities (ABS)

	Level (\$billions)	<i>As a percentage of:</i>	
		Total U.S.-issued ABS (\$4.3 trillion)	Foreign Claims on U.S. (\$15.3 trillion)
1. Gross Foreign Exposure*	\$2,565	60%	17%
2. Gross Foreign Holdings*	\$1,190	28%	8%
<i>of which: RMBS</i>	\$725	17%	5%
3. Net Foreign Exposure*	\$835	19%	5%
<i>of which: RMBS</i>	\$650	15%	4%

\*As of June 2007. Includes \$200 billion in whole loans. Excludes securities issued by GSEs. Based on TIC data and other sources.

Source: Beltran, Pounder, and Thomas (2008).

Table 2

## Putting Estimated Foreign Losses on U.S. ABS in Perspective

	Level (\$bill.)	Loss Factor	Loss (\$bill.)	<i>As a percentage of:</i>		
				For. Bond Mkt. Cap** (\$50 tr.)	For. Equity Mkt. Cap** (\$45 tr.)	For. Bank Capital** (\$4 tr.)
1. Gross Foreign Exposure*	\$2,565	30%	\$770	1.5%	1.7%	21%
2. Gross Foreign Holdings* <i>of which: RMBS</i>	\$1,190 \$725	30%	\$360	0.7%	0.8%	10%
3. Net Foreign Exposure* <i>of which: RMBS</i>	\$835 \$650	30%	\$250	0.5%	0.6%	7%

\*Source: Beltran, Pounder, and Thomas (2008)

\*\*As of year-end 2007. Sources: Bank for International Settlements Quarterly Review (2008), Standard & Poor's (2008), and staff calculations.

Table 3

Writedowns by Global Banks (\$ billions)

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	Total Assets	Writedowns
18 Largest U.S. Banks	10673	291.0
57 Largest European Banks	44678	277.4
6 Largest Japanese Banks	4513	17.4
5 Largest Canadian Banks	2253	11.9

Source: Bloomberg (as of January 1, 2009).

Table 4

## Estimates of Foreigners' Valuation Losses on Portfolio Holdings of U.S. Securities

	Valuation Change		Position in June 2007	
	July 2007 - June 2009		Amount (\$, billions)	Share of Total (Percent)
	Amount (\$, billions)	Price Change*		
1. Corporate ABS	-160	-16.1	902	9
Selected other assets:				
2. Common stock	-1,171	-40.4	2,670	27
3. Corporate non-ABS	-221	-9.9	1,835	19
4. Agency non-ABS	50	6.4	735	8
5. Agency ABS	44	6.8	570	6
6. Long-Term Treasuries	154	7.4	1,965	20

Source: Staff estimates using June 2007 and June 2008 liabilities surveys and Bloomberg.

\* Includes the effects of reallocations within security classes during the period, and excludes the effects of reallocations among security classes.



Table 5  
**Change in CDS Spreads of Financial Firms**  
*June 2007 to September 2007*

US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>	1.105 (0.05)	-11.506 (0.32)	-27.530 (0.78)	-11.673 (0.37)	-3.230 (0.08)	-7.896 (0.23)	-12.423 (0.30)	-20.094 (0.53)	-13.170 (0.35)	
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	-0.404 (0.04)	11.510 (0.60)	16.313 (0.90)	4.012 (0.24)	12.144 (0.62)	9.953 (0.56)	12.377 (0.50)	19.032 (0.90)	11.536 (0.59)	
Deposits/Loan Ratio <sup>‡</sup>			-6.168 (1.64)							
Change in Loan/GDP Ratio <sup>‡</sup>				18.098 (2.32)**						
Non-performing loans/Total loans <sup>‡</sup>					0.652 (0.70)					
Bank Regulatory Capital/Risk Weighted Assets <sup>‡</sup>						-2.071 (1.71)				
Bank Capital/Assets <sup>‡</sup>							0.078 (0.06)			
Bank return on assets <sup>‡</sup>								4.721 (0.86)		
Bank return on equity <sup>‡</sup>									0.177 (0.57)	
Constant	18.524 (7.56)***	18.922 (11.62)***	19.187 (7.48)***	25.107 (5.79)***	16.480 (6.63)***	17.307 (4.60)***	43.847 (2.99)**	18.755 (2.40)**	15.632 (3.21)***	16.616 (3.17)***
Observations	17	17	15	15	15	15	15	15	15	15
R-squared	0.00	0.00	0.03	0.22	0.35	0.07	0.23	0.03	0.09	0.06
R-squared adjusted	-0.07	-0.07	-0.13	0.01	0.17	-0.18	0.03	-0.23	-0.15	-0.20

Absolute value of t statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007; ‡ - December 2006

Note: Total assets are average of 2006 and 2007 annual data.

Table 6  
**Change in CDS Spreads of Financial Firms**  
*June 2007 to September 2008*

US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>	458.602 (2.94)**	674.212 (3.64)***	656.594 (3.28)***	673.749 (3.67)***	747.229 (3.94)***	676.112 (3.49)***	669.158 (3.20)***	730.938 (3.86)***	681.747 (3.55)***	
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	155.513 (1.86)*	-107.317 (1.10)	-102.037 (1.00)	-128.010 (1.30)	-101.724 (1.07)	-108.137 (1.07)	-102.541 (0.81)	-157.002 (1.49)	-107.434 (1.07)	
Deposits/Loan Ratio <sup>‡</sup>			-6.782 (0.32)							
Change in Loan/GDP Ratio <sup>‡</sup>				49.947 (1.09)						
Non-performing loans/Total loans <sup>‡</sup>					5.751 (1.27)					
Bank Regulatory Capital/Risk Weighted Assets <sup>‡</sup>						-1.091 (0.16)				
Bank Capital/Assets <sup>‡</sup>							0.427 (0.06)			
Bank return on assets <sup>‡</sup>								-31.183 (1.15)		
Bank return on equity <sup>‡</sup>									-0.801 (0.50)	
Constant	104.740 (6.54)***	134.810 (11.05)***	102.795 (7.89)***	109.304 (4.47)***	95.326 (6.51)***	86.205 (4.73)***	115.783 (1.39)	100.415 (2.53)**	126.277 (5.23)***	114.436 (4.28)***
Observations	17	17	15	15	15	15	15	15	15	
R-squared	0.37	0.19	0.61	0.62	0.65	0.66	0.61	0.61	0.65	0.62
R-squared adjusted	0.32	0.13	0.55	0.51	0.55	0.57	0.51	0.51	0.56	0.52

Absolute value of t statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007; ‡ - December 2006

Note: Total assets are average of 2006 and 2007 annual data.

Table 7  
**Change in Stock Prices**  
*June 2007 to September 2007*

US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>	-0.883 (0.02)	-16.244 (0.28)	-27.424 (0.42)	-22.396 (0.38)	-8.130 (0.13)	-16.334 (0.27)	-12.968 (0.20)	-24.041 (0.40)	-11.359 (0.19)	
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	12.696 (0.61)	0.452 (0.02)	4.430 (0.15)	-2.705 (0.10)	1.070 (0.04)	0.487 (0.02)	-2.738 (0.07)	8.805 (0.30)	-5.636 (0.20)	
Deposits/Loan Ratio <sup>‡</sup>			-3.632 (0.47)							
Change in Loan/GDP Ratio <sup>‡</sup>				17.155 (1.01)						
Non-performing loans/Total loans <sup>‡</sup>					0.639 (0.36)					
Bank Regulatory Capital/Risk Weighted Assets <sup>‡</sup>						0.062 (0.02)				
Bank Capital/Assets <sup>‡</sup>							-0.305 (0.12)			
Bank return on assets <sup>‡</sup>								8.154 (0.81)		
Bank return on equity <sup>‡</sup>									0.474 (0.85)	
Constant	-2.611 (0.55)	-4.142 (1.24)	-2.951 (0.64)	0.608 (0.07)	-5.264 (1.02)	-4.794 (0.68)	-3.689 (0.12)	-1.240 (0.08)	-9.388 (1.02)	-10.226 (1.05)
Observations	18	18	16	16	16	16	16	16	16	16
R-squared	0.00	0.02	0.01	0.03	0.09	0.02	0.01	0.01	0.06	0.07
R-squared adjusted	-0.06	-0.04	-0.14	-0.22	-0.14	-0.23	-0.24	-0.24	-0.18	-0.17

Absolute value of t statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007; ‡ - December 2006

Note: Total assets are average of 2006 and 2007 annual data.

Table 8  
**Change in Stock Prices**  
*June 2007 to September 2008*

US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>	-121.823 (1.78)*	-66.700 (0.74)	-22.892 (0.24)	-70.047 (0.75)	-102.573 (1.07)	-72.415 (0.80)	-79.733 (0.78)	-68.535 (0.72)	-64.253 (0.68)	
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	-46.147 (1.34)	-51.789 (1.25)	-67.376 (1.58)	-53.506 (1.23)	-54.524 (1.32)	-49.578 (1.19)	-39.100 (0.67)	-49.823 (1.08)	-54.839 (1.23)	
Deposits/Loan Ratio <sup>‡</sup>			14.232 (1.24)							
Change in Loan/GDP Ratio <sup>‡</sup>				9.331 (0.34)						
Non-performing loans/Total loans <sup>‡</sup>					-2.824 (1.06)					
Bank Regulatory Capital/Risk Weighted Assets <sup>‡</sup>						3.921 (1.03)				
Bank Capital/Assets <sup>‡</sup>							1.212 (0.32)			
Bank return on assets <sup>‡</sup>								1.919 (0.12)		
Bank return on equity <sup>‡</sup>									0.237 (0.27)	
Constant	-31.516 (4.54)***	-35.106 (6.38)***	-32.046 (4.51)***	-45.993 (3.49)***	-33.304 (4.05)***	-23.899 (2.29)**	-78.787 (1.72)	-38.853 (1.72)	-33.561 (2.29)**	-35.692 (2.32)**
Observations	18	18	16	16	16	16	16	16	16	16
R-squared	0.16	0.10	0.28	0.37	0.29	0.35	0.34	0.29	0.29	0.29
R-squared adjusted	0.11	0.05	0.17	0.21	0.11	0.18	0.18	0.11	0.11	0.11

Absolute value of t statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007; ‡ - December 2006

Note: Total assets are average of 2006 and 2007 annual data.

Table 9  
**Change in CDS Spreads of Financial Firms**  
*June 2007 to September 2008*

Sponsored ABCP Scaled by Total Bank Capital <sup>†</sup>	0.018 (0.56)	-0.002 (0.06)	-0.031 (0.80)	-0.010 (0.34)	-0.010 (0.32)	0.007 (0.20)	-0.011 (0.36)	-0.010 (0.31)	-0.011 (0.32)	-0.027 (0.83)	-0.015 (0.45)
US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>	461.059 (2.77)**		650.702 (3.18)***	633.535 (2.87)**	689.551 (3.31)***	722.964 (3.46)***	652.982 (3.04)**	651.693 (2.90)**	687.545 (3.46)***	650.112 (3.08)**	
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>			206.882 (1.69)	-77.458 (0.58)	-72.551 (0.51)	-150.384 (0.99)	-70.545 (0.54)	-78.989 (0.56)	-78.312 (0.51)	-95.262 (0.73)	-65.171 (0.47)
Deposits/Loan Ratio <sup>‡</sup>					-6.703 (0.30)						
Change in Loan/GDP Ratio <sup>‡</sup>						55.355 (1.00)					
Non-performing loans/Total loans <sup>‡</sup>							5.772 (1.22)				
Bank Regulatory Capital/Risk Weighted Assets <sup>‡</sup>								-0.933 (0.13)			
Bank Capital/Assets <sup>‡</sup>									-0.106 (0.01)		
Bank return on assets <sup>‡</sup>										-40.423 (1.36)	
Bank return on equity <sup>‡</sup>											-0.978 (0.58)
Constant	142.081 (12.86)***	104.821 (6.30)***	137.718 (10.87)***	104.415 (7.27)***	110.831 (4.27)***	93.425 (5.17)***	87.835 (4.50)***	115.484 (1.32)	105.021 (2.39)**	137.383 (4.93)***	119.295 (4.01)***
Observations	19	17	17	15	15	15	15	15	15	15	15
R-squared	0.02	0.37	0.17	0.62	0.62	0.65	0.67	0.62	0.62	0.68	0.63
R-squared adjusted	-0.04	0.28	0.06	0.51	0.47	0.51	0.53	0.46	0.46	0.55	0.48

Absolute value of t statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007; ‡ - December 2006

Note: Total assets are average of 2006 and 2007 annual data.

Table 10  
**Change in Stock Prices**  
*June 2007 to September 2008*

Sponsored ABCP Scaled by Total Bank Capital <sup>†</sup>	-0.014 (1.13)	-0.005 (0.47)	0.003 (0.21)	0.014 (0.83)	0.014 (0.87)	0.020 (1.07)	0.014 (0.85)	0.013 (0.77)	0.016 (0.91)	0.018 (0.93)	0.017 (0.92)
US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>	-114.658 (1.59)			-46.320 (0.49)	-1.771 (0.02)	-45.335 (0.47)	-82.230 (0.82)	-53.254 (0.56)	-65.432 (0.63)	-49.032 (0.50)	-37.550 (0.38)
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>			-74.983 (1.56)	-84.455 (1.47)	-100.760 (1.74)	-103.773 (1.63)	-87.710 (1.53)	-79.957 (1.38)	-67.946 (1.01)	-84.489 (1.42)	-96.760 (1.51)
Deposits/Loan Ratio <sup>‡</sup>					14.354 (1.24)						
Change in Loan/GDP Ratio <sup>‡</sup>						23.379 (0.78)					
Non-performing loans/Total loans <sup>‡</sup>							-2.851 (1.06)				
Bank Regulatory Capital/Risk Weighted Assets <sup>‡</sup>								3.734 (0.96)			
Bank Capital/Assets <sup>‡</sup>									2.088 (0.53)		
Bank return on assets <sup>‡</sup>										8.621 (0.49)	
Bank return on equity <sup>‡</sup>											0.477 (0.52)
Constant	-37.407 (8.76)***	-31.030 (4.31)***	-33.412 (6.28)***	-33.748 (4.52)***	-47.844 (3.54)***	-37.682 (4.13)***	-25.547 (2.38)**	-78.128 (1.67)	-45.752 (1.90)*	-41.015 (2.45)**	-41.390 (2.48)**
Observations	20	18	18	16	16	16	16	16	16	16	16
R-squared	0.07	0.18	0.19	0.32	0.41	0.36	0.39	0.38	0.34	0.34	0.34
R-squared adjusted	0.01	0.07	0.09	0.15	0.19	0.13	0.16	0.15	0.10	0.10	0.10

Absolute value of t statistics in parentheses

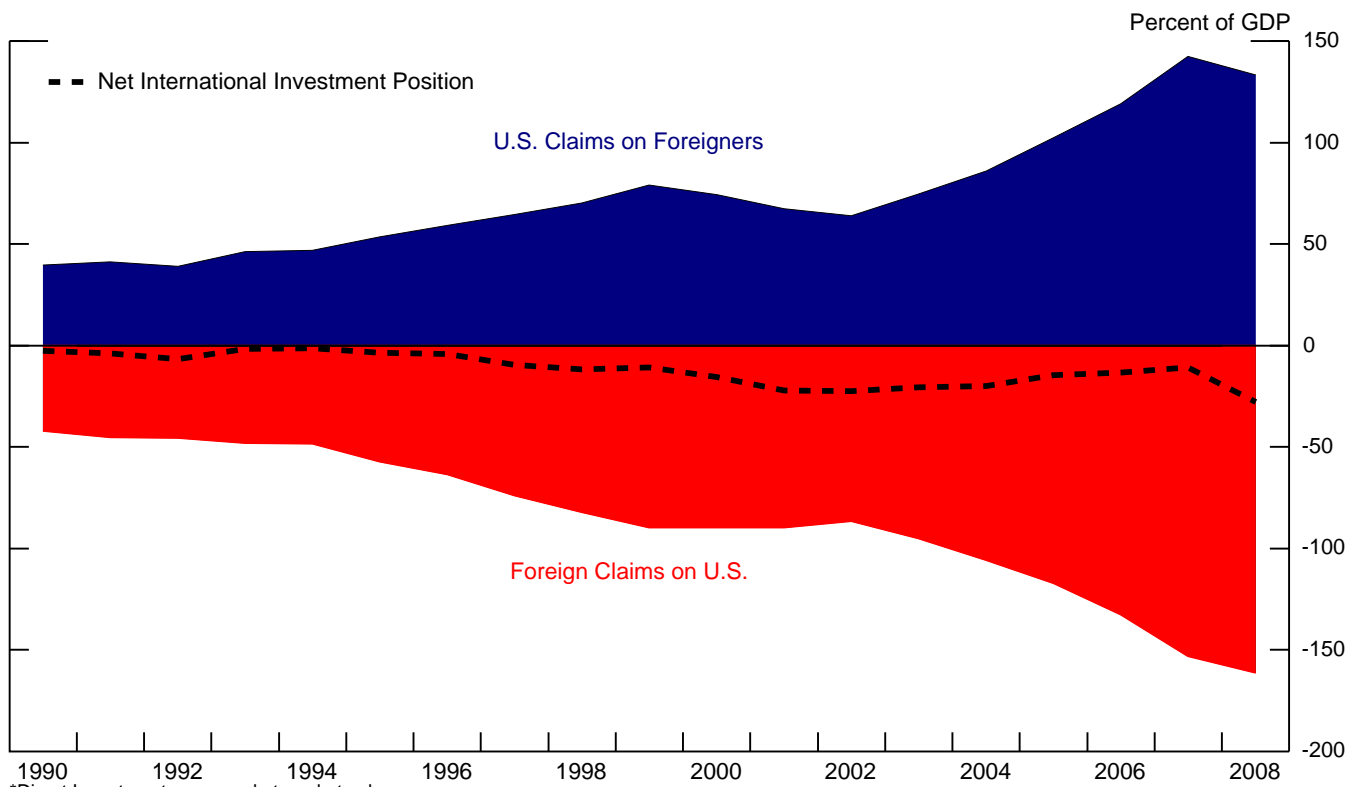
\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007; ‡ - December 2006

Note: Total assets are average of 2006 and 2007 annual data.

# Figure 1

## U.S. International Investment Position\*



\*Direct Investment measured at market value.

Source: U.S. International Investment Position, U.S. Department of Commerce.

# Figure 2

## Composition of U.S. External Liabilities

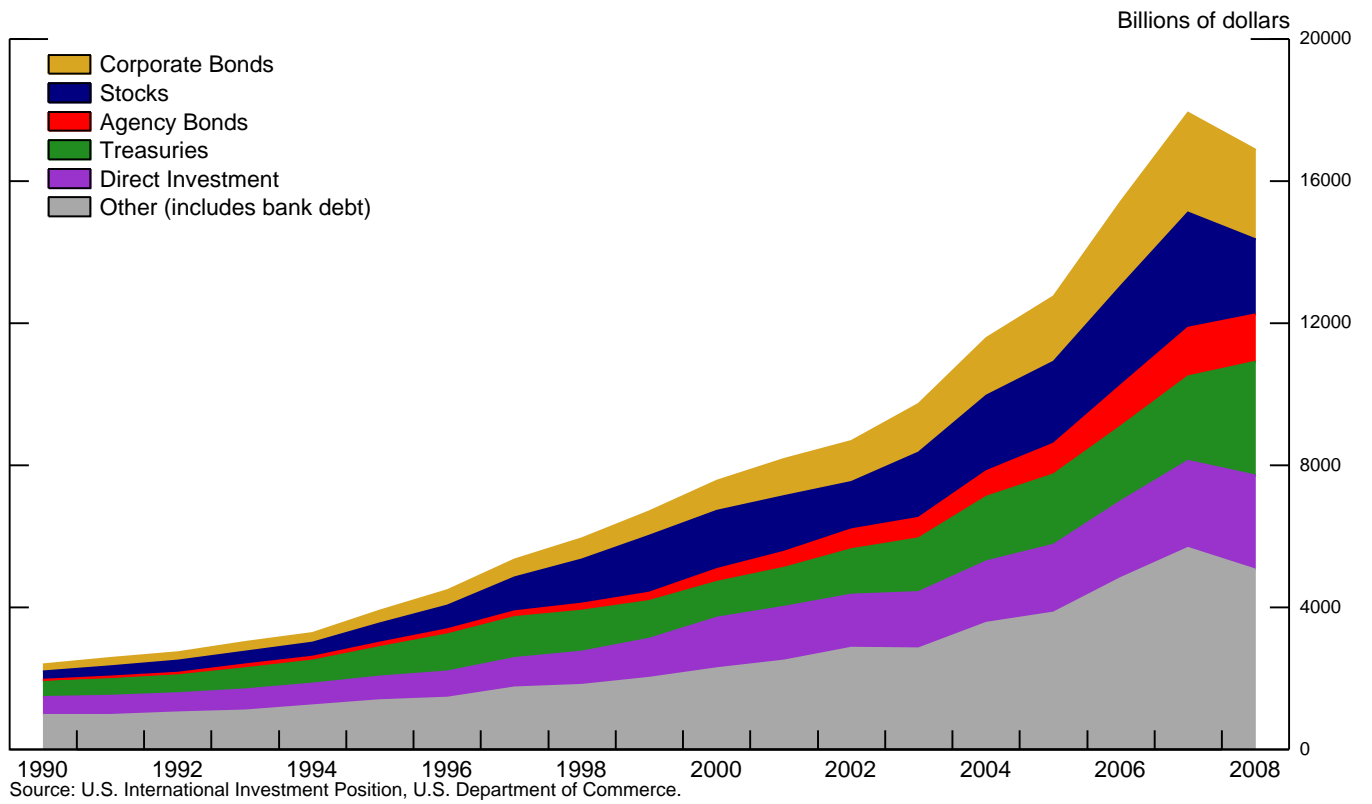
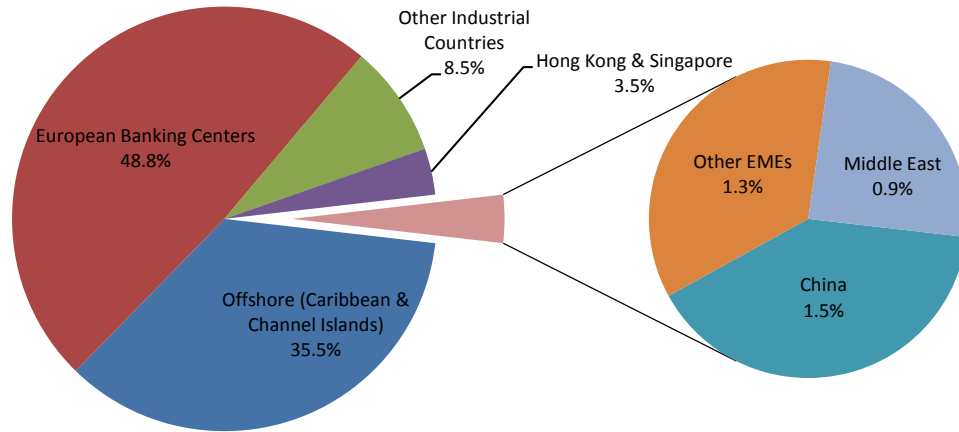




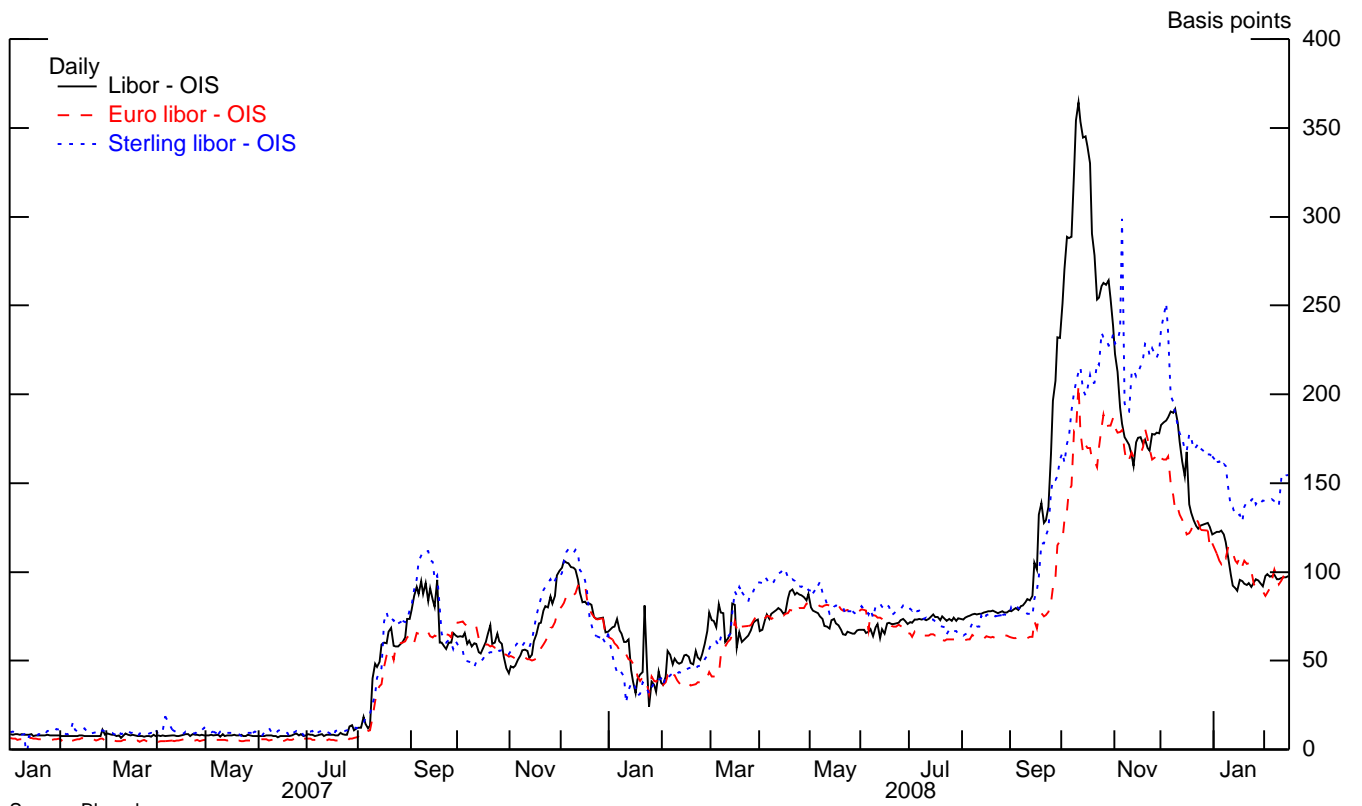
Figure 3  
2007 Holdings of U.S. ABS



Source: TIC data.

# Figure 4

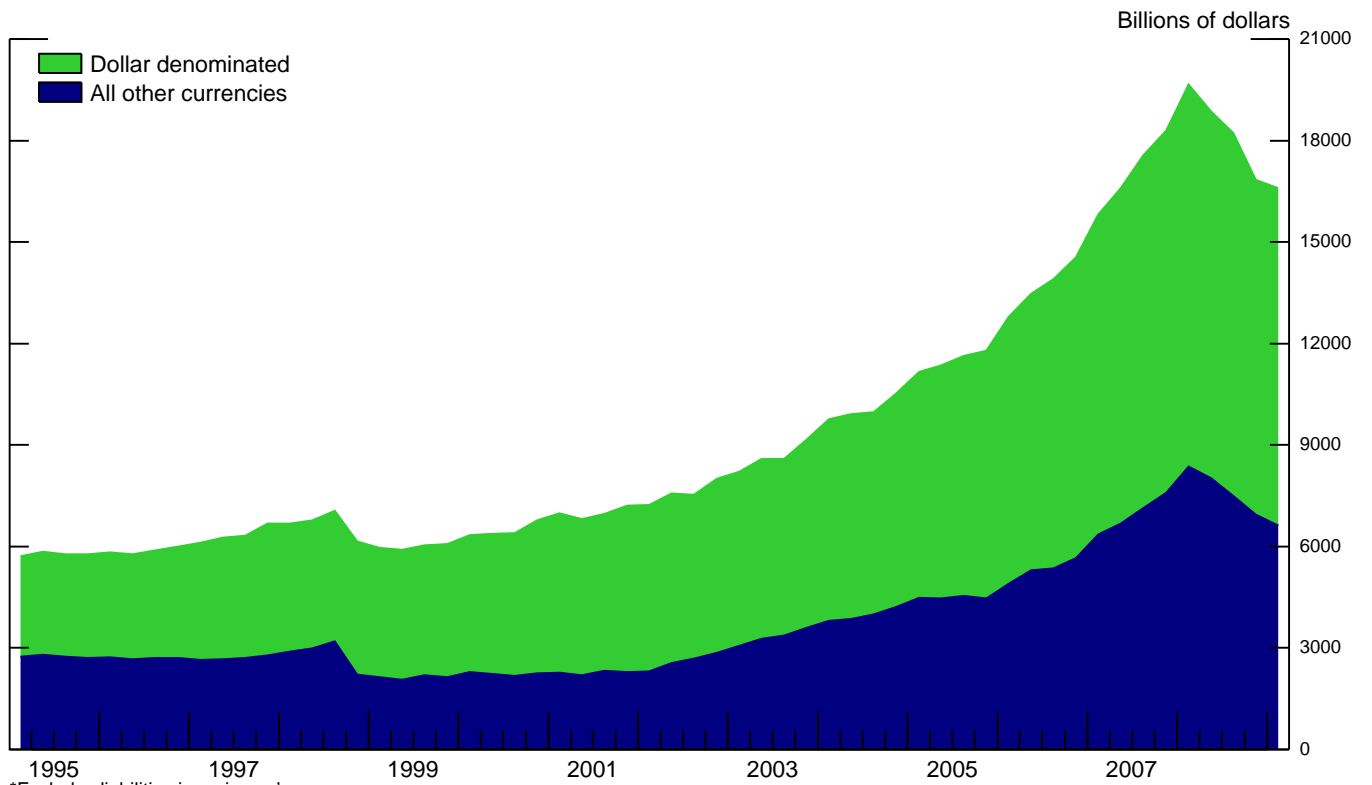
## Spread of LIBOR over OIS (3-Month) Interest Rates



Source: Bloomberg.

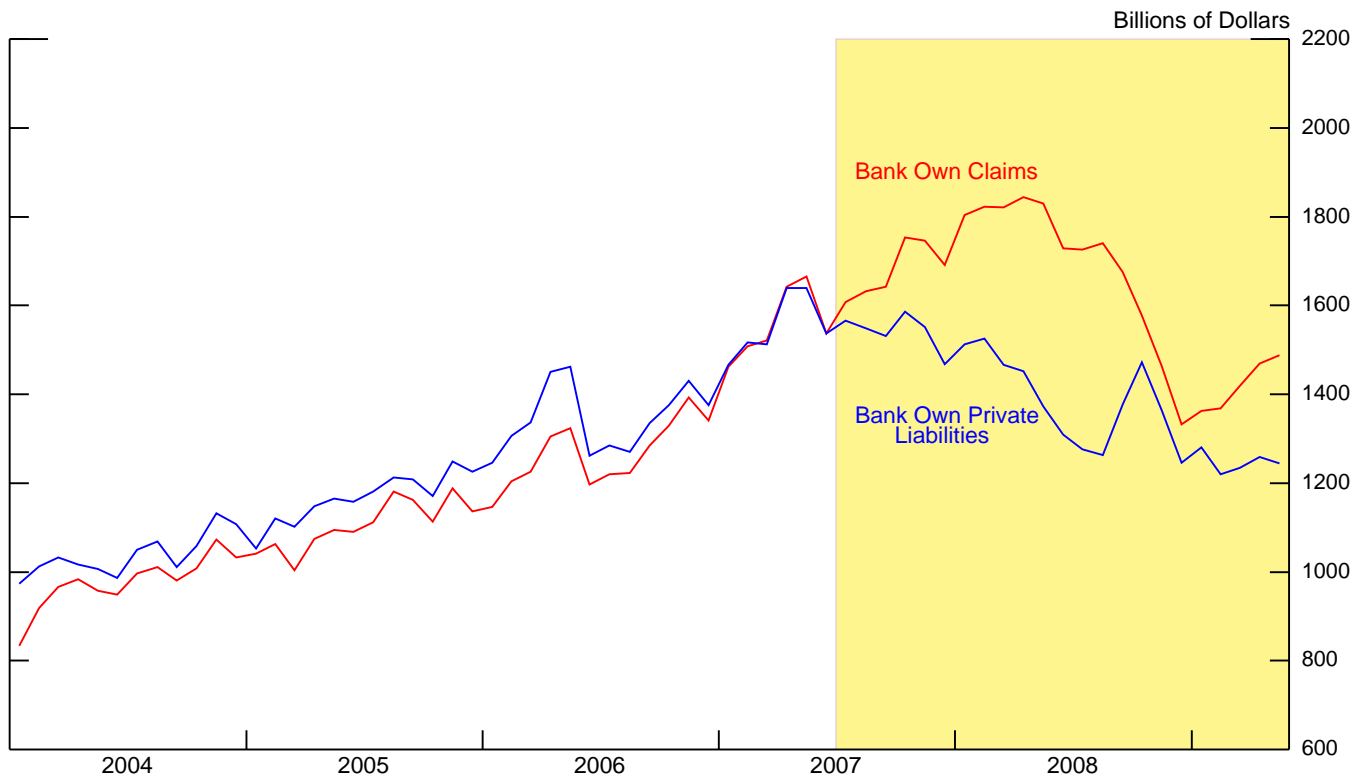
# Figure 5

## Cross-Border Foreign Currency Liabilities of Non-U.S. Banks\*



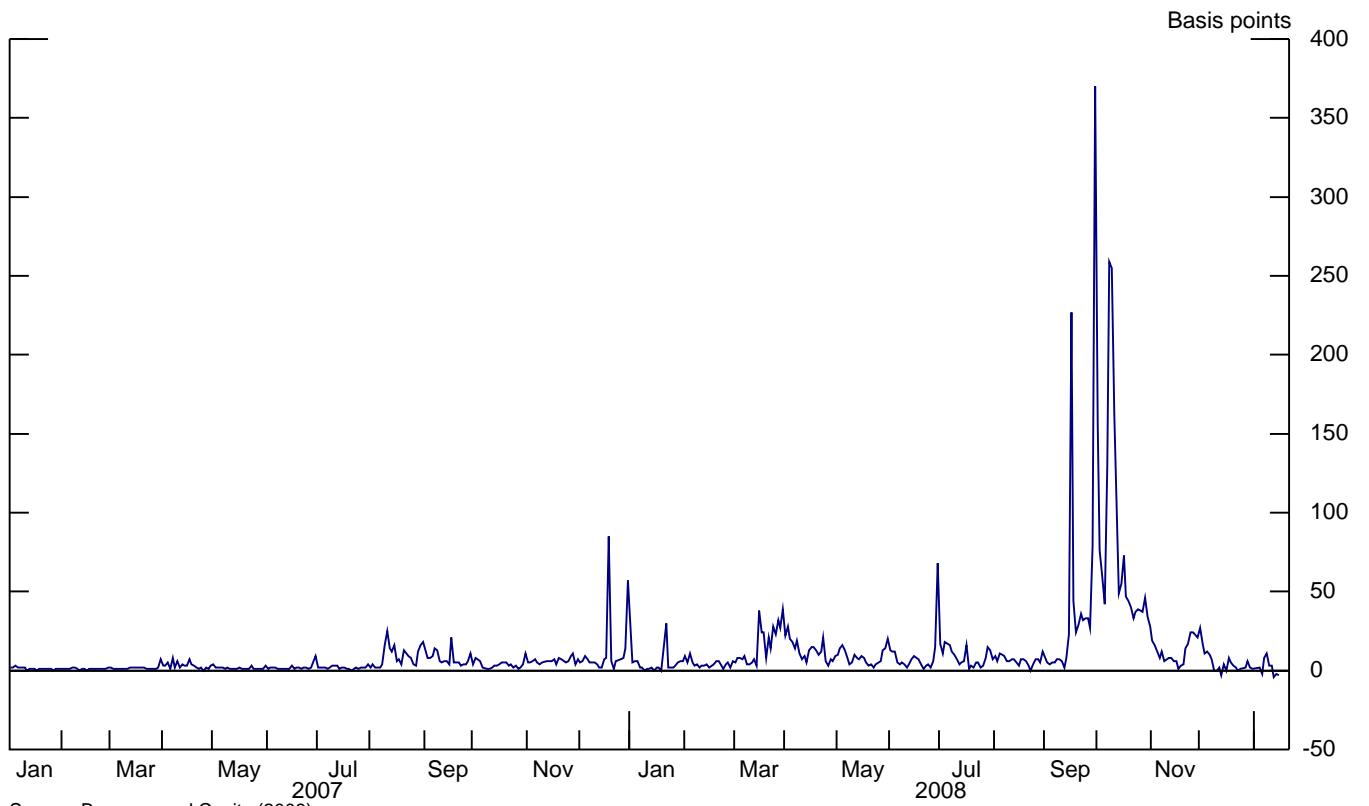
\*Excludes liabilities in an issuer's own currency.  
Source: BIS cross-border locational-by-residence banking data.

**Figure 6**  
**Cross-Border Banking Positions of Foreign-Owned Subsidiaries in the United States (Cumulative Changes)**



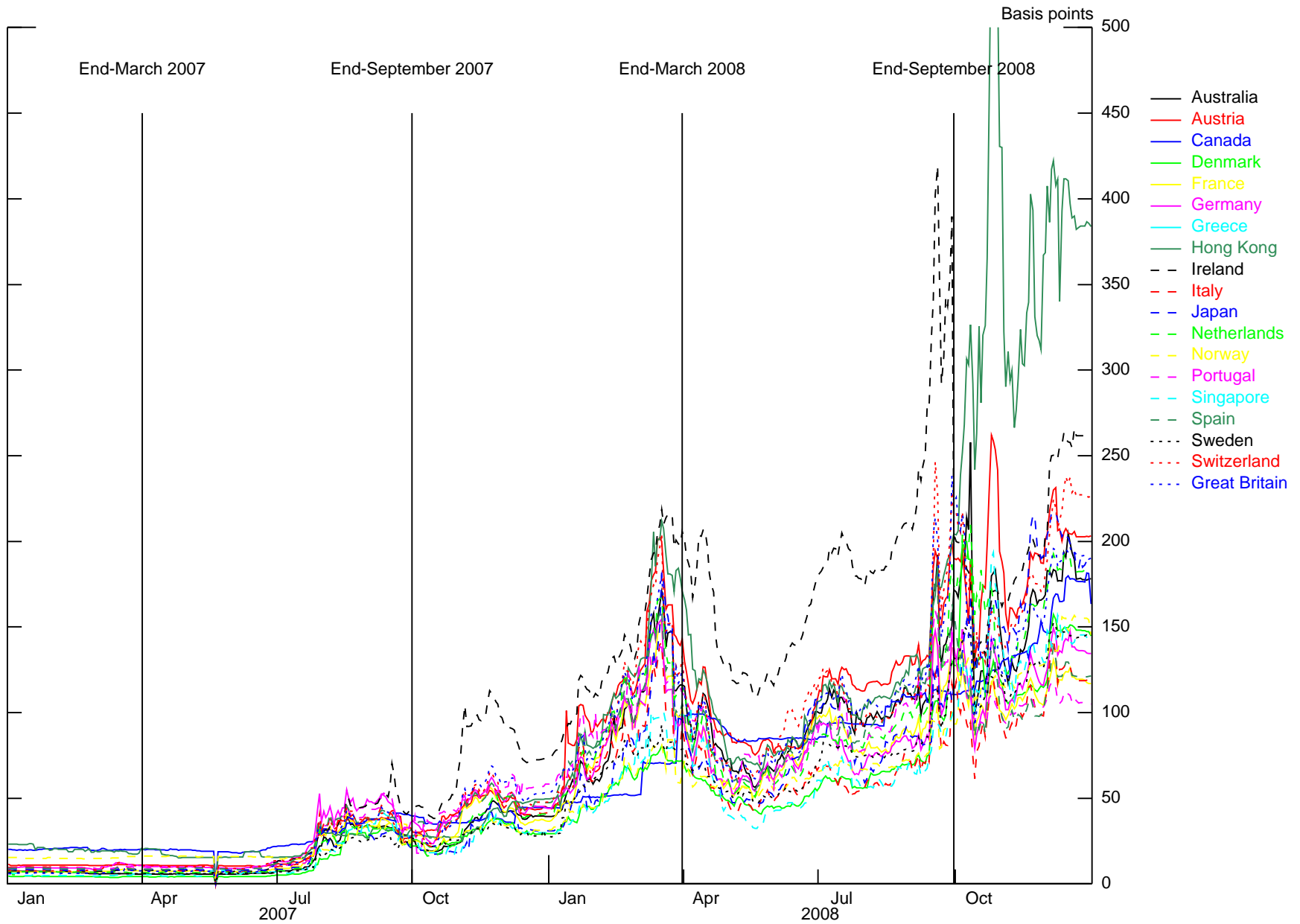
Source: Federal Reserve Board staff estimates.

**Figure 7**  
**Maximum Daily Spread Between Effective Eurodollar and Fed Funds Rates**



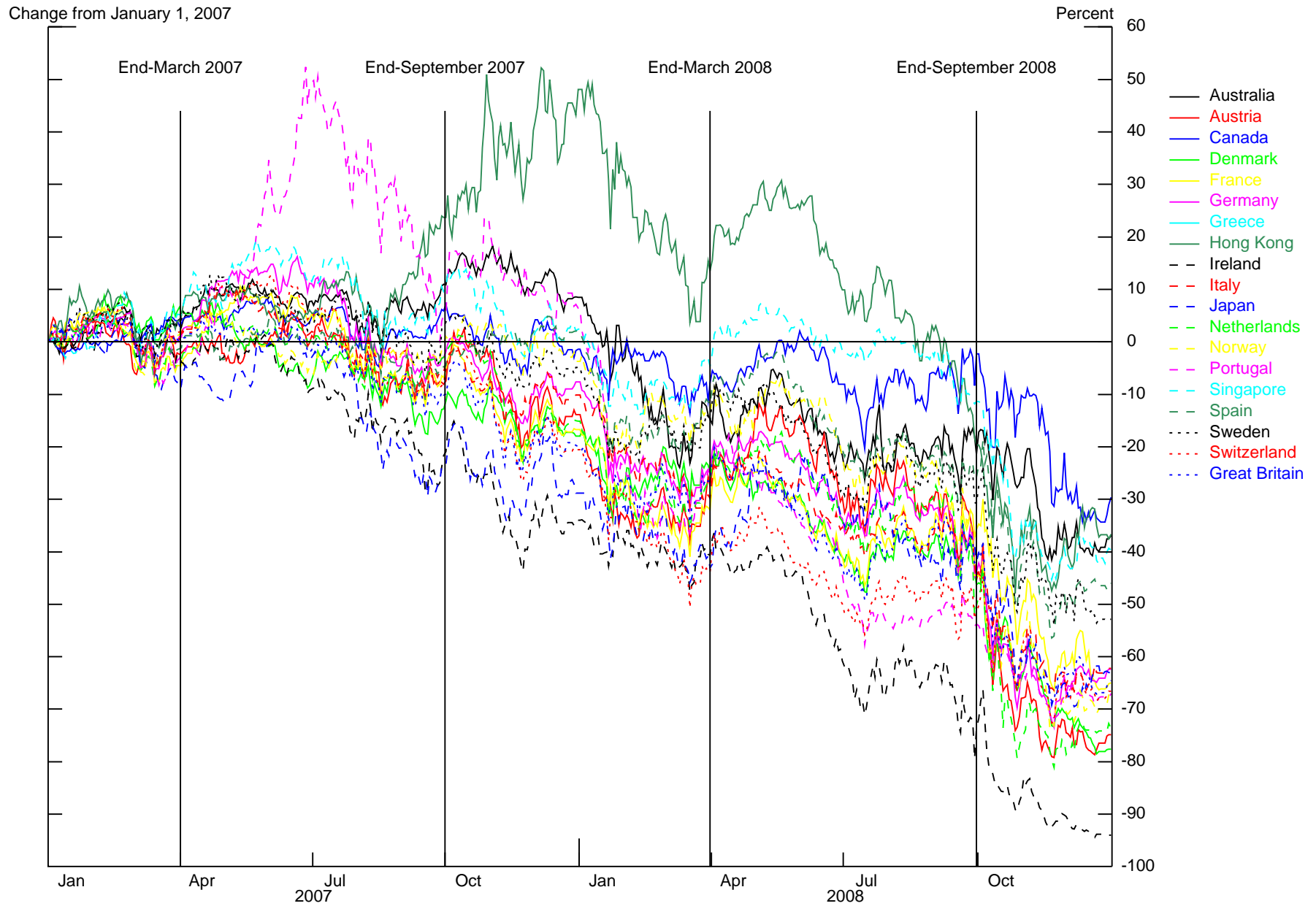
Source: Bowman and Covitz (2008).

**Figure 8**  
**CDS Premia by Nation\***



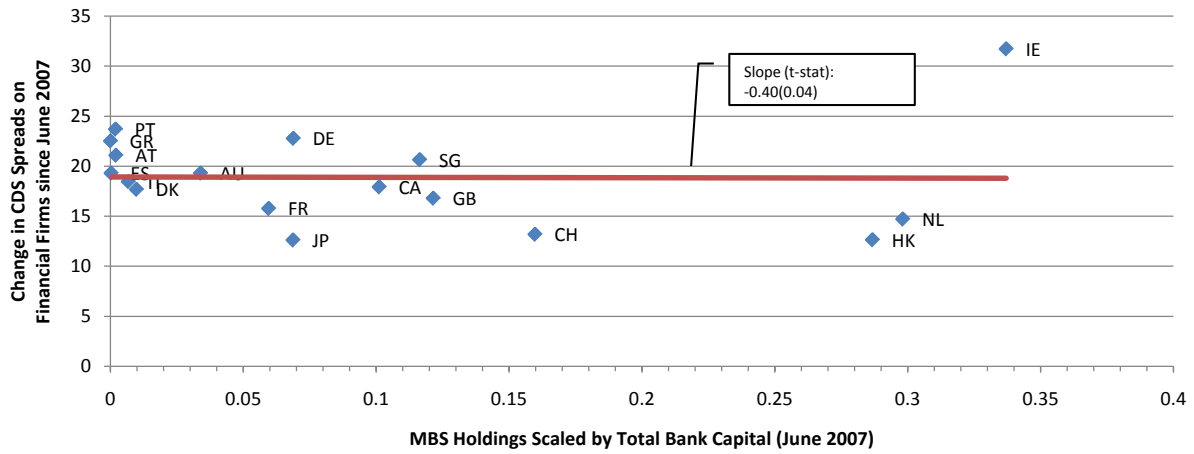
\*Individual bank premia weighted by total assets.  
Sources: Bloomberg and Markit.

**Figure 9**  
**Bank Stocks by Nation\***

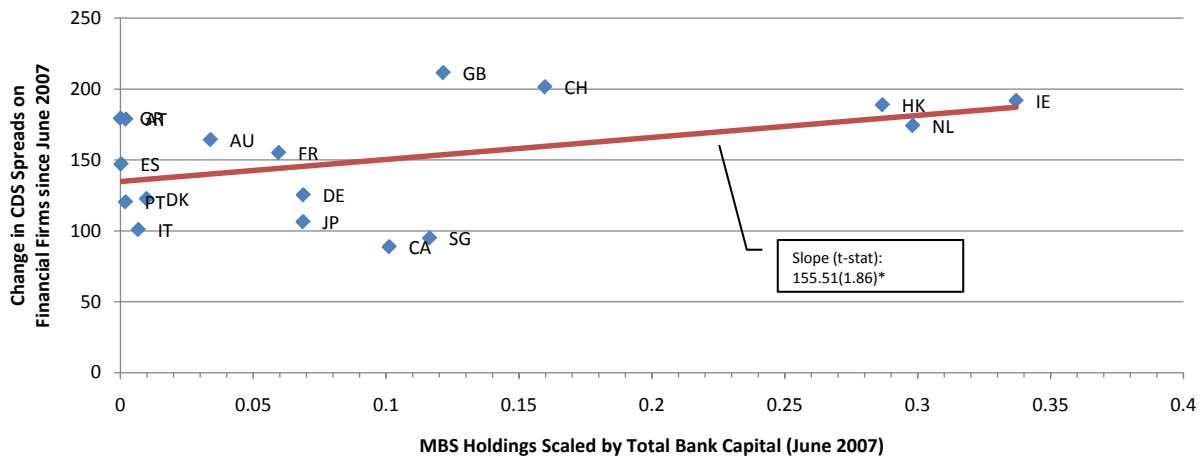


\*Individual bank premia weighted by total assets.  
Source: Bloomberg.

Figure 10  
**CDS Spreads vs. MBS Holdings Scaled by Bank Capital**  
 End-September 2007



End-September 2008

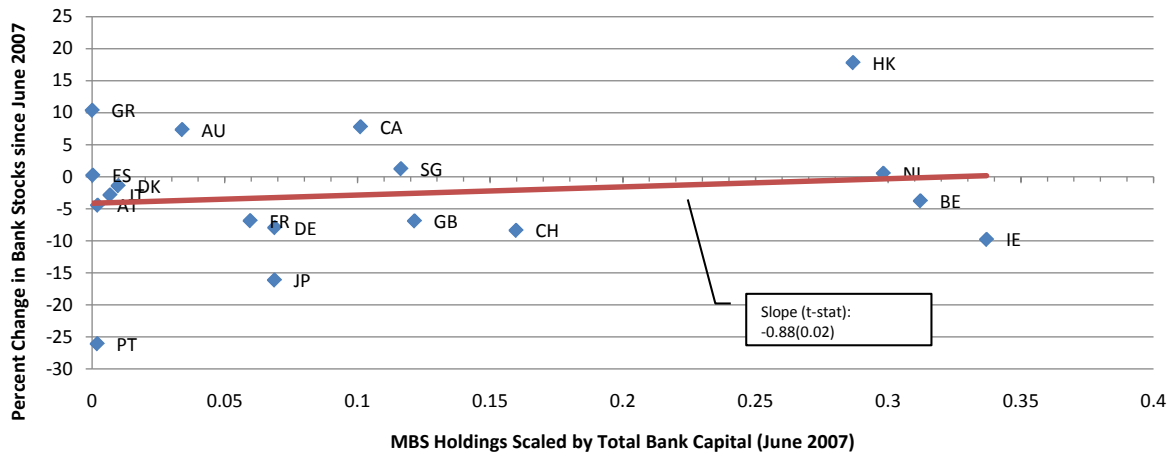


**Country Abbreviations:**

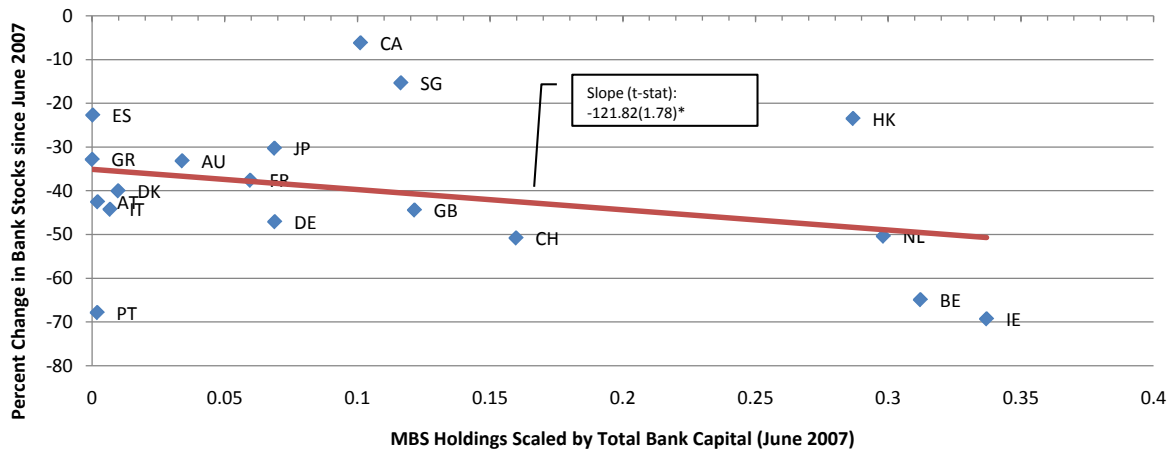
Australia	AU	Italy	IT
Austria	AT	Japan	JP
Belgium	BE	Netherlands	NL
Canada	CA	Norway	NO
Denmark	DK	Portugal	PT
France	FR	Singapore	SG
Germany	DE	Spain	ES
Greece	GR	Sweden	SE
Hong Kong	HK	Switzerland	CH
Ireland	IE	United Kingdom	GB



Figure 11  
**Bank Stock Returns vs. MBS Holdings Scaled by Bank Capital**  
 End-September 2007



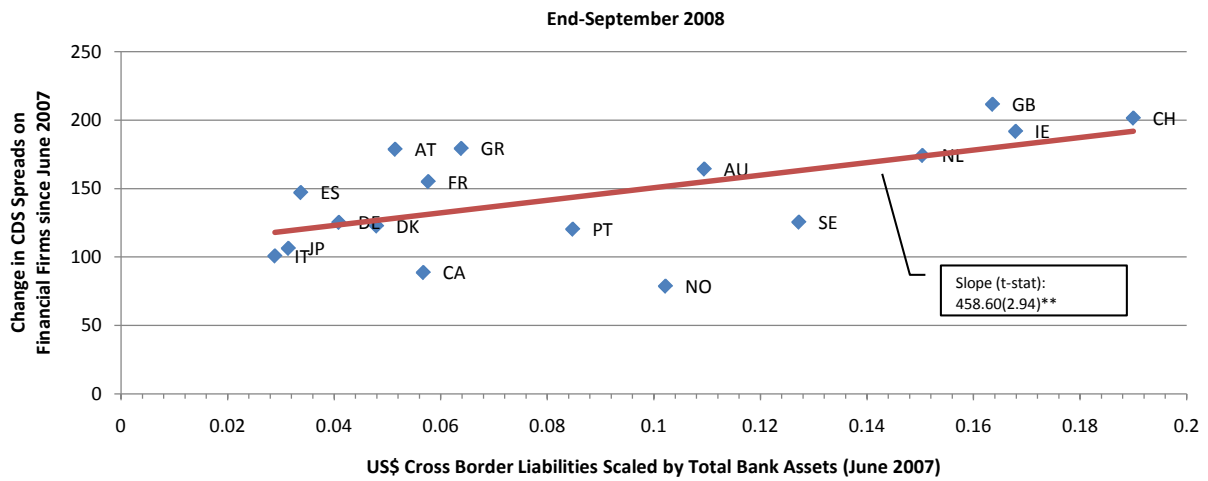
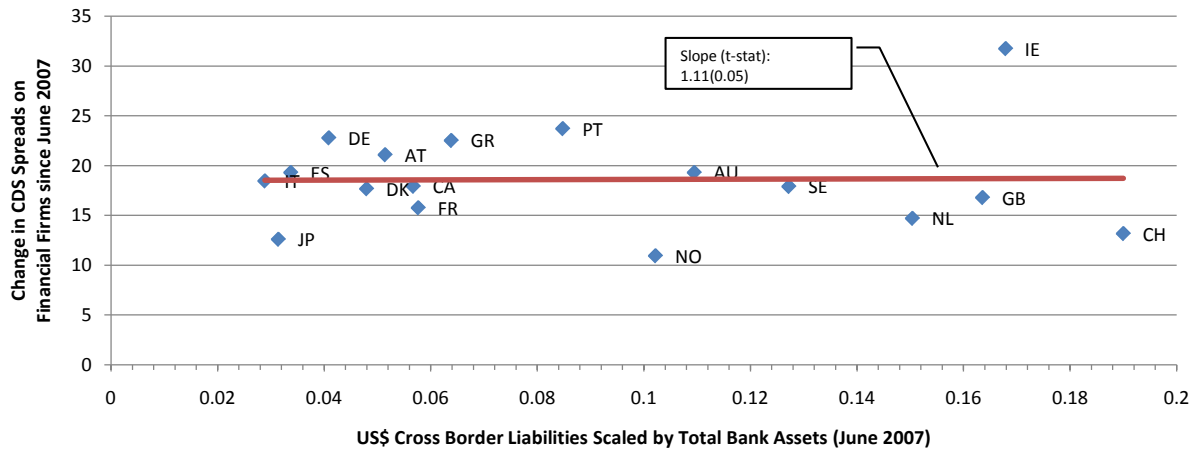
End-September 2008



**Country Abbreviations:**

Australia	AU	Italy	IT
Austria	AT	Japan	JP
Belgium	BE	Netherlands	NL
Canada	CA	Norway	NO
Denmark	DK	Portugal	PT
France	FR	Singapore	SG
Germany	DE	Spain	ES
Greece	GR	Sweden	SE
Hong Kong	HK	Switzerland	CH
Ireland	IE	United Kingdom	GB

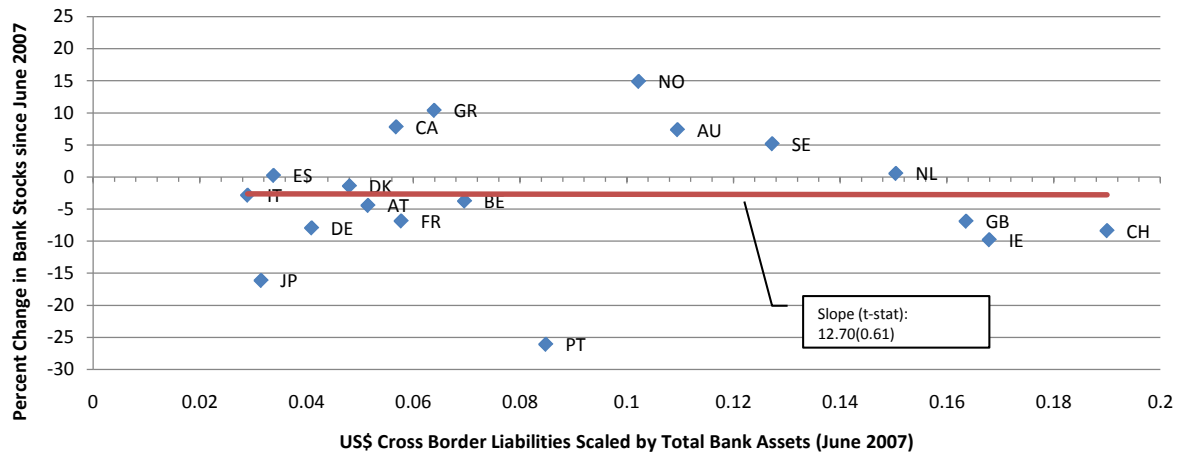
Figure 12  
**CDS Spreads vs. US\$ Cross Border Liabilities Scaled by Bank Assets**  
 End-September 2007



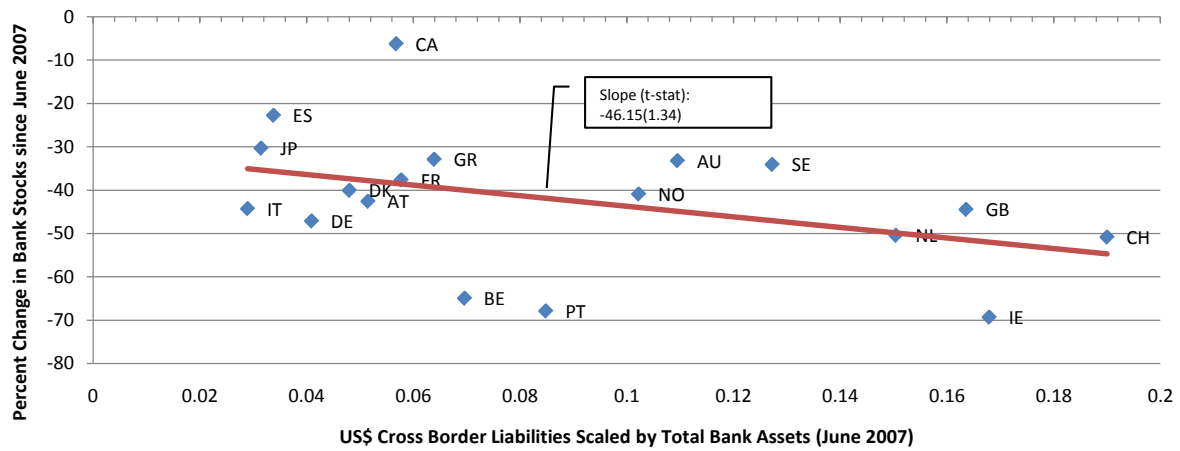
**Country Abbreviations:**

Australia	AU	Italy	IT
Austria	AT	Japan	JP
Belgium	BE	Netherlands	NL
Canada	CA	Norway	NO
Denmark	DK	Portugal	PT
France	FR	Singapore	SG
Germany	DE	Spain	ES
Greece	GR	Sweden	SE
Hong Kong	HK	Switzerland	CH
Ireland	IE	United Kingdom	GB

Figure 13  
**Bank Stock Returns vs. US\$ Cross Border Liabilities Scaled by Bank Assets**  
 End-September 2007



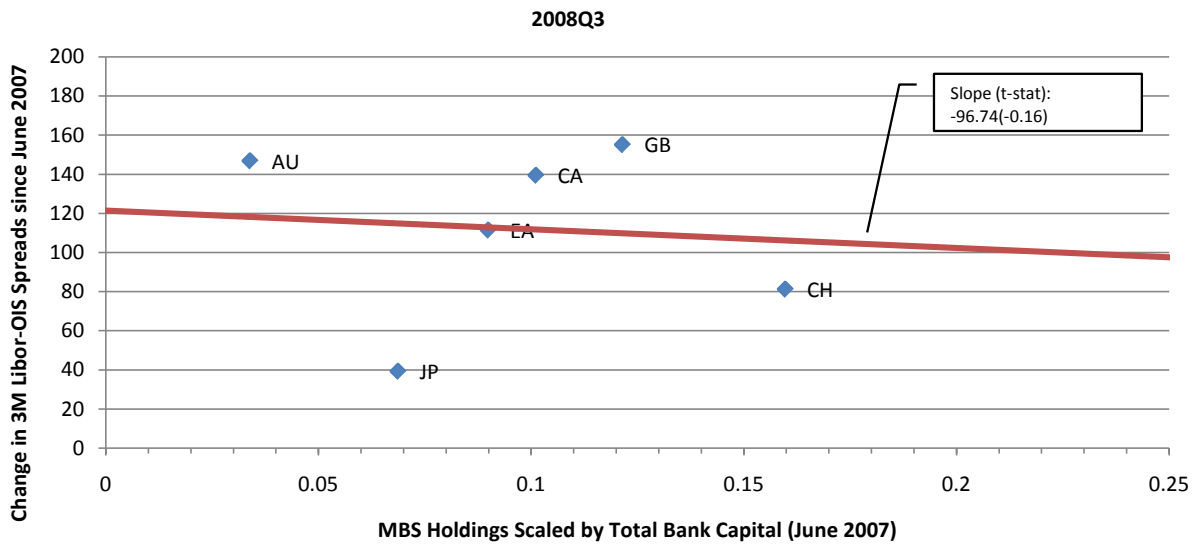
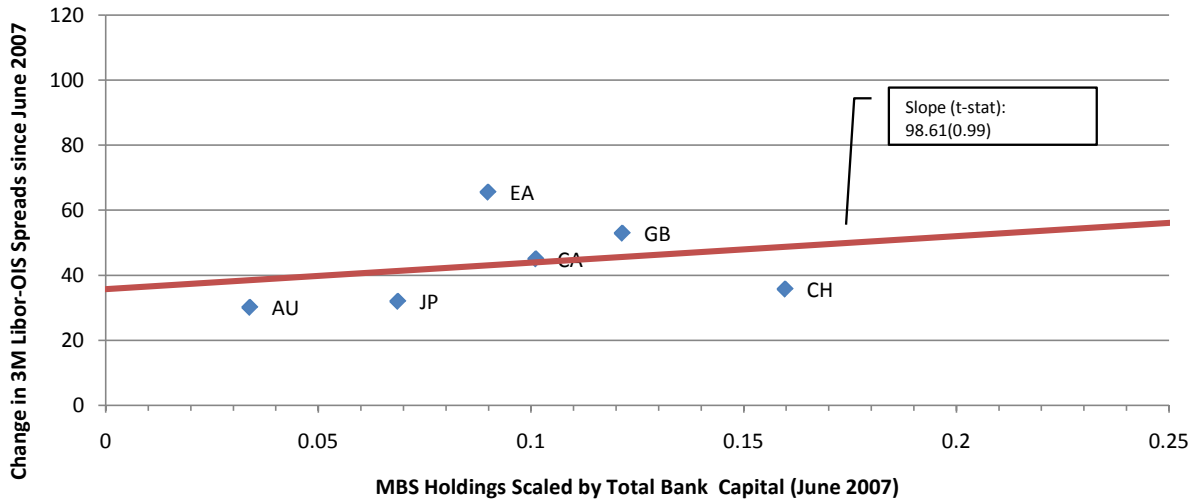
End-September 2008



**Country Abbreviations:**

Australia	AU	Italy	IT
Austria	AT	Japan	JP
Belgium	BE	Netherlands	NL
Canada	CA	Norway	NO
Denmark	DK	Portugal	PT
France	FR	Singapore	SG
Germany	DE	Spain	ES
Greece	GR	Sweden	SE
Hong Kong	HK	Switzerland	CH
Ireland	IE	United Kingdom	GB

Figure 14  
**3M LIBOR-OIS Spread vs. MBS Holdings Scaled by Bank Capital**  
 2007Q3



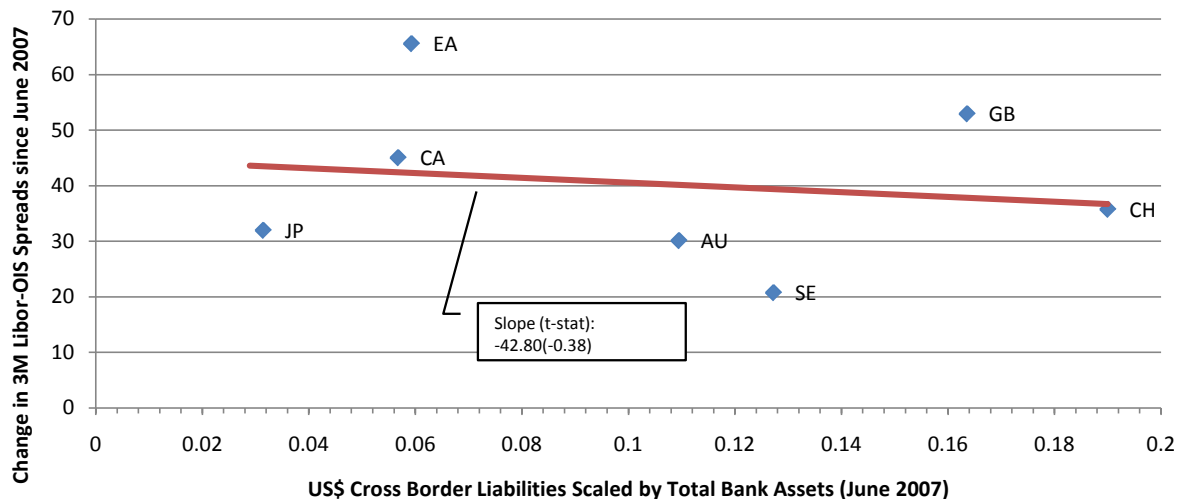
**Country Abbreviations:**

Australia	AU	Italy	IT
Austria	AT	Japan	JP
Belgium	BE	Netherlands	NL
Canada	CA	Norway	NO
Denmark	DK	Portugal	PT
France	FR	Singapore	SG
Germany	DE	Spain	ES
Greece	GR	Sweden	SE
Hong Kong	HK	Switzerland	CH
Ireland	IE	United Kingdom	GB

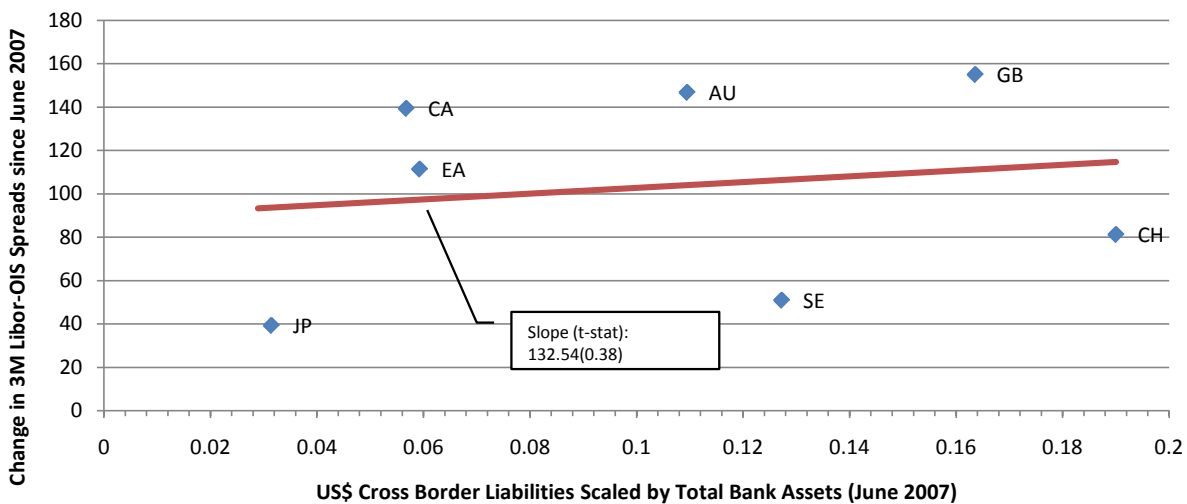
Figure 15

**3M LIBOR-OIS Spread vs. US\$ Cross Border Liabilities Scaled by Bank Capital**

2007Q3



2008Q3



**Country Abbreviations:**

Australia	AU	Italy	IT
Austria	AT	Japan	JP
Belgium	BE	Netherlands	NL
Canada	CA	Norway	NO
Denmark	DK	Portugal	PT
France	FR	Singapore	SG
Germany	DE	Spain	ES
Greece	GR	Sweden	SE
Hong Kong	HK	Switzerland	CH
Ireland	IE	United Kingdom	GB

## **Data Appendix 1**

### **Measures of Stress:**

#### **Bank Stock and Financial Firm CDS Indices**

##### *List of firms:*

The sample was constructed of firms in the Markit database from the desired countries classified as “Financials” by Markit. Firms were then removed if their 5-year CDS premium was not quoted on more than 1% of the reported days or if their CDS premium had been unchanged for more than 10 consecutive days since the start of 2007. Duplicate firms (eg ‘HBOS-ScotBkPLC’ vs ‘HBOS’) were subsequently removed to prevent double-counting.

##### *Indices:*

For the 120 firms left in the sample, stock price quotes and 5-year CDS premiums were pulled from Bloomberg and Markit, respectively, for the end of each quarter starting in June 2007. Additionally, 2008 total assets were pulled from Bloomberg. Two indices were created for each country:

1. taking the average of financial firms within a county weighted by each firm’s total assets
2. taking the firm with the median value (stock price or cds premium) within each country

##### *Geographic definition:*

These data use the headquarter country of the parent firm as the country designation.

##### *Detailed data issues:*

For two firms, Fortis and Dexia, the assignment of parent country disagreed between Bloomberg and Markit. For Dexia, the Bloomberg stock price data refers to the Dexia Group parent holding company, which is Belgian, whereas the Markit CDS premium refers to Dexia Credit Local, the French banking subsidiary of Dexia Group. Markit appears to not include a CDS premium for the Dexia Group parent. Therefore, Dexia’s country assignment remains split, Belgium for the stock price and France for the CDS premium. Fortis was assigned to the Netherlands and Belgium, respectively, in the two data sources. The Netherlands was chosen as the parent country for both measures based primarily on two facts. First, the dual Dutch/Belgian nature of Fortis was created from the merger of Dutch banking and Belgian insurance firms; since we are focusing more on banking in this analysis, that points to a Dutch designation. Second, Fortis would have been the only Belgian firm in the CDS premium data if it had been left as Belgian. As a split nationality firm, it’s not a good sole representative for the country. Removing Belgium entirely from the CDS premium data also has the advantage of removing a clear outlier.

Luxembourg, also an outlier, was removed from both the CDS premium and bank stock data. Luxembourg is a center for banking business but with very few banks headquartered there. In the Bloomberg and Markit data, the only bank designated as a Luxembourg firm is Espirito Santo Financial Group. This is the holding company for a Portuguese bank that does business primarily in Portugal, Spain, Brazil, and the U.S. It has no apparent ties to Luxembourg except for its holding company’s headquarters.

### **Measures of Exposure:**

#### **Cross Border US\$ Liabilities**

##### *Source data:*

Data on cross border liabilities by currency is compiled by the Bank of International Settlements and available as part of their “International Banking Statistics” database, specifically the locational assets and

liabilities stock data. Dollar denominated liabilities can be recorded between any two countries; these are not necessarily liabilities to the U.S.

*Geographic definition:*

The data used in the regressions are defined as the cross-border dollar liabilities of any bank located in the designated country, regardless of the nationality of the bank's parent (i.e. including subsidiaries and branches of foreign banks). These are the BIS' locational by residence data. As noted in footnote 19, cross-border dollar liabilities grouped by the nationality of the parent bank (from the BIS compilation of locational data by nationality) was used as an alternative measure.

*Scaling:*

US\$ Liabilities were scaled by each country's total bank assets. Country-level total bank assets were constructed by summing firm-level bank assets using Bankscope data accessed through the Wharton Research Data Services (WRDS) website. In each country the sample included all banks with at least \$1 million in assets reported on unconsolidated statements. The bank assets used were the average of end-2006 and end-2007.

### **Holdings of U.S. Mortgage-Backed Securities**

*Source data:*

Data on holding of securities issued in the United States are collected by the Treasury International Capital System (TIC) in the annual liabilities survey. The data used in this analysis exclude mortgage-backed securities issued by Fannie Mae, Freddie Mac, and other U.S. agencies. They include all corporate ABS backed by any type of mortgage, including commercial mortgages. Positions are reported as of June 30, 2007. The data are shown in Table 23 of the full survey report: <http://www.treas.gov/tic/shl2007r.pdf>

*Geographic definition:*

These data are defined as the cross-border dollar liabilities of any bank located in the designated country, regardless of the nationality of the bank's parent (i.e. including subsidiaries and branches of foreign banks).

*Scaling:*

Holdings of MBS were scaled by each country's total bank capital as of June 2007. Country-level bank capital was compiled country by country from Central Bank and/or National Statistics Agency websites. Data in home country currency is converted to dollars using the spot rate as of June 29, 2007.

Euro Area Countries:

[http://www.ecb.int/stats/money/aggregates/bsheets/html/outstanding\\_amounts\\_2007-06.en.html](http://www.ecb.int/stats/money/aggregates/bsheets/html/outstanding_amounts_2007-06.en.html)

*Line 2.5: Capital and Reserves.*

Australia:

<http://www.rba.gov.au/statistics/bulletin/index.html>

*Banks Consolidated Group Capital – B06*

Canada:

<http://www.bankofcanada.ca/en/bfsgen.html>

*Banking Financial Statistics, Statistical Table C4 "Chartered bank liabilities – month-end series"*

Sum of all columns under "shareholders' equity" (series V36960 through V36964 plus V29785526 and V41598372)

Denmark:

[http://www.nationalbanken.dk/C1256BE2005737D3/side/POB20080225Nyt/\\$file/POB20080225Nyt.pdf](http://www.nationalbanken.dk/C1256BE2005737D3/side/POB20080225Nyt/$file/POB20080225Nyt.pdf)  
Table 2 "Capital and Reserves" for MFIs, Consolidated. Denmark appears to split MFIs into mainly banks and mortgage-credit institutions. These appear to account for the vast majority of the MFI assets, so we take the whole MFI number.

Hong Kong:

<http://www.info.gov.hk/hkma/eng/statistics/msb/index.htm>

3.9.1 Balance sheet: Authorized institutions, "Capital, Reserves, and other liabilities"

Japan:

<http://www.stat.go.jp/english/data/nenkan/1431-14.htm>

Line 14-2 "Assets and Liabilities of Domestically Licensed Banks", Section B "Banking Accounts", Column "Net assets"

New Zealand:

<http://www.rbnz.govt.nz/statistics/monfin/rbssr/rbssrpartA/download.html>

Data Table: Line A4

Singapore:

[http://www.mas.gov.sg/data\\_room/msb/Monthly\\_Statistical\\_Bulletin.html#money](http://www.mas.gov.sg/data_room/msb/Monthly_Statistical_Bulletin.html#money)

"Money and Banking" Table I.3C Banks: Liabilities of Domestic Banking Units, choose "Capital and Reserves"

Switzerland:

<http://www.snb.ch/en/iabout/stat/statpub/bchpub/stats/bankench>

Table 18, Liabilities

Column 16, Total Equity

Norway:

[http://www.ssb.no/finansinst\\_en/arkiv/](http://www.ssb.no/finansinst_en/arkiv/)

Tables, Table 1 "Financial institutions, balance sheet...", "Equity"

UK:

<http://www.bankofengland.co.uk/mfsd/iadb/index.asp?Travel=NlxSTxTBx&levels=1&C=44H&A4420XBMX4312X4378X4391.x=7&A4420XBMX4312X4378X4391.y=5&FullPage=X4312&FullPageHistory=X4312&Nodes=X4312X4313X4327X4376X45986X4378X4391&SectionRequired=B&HideNums=1&ExtraInfo=false#BM>

Interactive data series RPMTBGA + RPMTBGT from Table B1.2 "Other banks' balance sheet"

Choose: Sterling liabilities (and foreign currency liabilities), Amounts outstanding, "capital and other internal funds"

### **Control Variables:**

#### **IMF Data**

IMF data comes from tables 22-27 in the latest (April 2009) Global Financial Stability Report, available at:

<http://www.imf.org/external/pubs/ft/gfsr/2009/01/index.htm>, as well as the International Financial Statistics, lines 22d, 24, 25 and 99b.



## Data Appendix 2

### Methods for Adjusting Holdings of U.S. Mortgage-Backed Securities:

#### **Adjustment for additional exposure through re-securitization**

As noted in Figure 3, more than one-third of U.S. MBS held by foreigners is held in offshore centers, primarily in the Cayman Islands. Much of the Cayman Island holdings are accounted for by special purpose vehicles (SPVs) that re-securitize U.S. MBS into Cayman-issued MBS. Therefore, other countries' exposure to these Cayman Island debt securities largely reflects indirect exposure to U.S. MBS. To account for this indirect exposure, we supplement the TIC data on foreign holdings of U.S. MBS with foreign holdings of Cayman Island debt from the 2007 Coordinated Portfolio Investment Survey (CPIS).

Starting with each country's reported holdings of all Cayman Island debt securities, we make two assumptions to estimate how much of these holdings ultimately are backed by U.S. MBS. We first estimate how much of Cayman Island debt represents ABS. Detailed information on Cayman Island debt securities held by U.S. residents is available in the TIC annual claims survey, and these data suggest that approximately three-quarters of debt securities issued in the Cayman Islands is ABS. Second, we estimate what fraction of Cayman-issued ABS is mortgage-backed. We base our estimate for Cayman Island *issuance* of MBS on their *holdings* of U.S. MBS, since those holdings are the inputs to the securitization process. Approximately 80 percent of U.S. ABS held in the Cayman Islands is MBS, according to the TIC annual liabilities survey. Multiplying the 75 percent of Cayman Island debt that is estimated to be ABS by the 80 percent of ABS that is estimated to be MBS suggests an estimate of 60 percent for the fraction of Cayman Island debt securities that likely represents exposure to MBS. For each country, we therefore add 60 percent of their CPIS-reported holdings of Cayman Island debt to their direct holdings of U.S. MBS. The resulting combined MBS exposure data are shown in the second column of Table A1.

#### **Adjustment for custodial bias**

*Basic method (used in tables A1 and A2)*

As discussed in the paper, the TIC data attribute the ownership of securities, including MBS, to the location where the security is being held. To the extent that some countries have sizable banking and brokerage industries that hold securities in custody for end-investors, the reported holdings for those countries are exaggerated because many of the end-investors reside elsewhere. Likewise, reported holdings are underestimated for countries with many end-investors but few financial firms specializing in custodial accounts. We use private holdings of long-term securities reported on the 2007 Coordinated Portfolio Investment Survey (CPIS) to make adjustments that reduce the "custodial bias" associated with the TIC data. Unlike the TIC data, which are drawn from a survey of the external *liabilities* of U.S. residents, the CPIS represents a survey where countries report the external *claims* of their residents. CPIS data should not suffer from custodial bias because countries report what securities their residents own, regardless of where they are held in custody. However, CPIS does not report detailed categories of holdings such as ABS or MBS.

To estimate the custodial bias for each country, we calculate the ratio of CPIS-reported holdings of long-term securities to TIC-reported holdings. Countries whose CPIS holdings are smaller than their TIC holdings are custody centers. Among our sample, such countries include Belgium, Switzerland, the United Kingdom, Ireland, and Hong Kong (Luxembourg is also a custody center but is not included in our data). Countries whose CPIS holdings are higher than their TIC holdings have more end-investors. The largest discrepancies in this direction can be found in Japan, Italy, and France. Assuming (plausibly) that custodial bias is similar across securities classes, we apply the custodial bias ratio based on all long-term securities to the TIC-reported holdings of U.S. MBS. This reduces holdings for the custodial centers and increases holdings for end-investor countries like Japan. The resulting adjusted MBS exposure data is shown in the

third column of Table A1 (combined with the Cayman Island re-securitization adjustment). For most countries, the addition of the Cayman Island holdings shown in column (2) of Table A1 makes a bigger difference than the further adjustment for custodial bias shown in column (3).

*Alternative Method (not shown)*

The basic method described above calculates an implied custodial bias ratio for total long-term securities and applies that ratio to TIC-reported holdings of U.S. MBS for each country. An alternative method assumes that the excess of CPIS-reported holdings over TIC-reported holdings for custody centers (Belgium, Switzerland, Luxembourg, United Kingdom, Ireland, and Hong Kong) represents the total dollar value of custody holdings that need to be reallocated to end-investors in other countries. The total excess for these six countries is nearly \$700 billion of long-term securities, about \$77 billion of which is estimated to be MBS (assuming that the composition of custody holdings is no different than the composition of total TIC-reported holdings for these countries). This \$77 billion is allocated to the countries with more end-investors, such as Japan, Italy, and France, based on their share of end-investors. A country's share of end-investors is calculated as their shortfall in the TIC-CPIS comparison as a fraction of the total shortfall across all countries whose TIC-reported holdings are smaller than their CPIS-reported holdings. Notably, this method generates broadly similar results to the basic method of adjusting for custodial bias described above, so we do not show the results in Table A1. Additionally, in the regressions of financial stress measures on MBS holdings, the estimation results based on the alternative adjustment method were very similar to the results based on the basic method, so we did not report them in Table A2, either.

Table A1

Different measures of MBS by country (\$ billions)

Country	Unadjusted (1)	Adjustments using CPIS data	
		(1) + Claims on Cayman Islands*	(2) + Custodial Reallocation**
	(1)	(2)	(3)
Australia	4.0	4.0	5.8
Austria	0.2	5.4	5.8
Belgium	18.6	22.7	6.0
Canada	10.6	11.9	12.4
Denmark	0.8	2.0	2.1
Finland	0.1	0.7	0.8
France	30.9	66.3	101.7
Germany	32.6	53.0	56.9
Greece	0.0	1.9	1.9
Hong Kong	14.6	22.3	21.7
Ireland	32.7	48.9	45.9
Italy	2.1	6.3	21.6
Japan	17.4	204.8	210.6
Netherlands	32.3	39.9	47.0
New Zealand	0.3	0.3	0.3
Norway	18.2	18.2	18.2
Portugal	0.1	8.4	8.6
Singapore	3.3	5.2	5.8
Spain	0.1	10.5	10.7
Switzerland	20.1	20.1	10.7
United Kingdom	90.2	165.4	159.8

\*Total holdings of debt securities issued by Cayman Islands multiplied by 60 percent.

\*\*Custodial reallocation represents the adjustment to TIC-reported holdings of U.S. MBS for discrepancies between TIC- and CPIS- reported data on total long-term securities holdings.

Table A2

Main regression results with different measures of MBS

Measure of MBS:	Unadjusted (1)		(1) + Cayman Claims (2)		(2) + Custodial Reallocation (3)	
	Univariate	Bivariate	Univariate	Bivariate	Univariate	Bivariate
<b>June 2007 to September 2007</b>						
Change in CDS Spreads of Financial Firms						
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	-0.404 (0.04)	11.510 (0.60)	-1.691 (0.28)	-2.212 (0.34)	-2.344 (0.40)	-2.857 (0.46)
US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>		-11.506 (0.32)		6.681 (0.26)		6.406 (0.26)
Constant	18.922 (11.62)***	19.187 (7.48)***	19.189 (11.82)***	19.027 (7.30)***	19.328 (11.77)***	19.197 (7.23)***
Change in Stock Prices						
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	12.696 (0.61)	0.452 (0.02)	-20.905 (1.89)*	-19.224 (1.82)*	-20.254 (1.80)*	-18.598 (1.76)
US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>		-16.244 (0.28)		-0.377 (0.01)		-4.469 (0.11)
Constant	-4.142 (1.24)	-2.951 (0.64)	1.284 (0.42)	-0.387 (0.09)	1.006 (0.33)	-0.342 (0.08)
<b>June 2007 to September 2008</b>						
Change in CDS Spreads of Financial Firms						
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	155.513 (1.86)*	-107.317 (1.10)	5.626 (0.11)	-30.070 (0.91)	-6.694 (0.14)	-29.454 (0.92)
US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>		674.212 (3.64)***		548.373 (4.24)***		539.264 (4.24)***
Constant	134.810 (11.05)***	102.795 (7.89)***	149.086 (11.03)***	110.117 (8.28)***	151.380 (11.04)***	111.034 (8.17)***
Change in Stock Prices						
MBS Holdings Scaled by Total Bank Capital <sup>†</sup>	-46.147 (1.34)	-51.789 (1.25)	-24.852 (1.23)	-14.515 (0.77)	-12.850 (0.61)	-4.496 (0.24)
US\$ Cross Border Liabilities Scaled by Total Bank Assets <sup>†</sup>		-66.700 (0.74)		-124.120 (1.65)		-132.946 (1.75)
Constant	-35.106 (6.38)***	-32.046 (4.51)***	-35.406 (6.34)***	-29.412 (3.80)***	-37.815 (6.65)***	-30.721 (3.87)***

Absolute value of t statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

† - June 2007

Note: Total assets are average of 2006 and 2007 annual data.