"ABS Inflows to the U.S. and the Global Financial Crisis"

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It is widely accepted that international capital flows played an important role in the emergence of the U.S. housing bubble and the global financial crisis that followed the bursting of that bubble. In this view, an excess of saving over investment in many emerging market economies, popularly referred to as the "global saving glut" (Bernanke, 2005, 2007), led to a surge in capital inflows to the United States that increased available credit and lowered interest rates. In combination with a number of additional factors—the increase in securitization, excessive reliance on credit ratings, increases in leverage, failures to manage liquidity and risk, and inadequacies of supervision and regulation—the expansion of financing associated with the capital inflows contributed to the U.S. housing bubble and to the buildup in financial vulnerabilities more generally that led to the crisis.

However, the global saving glut story represents an incomplete description of the developments in international capital flows that contributed to the crisis. The emerging market economies at the center of the global saving glut—China, other Asian developing economies, and the oil exporters—for the most part restricted their U.S. purchases to Treasuries, agency debt, and other low-risk investments. Their provision of savings to what ultimately proved to be risky borrowers—such as those with subprime mortgages —was indirect, as the massive capital

inflows pushed down yields on safe assets, thus increasing the appetite for riskier assets on the part of other investors.

A second feature of international capital flows contributing to the global financial crisis—direct foreign purchases of asset-backed securities (ABS) and other structured products—has received less attention. To be clear, throughout the paper, "ABS" refers to both mortgage-backed and other asset-backed securities that are "private-label", meaning they are not guaranteed by the GSEs. All securities issued or guaranteed by the GSEs are collectively referred to as Agency securities. By adding to the demand for private-label ABS, foreign acquisitions of these riskier securities likely contributed to the decline in their spreads over safe yields and to the increase in their supply, thus directly increasing the flow of resources to subprime and other risky borrowers. At the same time, foreign purchases of U.S. ABS ensured that when the bubble finally burst, the financial crisis would not be confined to the United States, but would spread throughout the world.

In our paper, we analyze data on international capital flows and portfolio positions in order to describe the evolution, magnitude, and financing of foreign acquisitions of U.S. ABS and structured instruments. We compare these acquisitions to those of U.S. Treasuries and Agencies by the "global saving glut" countries in order to examine the relative importance of these flows to the development of vulnerabilities leading to the crisis. We then develop a portfolio balance model to calculate how changes in the foreign demand for U.S. ABS might have affected interest rates on riskier U.S. assets, and compare that estimated effect to an estimate of the effect of purchases of U.S. Treasuries and Agencies by the global saving glut countries. We also contrast the effect of changes in either of these foreign demands with the effect of changes in the supply of U.S. ABS, another potential factor in the U.S. housing bubble.

Finally, we present the results of some rudimentary empirical research aimed at gauging the role of foreign capital inflows in the evolution of Treasury yields and spreads on U.S. ABS. This research has ready implications for policy analysis: the better we can identify the underlying roots of the recent global financial crisis, the better we can identify trends that anticipate future crises and design measures to counteract them.

To analyze the pattern of international capital flows, we combine data from several sources. The Treasury International Capital (TIC) System provides detailed data on the composition of U.S. capital flows and the U.S. external position by country and instrument. To these data we add details from other countries' published external positions, the BIS data on international banking positions, and the IMF's Coordinated Portfolio Investment Survey (CPIS), which provides geographic breakdowns of many countries' external securities claims. Finally, the detail available in the TIC data allows us to estimate the composition of other countries' claims and liabilities that are not otherwise available. Such estimates help fill out the picture of international capital flows and positions, providing the basis for addressing the role of ABS and other structured products in global imbalances.

Our research builds on a number of papers linking the emergence of the global financial crisis to international imbalances. Previous research on the role of international capital flows in the global financial crisis has followed two distinct strands. The first of these is the story sketched out above, in which current account surpluses in the emerging market economies enhanced the global supply of capital, reduced interest rates in the United States and other advanced economies, and thus encouraged the emergence of the bubble in subprime housing. Caballero, Farhi, and Gourinchas (2009), Jagannathan, Kapoor, and Schaumburg (2009), and Obstfeld and Rogoff (2009), among others, all muster theoretical models and/or empirical

evidence to discuss variants of this argument. Members of the official sector, such as Bernanke (2009) and Bini Smaghi (2008) have also referred to this line of causation.

The second strand of research into the international capital flows and the crisis has focused on the extent to which exposure to U.S. dollar assets and dollar liabilities—and particularly to U.S. ABS and other structured instruments—made foreign economies more vulnerable to financial disruptions, once the crisis began. Archaya and Schnabl (2009) assesses whether issuance of asset-banked commercial paper was associated with subsequent financial distress, while Kamin and Pounder (2010) examine whether holdings of U.S. ABS or financing in dollars led to greater declines in bank asset values in different economies. Rose and Spiegel (2009) and Ehrman, Fratzscher, and Mehle (2009) examine how exposure to U.S. assets and liabilities was related to broader economic movements during the crisis. Baba, McCauley, and Ramaswamy (2009) and McGuire and von Peter (2009) both analyze the funding patterns of non-U.S. banks that led to a severe shortage of dollar liquidity once the crisis began.

However, previous research has not considered whether the substantial acquisitions of U.S. ABS by foreigners, primarily in Europe, might not only have rendered foreigners more vulnerable to a bursting of the subprime housing bubble, but might also have contributed to the emergence of that bubble. Nor has previous research attempted a thorough-going comparison of the international capital flows associated with the "global saving glut" economies with those linked to the acquisition of U.S. ABS. Our research will thus fill gaps in the evolving literature on the global financial crisis in two respects, by exploiting the full range of available data to build a composite picture of the pattern of global capital flows in the lead-up to the crisis, and by assessing the extent to which foreign acquisitions of U.S. ABS and other structured investment products may have added to the factors propelling the emergence of the housing bubble.

The first section of the paper establishes that foreign purchases of U.S. ABS were quantitatively important in the financing of U.S. investment, particularly in housing. The second section of the paper focuses on the role of ABS in the increasing globalization of financial markets. A third section of the paper looks more closely at how economies financed their acquisitions of U.S. assets. The fourth section presents implications from simulations using a portfolio balance framework. The fifth section provides some empirical evidence on the impact of foreign demand for U.S. securities on Treasury yields and mortgage spreads.

Section 1: Quantitative importance of foreign purchases of U.S. ABS

Figure 1 summarizes the evolution of U.S. external liabilities, while Figure 2 compares the flow of foreign capital into U.S. Treasuries and Agencies with that into U.S. corporate bonds. The increase in liabilities required to finance the U.S. current account deficit in the years leading up to the crisis was very broad-based (Figure 1). While the stock of U.S. Treasuries and Agencies held by foreigners exceeded holdings of corporate bonds,in the years leading up to the crisis, foreign *flows* into corporate debt (including ABS) were at least as large as those into Treasuries and Agencies (Figure 2). Nearly half of the inflows in corporate bonds come from ABS. In addition, much of the remaining, non-ABS, portion of foreign flows into corporate debt securities was actually purchases of financial debt, floating rate notes, and various structured products, rather than relatively safe conventional nonfinancial corporate bonds. [1]

Furthermore, while foreign holdings of U.S. Treasuries and Agencies in mid-2007 were a large share of the amount outstanding—31 percent (see Table 1)—foreign holdings of ABS were not all that far behind. At 24 percent, they represented a substantial share of the market,

[1] Albertus, Bertaut, and Curcuru "Has the Crisis Changed Foreign Positions in U.S. Securities?" Federal Reserve staff working paper 2010.

certainly enough to have had a material impact on pricing. However, the geographic distribution of the inflows into these respective securities is quite different. Figure 3 shows the cumulated flows into the same securities as Figure 2, but differentiates these inflows by source of origin. Inflows from Emerging Asia and the Middle East were almost entirely in the form of U.S. Treasuries and Agencies, and investors from these countries account for about 60 percent of the inflows into these securities from 2003 up to June 2007. In contrast, inflows from Europe were largely in the form of corporate debt securities, with Europe responsible for most of the foreign purchases of corporate debt and about two-thirds of the foreign purchases of ABS. Most of the remaining corporate debt and ABS inflows came from Caribbean financial centers. The stark differences in the geography of the inflows suggest a role for ABS in capital flows that is distinct from that implied by the standard saving glut story.

Section 2: Role of ABS in increasing globalization of financial markets

Although all securities markets grew rapidly in the decade before the crisis, ABS and other structured products stand out as a significant component of the buildup in cross-border positions. Figures 4a and 4b show holdings of long-term debt securities by the euro area and the United Kingdom. Using TIC data, we can identify the portion of U.S. securities that is ABS, and some ABS issued in offshore centers. But some of the bar segments labeled "non-ABS", particularly the offshore and U.S. non-ABS segments, may also contain some ABS and other structured products. Though it is difficult to distinguish with certainty among external holdings of ABS, other structured credit products, and conventional debt, it is nonetheless evident that ABS and other structured debt instruments played an important role in the expansion of external

assets in the United Kingdom and the euro area, and thus contributed significantly to the increasing globalization of financial markets.

The role of ABS and other structured debt in financial globalization is illustrated more starkly in Figure 5. This figure identifies the part of the reduction in "home bias" for a number of advanced economies between 2003 and 2007 that is attributable to increased acquisitions of ABS and other structured products.[2] In the figure, reductions in home bias are expressed as positive values—the red portions of the bars represent the reduction in home bias associated with expanded holdings of ABS, while the blue portions represent reductions in home bias associated with acquisitions of other debt securities. For most of the economies examined, ABS accounted for a substantial part of the change in portfolios associated with a reduction in home bias during the period. Thus, while the process of financial globalization enhanced the breadth and depth of global financial markets, it also made it more likely that once the subprime housing bubble burst, its effects would be transmitted around the world.

Section 3: How did other economies finance their acquisitions of U.S. assets?

Here, significant differences in the financing of purchases of Treasuries by the emerging market economies and ABS purchases by Europeans become apparent. Figure 6 focuses on the three groups of economies most associated with the global saving glut—China, other developing Asian economies, and the OPEC countries—and compares their current account surpluses over the period 2003 to 2007 with their acquisition of U.S. securities and their deposits into European

[2] Home bias refers to the extent to which a country's holdings of external assets as a share of its total portfolio fall short of the standard CAPM benchmark: the share of total external market capitalization in global market capitalization.

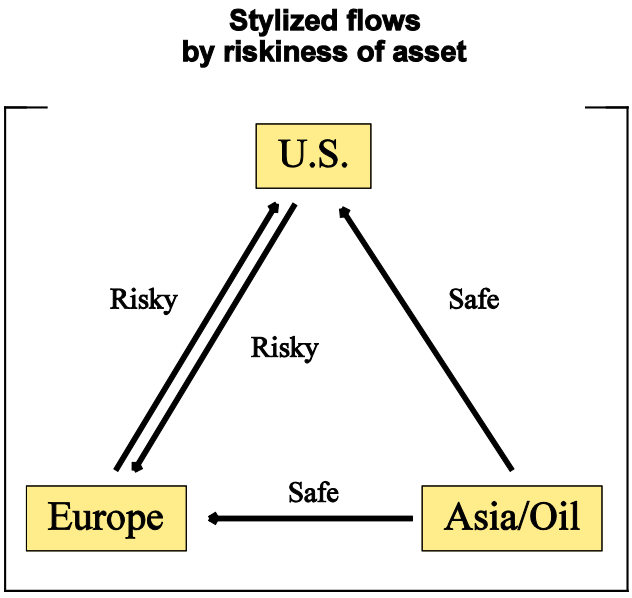
banks.[3] Although the data are incomplete, especially for OPEC, it is apparent that these economies' acquisitions of foreign assets were financed primarily by their own current account surpluses. It is also apparent that these surpluses financed not only purchases of U.S. assets, but investments in other economies, such as in Europe, as well.

By comparison, Europe, which accounted for most of the foreign purchases of U.S. ABS during the period, was running a small current account deficit in aggregate. Accordingly, as shown in Figure 7, the expansion of its claims – primarily in the form of debt securities and banking flows – was financed by a comparable expansion in its liabilities. Figure 8 decomposes Europe's gross portfolio flows by our estimates of the relative riskiness of the instruments ex-post. The bottom segment shows ABS, which proved to be the most toxic securities during the crisis. On the liabilities side, this bottom segment represents our lower bound estimate of external acquisitions of European ABS, while the next segment represents our upper bound. By either measure, Europe bought much more ABS than they sold. The same is true for the next segment up, other financial debt securities. Europe's acquisitions of financial debt were mostly from the U.S. and from offshore centers, which also tended to issue exotic debt. Moving up the bar, Europe bought similar amounts of equity as they sold, but bought slightly less of the somewhat safer nonfinancial debt than they sold. Finally, we estimate that Europe bought essentially no sovereign debt, on net. However, a large part of their financing inflows were from foreign purchases of European sovereign debt, which is usually perceived as quite safe (Greece aside). Figure 9 decomposes the debt securities flows from Figure 8 by the destination of Europe's outward investment (on the claims side) and the source of the inflows (on the liabilities side). Outward investment was largely to the United States and offshore centers, whereas most

[3] Data on the full range of external investments by these economies are not available. In particular, we have not yet identified their purchases of European securities.

of the expansion in liabilities is accounted for by increased holdings of its currencies in the international reserves of other countries as well as a large residual category, comprising mainly EMEs and offshore centers. Most likely, both the international reserves and the EME residual category are largely accounted for by liabilities to the global saving glut economies.

Hence, the global saving glut countries not only provided financing to the United States directly through purchases of U.S. assets, but also indirectly through purchases of European assets that financed purchases of U.S. assets. Moreover, insofar as European liabilities to the saving glut countries were in the form of safe assets such as government bonds and bank deposits, whereas European claims on the United States were in the form of ABS and other risky structured credit instruments, Europeans had considerable exposure to the subsequent crisis (as illustrated by the diagram of the "triangular trade" in financial assets. Ironically, Europe was acting as an international hedge fund in this regard; a role that previously had been attributed to the United States.



Section 4: A calibrated portfolio balance model of asset demands and supplies

How might purchases of Treasuries and Agencies by the global saving glut countries and purchases of ABS by Europeans and others have affected financial conditions in the United States? In particular, how might they have affected yields on asset-backed securities which, in

turn, would have affected the costs of mortgage borrowing by households and thus influenced the evolution of the housing bubble? To address this question, we next consider a stylized portfolio balance framework with three assets: (1) bank deposits; (2) U.S. Treasuries; and U.S. asset-backed securities (ABS). These assets are demanded by residents of three different economies: the United States, Europe, and the global saving glut countries (which, for convenience, we will refer to as "China"). We initially assume asset supplies are exogenous ; this assumption is relaxed for ABS supply in section 4.2 below. All assets are freely exchanged between investor countries at fixed exchange rates.

Let *a* stand for ABS, *b* for bank deposits, and *t* for Treasury securities. In this framework, demand for each asset A (shown here for ABS, or "A") in each country as a share of wealth W takes the form

$$\frac{A_a}{W} = b_{0a} + \beta_{aa} r_a - \beta_{ab} r_b - \beta_{at} r_t$$

Demand for each asset thus consists of an intercept term, and then is positively related to its own interest rate and negatively to the interest rates on other assets. Our goal is to solve for the various changes in interest rates that result from different configurations of investor preferences. Because in each country total wealth must be held in one of the three assets, the various cross elasticities for each country must obey

$$\beta_{aa} - \beta_{ab} - \beta_{at} = 0$$

$$\beta_{bb} - \beta_{ba} - \beta_{bt} = 0$$

$$\beta_{tt} - \beta_{ta} - \beta_{tb} = 0$$

Global demand can then be expressed as the averages of demands for the individual assets in each country, weighted by the shares of each country's wealth in global wealth. Further, because demand for each asset must equal the fixed asset supply, the system as specified is over-

determined: one of the interest rates will be completely determined by the equilibrium interest rates of the other two assets. For convenience, we set the interest rate on bank deposits to zero, and interpret the movements in returns on the other two assets as movements relative to the return on bank deposits.

We set initial stocks of assets and levels of country wealth to be roughly comparable to levels of deposits held in Europe and the United States, Treasury securities held by the public, and ABS outstanding in 2003. In our simplified version, these assets are held primarily by the United States and Europe, which have the same level of wealth ($10,000 billion), but Europe holds more of its wealth in deposits and smaller amounts in ABS and Treasuries; at $150 billion for ABS and $500 billion for Treasuries these are roughly comparable to the stocks of ABS and Treasuries held by Europe in 2003. "China" has wealth of $1,000 billion, which is roughly the size of the combined foreign exchange reserves of Asian and OPEC countries in 2003. "China's" wealth is held in equal amounts of deposits and Treasuries; the $500 billion assumption for Treasuries is roughly the stock of U.S. Treasuries held collectively by Asia/OPEC in 2003.

Initial Asset Stocks and Country Wealth Allocations

	Total (bill $)	United States	Europe	China
Deposits	17000	7175	9350	500
ABS	1000	850	150	0
Treasuries	3000	2000	500	500
Total Wealth	21000	10000	10000	1000

Expressed in portfolio share terms (the b0 coefficients in the asset demand equations), asset holdings in each country are

Initial Portfolio Shares			
	United States	Europe	China
Deposits	.7175	.935	.5
ABS	.085	.015	0
Treasuries	.2	.05	.5

With this framework, we consider the following comparative static exercises. First, we analyze the impact on yields of a step-up in Chinese purchases of Treasuries. Inflows from the saving glut countries can be thought of as an exogenous increase in China's wealth which initially is matched by an increase in the global supply of deposits. Because China still desires to hold half of its wealth in U.S. Treasuries, the increase in China's demand for Treasuries will lower the interest rate on Treasuries relative to bank deposits, but will also, depending on asset substitutabilities, lower interest rates on ABS as well, as investors in the United States and Europe are induced to absorb some of the excess supply of deposits and relinquish some of their holdings of Treasuries.

Second, we analyze the effect on yields of a rise in European demands for U.S. ABS. Europe did not run current account surpluses in aggregate to acquire U.S. ABS, but rather took in safe deposits from other countries to finance the ABS; this can be modeled as a reduction in European demand for deposits coupled with an increase in their demand for ABS, and will also have the effect of lowering the interest rate on ABS (and Treasuries) relative to the interest rate on deposits.

The extent to which Chinese purchases of U.S. Treasuries lower interest rates on ABS more or less than European purchases of ABS depends on (1) the relative magnitudes of these

purchases, and (2) the elasticities and cross-elasticies of demand for the different assets. We present calculations of the effects of each of these shifts in foreign demand under 3 different assumptions about the elasticities.

Third, and finally, we analyze an alternative scenario in which the U.S. housing boom is driven by factors internal to the U.S. housing and financial markets themselves rather than by foreign demand for assets. Accordingly, we present a "supply" shock, modeled as an exogenous increase in the quantity of ABS in the market.

Under the "low elasticity" assumption, U.S. investors regard Treasuries and deposits as fairly substitutable, but their demand ABS is less elastic, and the cross elasticities of demand for deposits and Treasuries with respect to changes in the ABS return are smaller. The sizes of the relative interest rate elasticities are based on an earlier body of empirical estimates of portfolio allocation responses of U.S. investors to changes in interest rates on time deposits, Treasury securities, and corporate debt. European investors are assumed to regard deposits and Treasuries as somewhat less substitutable, but in particular their asset demands are quite inelastic with respect to the yield on ABS. In the "medium elasticity" case, European investors are assumed to have the same elasticities and cross-elasticities for ABS as do U.S. investors. Under the "high elasticity" assumption, both U.S. and European are assumed to be more willing to substitute between ABS and deposits or Treasuries. In all three cases, China's asset demands are only for deposits and Treasuries, and these demands are unresponsive to changes in the return on ABS. Elasticity assumptions are listed in the table below.

Interest Rate Elasticities and Cross Elasticities									
	Low elasticity			Medium elasticity			High elasticity		
	Deposits	MBS	Treasuries	Deposits	MBS	Treasuries	Deposits	MBS	Treasuries
	US			US			US		
Deposits	0.9	-0.1	-0.8	0.9	-0.1	-0.8	0.9	-0.1	-0.8
MBS	-0.1	0.3	-0.2	-0.1	0.3	-0.2	-0.1	0.5	-0.4
Treasuries	-0.6	-0.2	0.8	-0.6	-0.2	0.8	-0.5	-0.3	0.8
	Europe			Europe			Europe		
Deposits	0.75	-0.05	-0.7	0.75	-0.05	-0.7	0.75	-0.05	-0.7
MBS	-0.05	0.15	-0.1	-0.1	0.3	-0.2	-0.1	0.5	-0.4
Treasuries	-0.6	-0.1	0.7	-0.6	-0.2	0.8	-0.5	-0.3	0.8
	China			China			China		
Deposits	0.8	n.a.	-0.8	0.8	n.a.	-0.8	0.8	n.a.	-0.8
MBS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Treasuries	-0.8	n.a.	0.8	-0.8	n.a.	0.8	-0.8	n.a.	0.8

Parameter settings and interest rate responses are listed in Table 2. In our first exercise (1A), China's external investments rise to $2 trillion, roughly comparable to the increase in foreign exchange reserves of the saving glut countries from 2003 through 2005. The increased demand from China generates a decline in the equilibrium interest on Treasuries of about 340 to 400 basis points in all three cases, and after interest rates respond, China holds roughly 30 percent of the stock of Treasuries and total foreign holdings increase from 1/3 of the Treasury stock to a little over 40 percent. The decline in the ABS yield is somewhat more variable, falling almost 230 basis points in the low elasticity case and slightly less when Europe's demand is more elastic. However, ABS yields decline a sizable 330 basis points in the "high" elasticities case, as U.S. investors' demand for ABS is now also more affected by the decline in the Treasury yield.

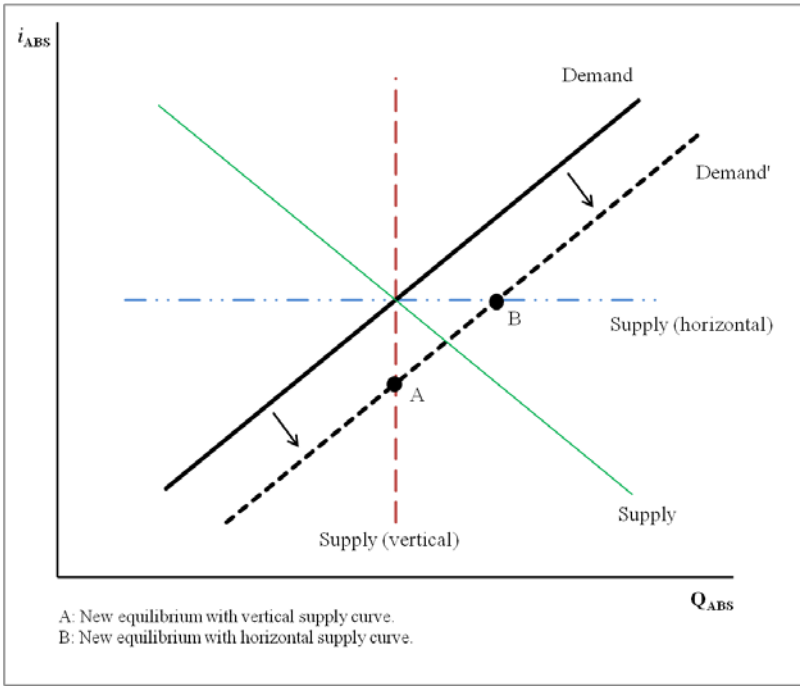
In our second set of experiments, we consider an increase in Europe's desired portfolio share in ABS from 1.5 percent to 3 percent, with a corresponding decline in Europe's demand for deposits (2A). Not surprisingly, this shift also has a sizable affect on ABS yields, but here the effect is larger when elasticities are lower: when ABS is less substitutable for Treasuries or deposits, U.S. investors require a larger decline in the ABS yield to be willing relinquish the

securities and absorb the excess demand for deposits. European investors end up holding roughly 25 percent of the stock of ABS in the low elasticities case and slightly less (about 20 percent) in the high elasticities case.The results of these exercises indicate that both Treasury and ABS yields are affected by both types of shifts in external asset demands, but are inconclusive about which affect is likely to have contributed more to the decline in ABS yields. Moreover, greater willingness on the part of U.S. investors to shift between Treasuries and ABS serves to lessen the affect on the ABS yield if the external shock comes from a shift in European demand, but increases the affect when the demand shock comes from an increase in China's wealth. Spreads of ABS over Treasuries narrow in the case of European purchases of ABS but widen in the case of increased inflows from China.

In scenario 3A, we allow for an exogenous shift in the supply of ABS, increasing the quantity of ABS by 20 percent with a corresponding decrease in the supply of deposits. As expected, this shock generates a pronounced increase in the ABS yield to persuade U.S. and European investors to absorb the excess ABS supply, with a larger response (roughly 500 basis points) when substitutability between ABS and other assets is low and a still-sizable nearly 300 basis points in the more elastic response. Yields on Treasuries are also pushed up by this shock, rising roughly 100 basis points under all three cases. Considering that yields on Treasuries and ABS actually declined during this period, it suggests that an exogenous rise in ABS issuance cannot be the whole story behind the U.S. housing bubble.

4.2 Allowing for an ABS supply response

In our results above, we assume that asset supplies are fixed, thus generating fairly large interest rate responses to bring about equilibrium in asset markets in response to either demand or supply shocks. In the context of a standard supply/demand diagram, this would correspond to a vertical supply curve for each of the three assets. In practice, of course, a large part of the subprime bubble was a substantial rise in the quantity of ABS issued, at least in part as lower yields contributed to the U.S. housing boom and the granting of mortgages that were then repackaged as additional ABS. To explore how our results would change if we were to allow for an ABS quantity response, we relax the assumption that the ABS supplies are fixed, allowing instead for ABS to respond, over time through an auto-regressive process, to movements in the return on ABS.[4] In effect, we replace the vertical ABS supply curve in our stylized framework, with a new equilibrium following a demand shock at point A, with a completely horizontal one. In



[4] Although we do not formally model the process, we assume that additional wealth generated through this process accrues to the United States, reflecting the underlying economic activity in the housing market.

this setup, interest rates on ABS cannot move, and the quantity of ABS issued moves one-for-one with its demand, generating a new equilibrium at point B.[5] All other asset supplies are kept fixed. We conduct the same comparative static results as above. Table 3 summarizes these new results in comparison with the original "vertical" ABS supply curve results.

When ABS supplies can respond fully to changes in ABS yields, the new equilibrium interest rates on ABS are (naturally) unchanged, regardless of the source of the shock. Yields on Treasuries are still pushed down by either demand shock, and are still raised with the exogenous ABS supply shock, but the sizes of these movements are smaller than when the supply curve for ABS is vertical. ABS *quantities* are particularly affected by the demand cross-elasticities in the China wealth shock case. When investors do not view ABS as particularly substitutable for either deposits or Treasuries (when elasticities are fairly low) the (initial) decline in ABS yields generates an increase in ABS supply of roughly 10 percent to $1103 billion. In contrast, ABS quantities rise to $1276 billion – an increase of over 25 percent – in the high elasticities case. This larger supply response is the counterpart of the large yield responses on both ABS and Treasuries in the high elasticities case when ABS supplies are fixed.

For the China wealth shock (1A), China ends up holding slightly more Treasuries (thus allocating a share slightly closer to the initial desired 50 percent of the portfolio) in the case of the horizontal ABS supply curve than in the vertical ABS case across all configurations of elasticities, but the differences are fairly small. In the European shift in demand shock (2A), European holdings of ABS are (naturally) a good bit larger when the ABS quantities are allowed to respond. In the new equilibrium, European investors actually slightly exceed the (initial) desired 3 percent of their portfolio in ABS.

[5] This strong assumption was adopted for technical reasons. In subsequent revisions to this paper, we plan to introduce a more standard downward sloping (but not vertical) supply curve for ABS with respect to its interest rates.

Table 3 also summarizes the effects on the spreads between ABS and Treasuries resulting from our various comparative static exercises, a natural focus when both yields are moving. For the China wealth shock, the spread increases when supply curves are vertical, and this result is made even stronger when we consider a horizontal supply curve. For the European demand shock, however, results are inconclusive: the spread narrows when the ABS supply curve is vertical, but widens very slightly when it is horizontal. The effect on the spread is also inconclusive for the exogenous increase in ABS supply shock.

Figure 10 shows the evolution of the interest rate and ABS quantity responses under the "medium" elasticities assumptions for each of our three shocks, to provide some sense of the dynamics of the response to shocks.[6] In the China wealth shock scenario (shown in panels 1 and 2), yields on both ABS and Treasuries are depressed in the first period. With a vertical supply curve for ABS, the response would stop here, with both yields pushed down by the initial shock. But with a horizontal supply curve for ABS in the long run, the supply of ABS begins to respond to the lower ABS yield, eventually pushing ABS yields back up to their original level and, as a result, lifting Treasury yields back slightly as well. In the European demand shock scenario (panels 3 and 4), the yield on ABS initially falls below the yield on Treasuries, narrowing the spread, but this relationship reverses as the ABS quantity begins to respond, and in equilibrium the ABS yield is unchanged while the Treasury yield remains somewhat lower, resulting in slightly wider spread between the two. A similar effect happens with the ABS shock (panels 4 and 5), although in this case the ABS yield initially starts out with a larger increase than the Treasury yield. We view these results of the vertical ABS supply curve and the full ABS supply

[6] It should be noted that time periods in this stylized framework have no particular interpretation, but they do show that the equilibrium interest rate and ABS quantity responses are not instantaneous and instead are the result of an iterative process that make take some period of time.

response as bounding what we think the likely response would be for a normal downward sloping supply response.

Section 5: Empirical evidence on mortgage spreads and effect of foreign demand

What was happening to mortgage spreads in the United States during this period? Figure 11 displays rates on subprime mortgages (shown here as the origination rates on subprime ARMs), which declined roughly 250 basis points from 2000 through 2006; but the spread between subprime ARMs and conforming ARMs moved down only slightly. Much of the decrease in the subprime mortgage rate is from a decline in the Treasury yield, consistent with the role of saving glut inflows contributing to the U.S. housing bubble. However, even a small decline in spreads is quite remarkable, given the explosion in the number of subprime loans issued over this period: subprime originations grew nearly 20-fold, while Treasury issuance increased roughly 50 percent over the time frame. Figure 12 shows a similar development for Alt-A ARMs; here there is a somewhat more noticeable decline in the spread over conforming ARMs even in the face of a substantial increase in Alt-A issuance.

In light of the calibrated model calculations shown in the previous section, it seems clear that the developments described above cannot be attributed exclusively to a rise in the supply of ABS, as, in the absence of a corresponding rise in ABS demand, that would have boosted ABS yields and their spreads over Treasuries. In addition, Treasury yields might have risen somewhat. Thus, it seems likely that increases in the demand for Treasuries and ABS, including by foreigners, were also influential during the housing bubble. To provide additional evidence on this point, we estimate some simple, reduced-form regressions linking asset yields to foreign capital inflows.

We start by looking at the effect, in the spirit of Warnock and Warnock (2009), of foreign official purchases of U.S. Treasuries on Treasury yields. Most of these purchases came from countries associated with the global saving glut, and they could reasonably be described as exogenous to the Treasury yields themselves—China and other Asian countries were intervening to buy dollars in FX markets and channeling the proceeds into U.S. Treasuries and Agencies in a fairly stable allocation. For the effect of foreign purchases on Treasury yields, we use the following single equation OLS specification in Beltran, Marquez, Thomas (2009), which reformulates the Warnock and Warnock model as an AR(1) after extensive testing of alternative specifications:

$$R_{120,t} = f(\widehat{Y_t^e}, \pi_{t+12}^e, \pi_{t+120}^e, rp_t, R_{ff,t}, R_{120,t}^{\epsilon}, \frac{F_t}{D_t})$$

$R_{120,t}$: 10-year U.S. Treasury yield, nominal
$\widehat{Y_t^e}$: expected GDP growth (blue chip)
π_t^e: expected inflation rate (1-year and 10-year ahead Michigan survey)
rp_t : risk premium
$R_{ff,t}$: federal funds rate
$R_{120,t}^{\epsilon}$: 10-year Euro nominal interest rate
F_t: foreign holdings of U.S. Treasuries and Agencies
D_t: total outstanding marketable U.S. Treasuries and Agencies

One lag of the 10-year Treasury yield is included on the right-hand side, in addition to one lag of each independent variable. Table 4 shows our results replicating those from Beltran, Marquez, Thomas using data over the period 1990 to June 2007. The foreign share of Treasuries and Agencies significantly decreases Treasury yields, just as in Warnock and Warnock. The first column regression is at a monthly frequency, as in previous work. The second column shows that a quarterly frequency, which we will use in later regressions, does not substantially change the results. All told, therefore, it seems likely that "China's" purchases of U.S. assets depressed Treasury yields, just as in the model explored in Section 4.

But to what extent did foreign demand for assets influence the cost of U.S. mortgage borrowing? The regressions in Table 5 are of a similar nature as those in Table 4, but use the foreign share of U.S. ABS securities outstanding to explain various measures of mortgage spreads to Treasury yields.

Unfortunately, foreign holdings of ABS are only available beginning in the fourth quarter of 2001. At a quarterly frequency (used because the denominator, U.S. ABS outstanding, is only available quarterly from Flow of Funds data), this generates only 22 observations of our key independent variable.[7] We look at 3 measures of mortgage spreads: a 30-year fixed rate mortgage to 10-year Treasury, an AltA 1-yr ARM to a conforming ARM indexed to a 1-yr Treasury, and a subprime 1-yr ARM to a conforming ARM indexed to a 1-yr Treasury. The 10-year Treasury yield and a time trend are also included as regressors.

We find that the foreign share of ABS significantly predicts the subprime and AltA ARM spreads, with spreads lower by about 30 basis points for every percentage point increase in the foreign share of ABS. There is no significant effect of the foreign share on 30-year fixed mortgage spreads. As a consistency check, the final column shows the results of the fixed mortgage spread regression over the longer 1990-2007 period, but omits the foreign share variable, which lacks data over much of the period.

Thus, these results provide some empirical support for the view that foreign demand for assets not only helped to push down Treasury yields over the period, but also yields on riskier asset-backed securities. A complication for this analysis, of course, is that while foreign official

[7] To test a longer time period, we also used the foreign share of all U.S. corporate debt (of which ABS is a subset) as a proxy for the foreign share of ABS. The coefficients were insignificant on the fixed mortgage and subprime spreads and significantly negative on the AltA spread. However, the subprime and AltA spreads themselves are also unreliable before the 2000s because the volume of such loans was so small. Further, because private-label MBS was such a tiny fraction of U.S. corporate debt before the 2000s, we would not expect a significant relationship between fixed-rate mortgage spreads and foreign purchases of corporate debt in the 1990s.

purchases of Treasuries might be viewed as exogenous to interest rate movements, European investors' purchases of ABS clearly were not. However, Granger causality tests (not shown) suggest that foreign purchases more likely Granger cause subprime and AltA spreads than the reverse. Moreover, although we take the identification problem seriously, if changes in ABS spreads were causing foreign purchases, then presumably the coefficient on the foreign purchases variable would have been positive, not negative. Accordingly, it appears that changes in foreign demand for ABS dominated changes in U.S. issuance of ABS as a factor influencing spreads during this period.

Concluding Remarks

This paper explores the channels through which foreign demand for U.S. assets may have contributed to the evolution of the U.S. housing bubble, thus laying the foundations for the subsequent financial crisis. We distinguish between two sources of foreign demand: demand for Treasuries and Agencies from China, OPEC, and other emerging market Asian economies (the "global saving glut" countries) on the one hand, and European demand for U.S. ABS on the other. We show that although these two types of financial inflows were of comparable magnitudes in the years leading up to the crisis, they were financed in very different ways. Acquisitions of U.S. assets from the saving glut countries were financed by their sizable current account surpluses. In contrast, Europe had roughly balanced current accounts, and thus financed their acquisitions through a considerable expansion in their external liabilities. We show that when taken together, the cross border financial flows between the United States, Europe, and the saving glut countries make up a global "triangular trade" in financial assets.

We developed a calibrated portfolio balance model to compare the effects on Treasury and ABS yields of shocks to either source of foreign demand. Our results show that they could have both exerted significant downward effects on yields, thus contributing to the housing bubble. In contrast, we show that a shock to ABS supply would have lifted yields, which suggests that increases in demand were likely crucial in influencing the patterns of U.S. interest rate responses. Our preliminary empirical results confirm the role of the "saving glut" inflows in depressing Treasury yields—replicating previous findings—but also provide preliminary support to the role of foreign purchases of ABS in pushing down spreads on the mortgages underlying these securities.

However, our analysis to date is still very much work in progress. In next steps, we plan to address more fully the asset supply responses as part of a fleshed out theoretical model and further test model implications with additional empirical analysis. This will allow for more thorough investigation of the channels through which foreign demand shocks influenced asset prices and quantities.

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Table 1. Foreign Holdings of U.S. Securities as a Share of Outstandings

(as of June 2007, Billions of U.S. dollars)

		Total Outstanding [1]	Foreign Held[2]	Foreign Share of Total (Percent)
1	Treasury and agency securities[3]	11,688	3,607	31%
2	Corporate & municipal credit securities (non asset-backed)[4]	8,616	2,045	24%
3	Corporate ABS + ABCP[5]	4,185	990	24%
4	Corporate equities and fund shares	27,768	3,130	11%

Notes

1 Source: Flow of Funds March 6, 2008 Z.1 Statistical Release, tables L.200-L.228 (Federal Reserve Board, 2008). See note 5 for ABS and ABCP outstandings.

2 Foreign holdings were obtained from tables 1, 23 and 24 of the "Report on Foreign Portfolio Holdings of U.S. Securities," as of June 30, 2007 (Department of the Treasury, 2008) with slight modifications to foreign held corporate ABCP from Beltran, Pounder, Thomas (2008).

3 Total includes savings bonds and holdings of the Federal Reserve System.

4 Includes open market paper.

Table 2. Parameter settings and interest rate responses from the portfolio balance model exercises

	Total Assets Outstanding	Initial desired portfolio shares: US	Europe	China	interest rate responses: low elasticity	medium elasticity	high elasticity
Deposits	17000	0.7075	0.9425	0.5			
MBS	1000	0.0925	0.0075	0			
Tbills	3000	0.2	0.05	0.5			
Total	21000	10000	10000	1000			
1A. Wealthier China matched by increased asset supply in deposits							
Deposits	**18000**	0.715	0.935	0.5			
ABS	1000	0.085	0.015	0	-228	-223	-313
Tbills	3000	0.2	0.05	0.5	-342	-335	-391
Total	22000	10000	10000	**2000**			
2A. Europe desires larger portfolio share in ABS							
Deposits	17000	0.715	0.92	0.475			
ABS	1000	0.085	**0.03**	0.025	-382	-297	-210
Tbills	3000	0.2	0.05	0.5	-72	-71	-75
Total	21000	10000	10000	1000			
3A. Exogneous shift in quantity of ABS							
Deposits	**16800**	0.715	0.935	0.475			
ABS	**1200**	0.085	0.015	0.025	509	396	280
Tbills	3000	0.2	0.05	0.5	97	94	100
Total	21000	10000	10000	1000			

Table 3. Comparison of interest rate and ABS quantity responses under the alternative ABS supply curves

	"Vertical" ABS supply curve			"Horizontal" ABS supply curve		
1A. Wealthier China matched by increased asset supply in deposits	**low elasticity**	**medium elasticity**	**high elasticity**	**low elasticity**	**medium elasticity**	**high elasticity**
ABS	-228	-223	-313	0	0	0
Tbills	-342	-335	-391	-312	-297	-312
ABS-Tbill spread	114	112	78	312	297	312
Quantity of ABS	1000	1000	1000	1103	1131	1276
2A. Europe desires larger portfolio share in MBS						
ABS	-382	-297	-210	0	0	0
Tbills	-72	-71	-75	-21	-20	-22
ABS-Tbill spread	-309	-226	-135	21	20	22
Quantity of ABS	1000	1000	1000	1171	1173	1183
3. Exogenous increase in supply of MBS						
ABS	509	396	280	0	0	0
Tbills	97	94	100	29	28	31
ABS-Tbill spread	412	302	180	-29	-28	-31
Quantity of ABS	1200	1200	1200	972	970	958

Table 4: Foreign Purchases Effect on Treasury Yields

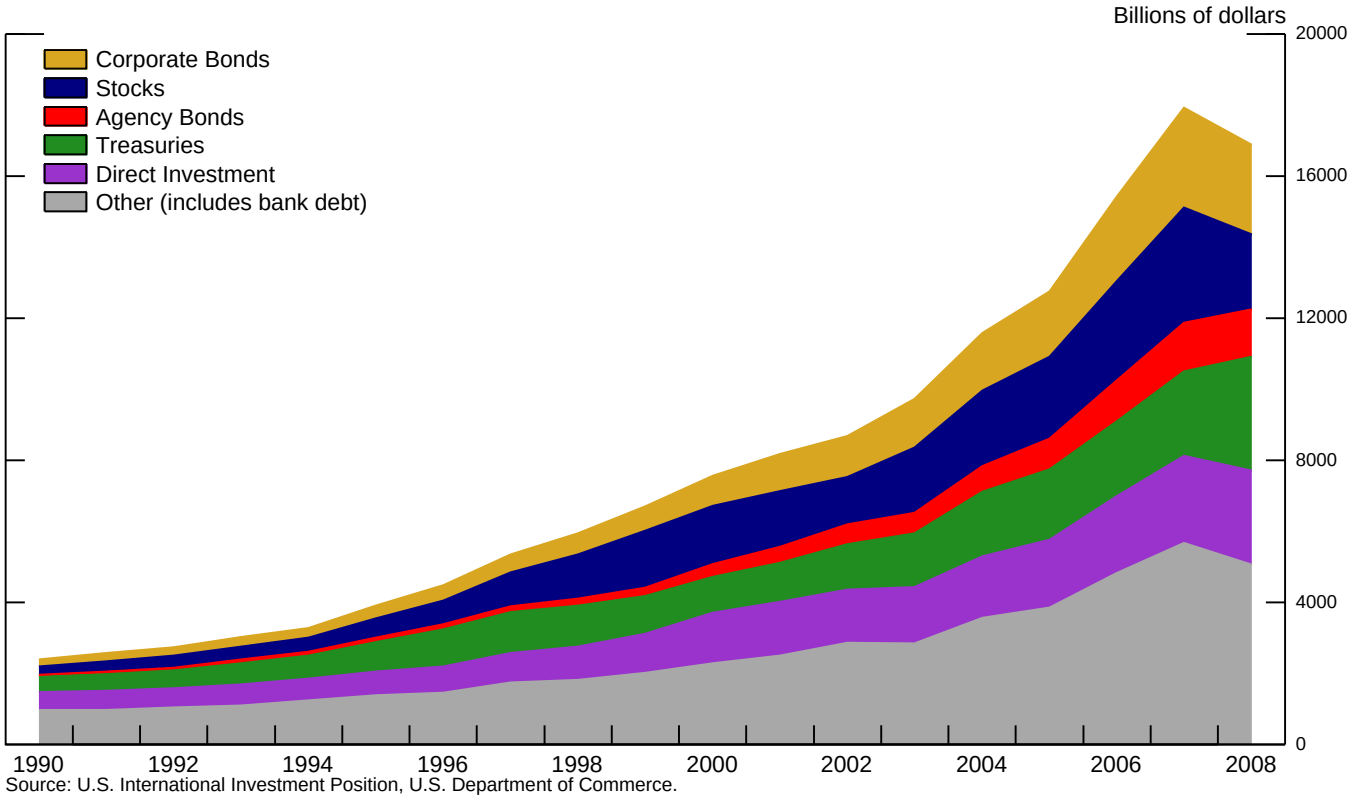
	Monthly	Quarterly
Dependent: 10-yr Treasury Yield		
Y^e	-0.424	-0.444
	(-2.03)	(-1.64)
$\pi^e(t+1)$	-0.460	-0.587
	(-1.74)	(-1.28)
$\pi^e(t+10)$	0.933	1.294
	(2.91)	(2.38)
risk premium (rp)	4.110	5.014
	(1.77)	(1.67)
Rff (federal funds rate)	0.164	0.202
	(2.42)	(2.27)
$R^€$ (10-year Euro rate)	-0.020	-0.137
	(-0.16)	(-0.72)
F^T (foreign share of Treasuries and Agencies)	**-0.038**	**-0.041**
(t-statistic)	**(2.82)**	**(2.24)**
Constant	0.788	1.38
	(3.42)	(2.25)
Adj R2	0.98	0.96
Obs	206	68

Table 5: Foreign Purchases of ABS Effect on Mortgage Spreads

Dependent:	Subprime 1-yr ARM Spread	AltA 1-yr ARM Spread	30-yr Fixed Mortgage Spread (ABS period)	30-yr Fixed Mortgage Spread (longer period)
10-year Treasury yield	0.416	-0.539	0.054	0.134
(t-statistic)	(1.54)	(-1.03)	(0.26)	(1.40)
F^{ABS} (foreign share of US ABS)	**-0.289**	**-0.308**	-0.027	
(t-statistic)	**(-2.64)**	**(-1.65)**	(-0.42)	
time trend	**0.073**	0.035	0.012	0.006
(t-statistic)	**(3.12)**	(0.71)	(0.63)	(2.62)
Constant	**-9.47**	-2.63	-1.44	-0.68
(t-statistic)	**(-2.27)**	(-0.31)	(-0.45)	(-1.38)
Adj R2	0.92	0.91	0.39	0.71
Obs	22	22	22	**68**

Figure 1

Composition of U.S. External Liabilities



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

Figure 2

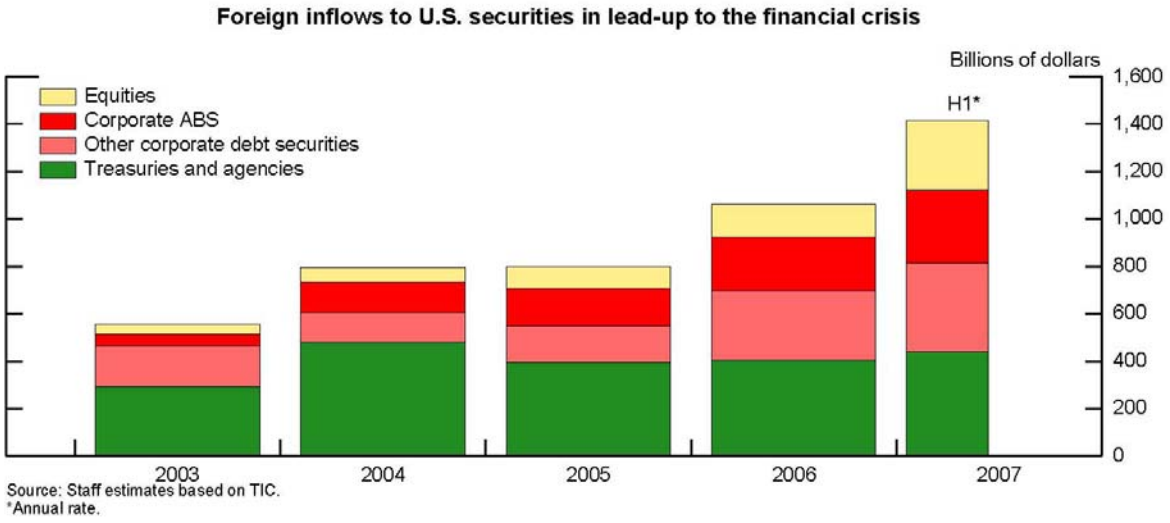

Foreign inflows to U.S. securities in lead-up to the financial crisis
Billions of dollars
Equities
Corporate ABS
Other corporate debt securities
Treasuries and agencies
H1*
1,600
1,400
1,200
1,000
800
600
400
200
0
2003
2004
2005
2006
2007
Source: Staff estimates based on TIC.
*Annual rate.

Figure 3

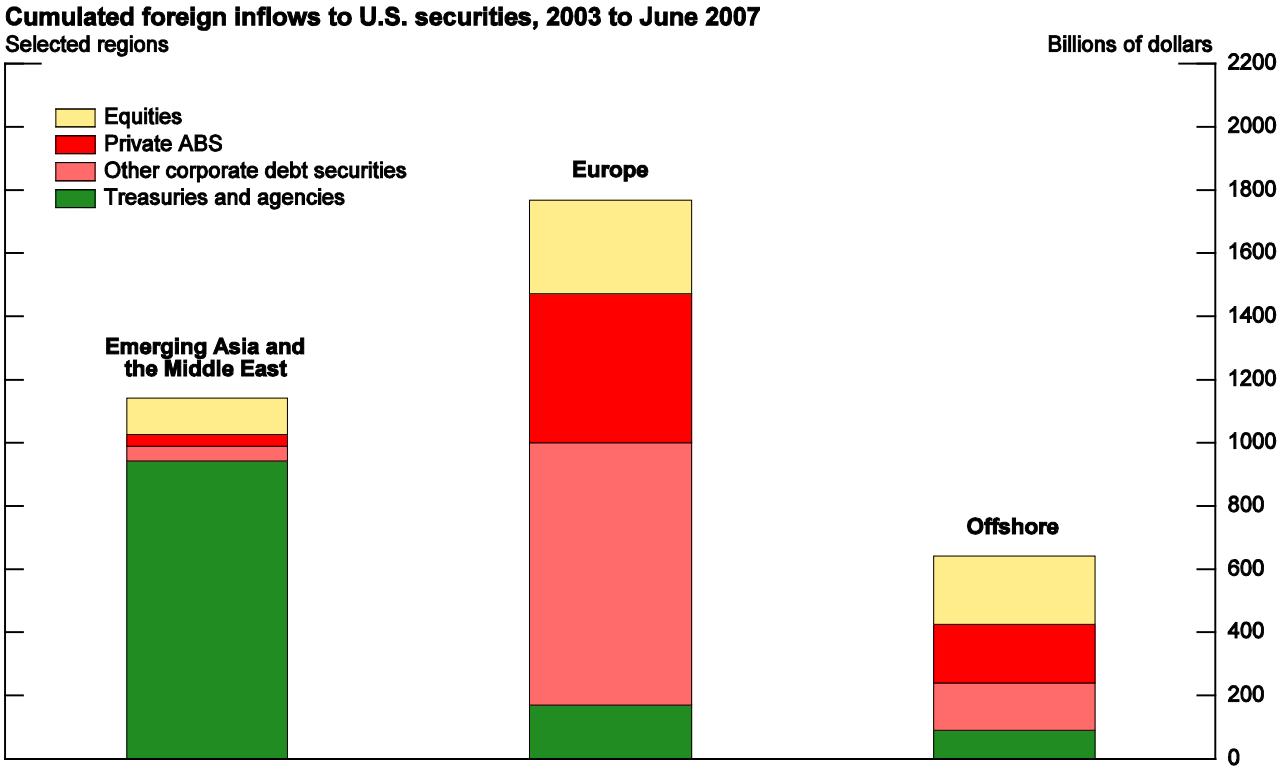
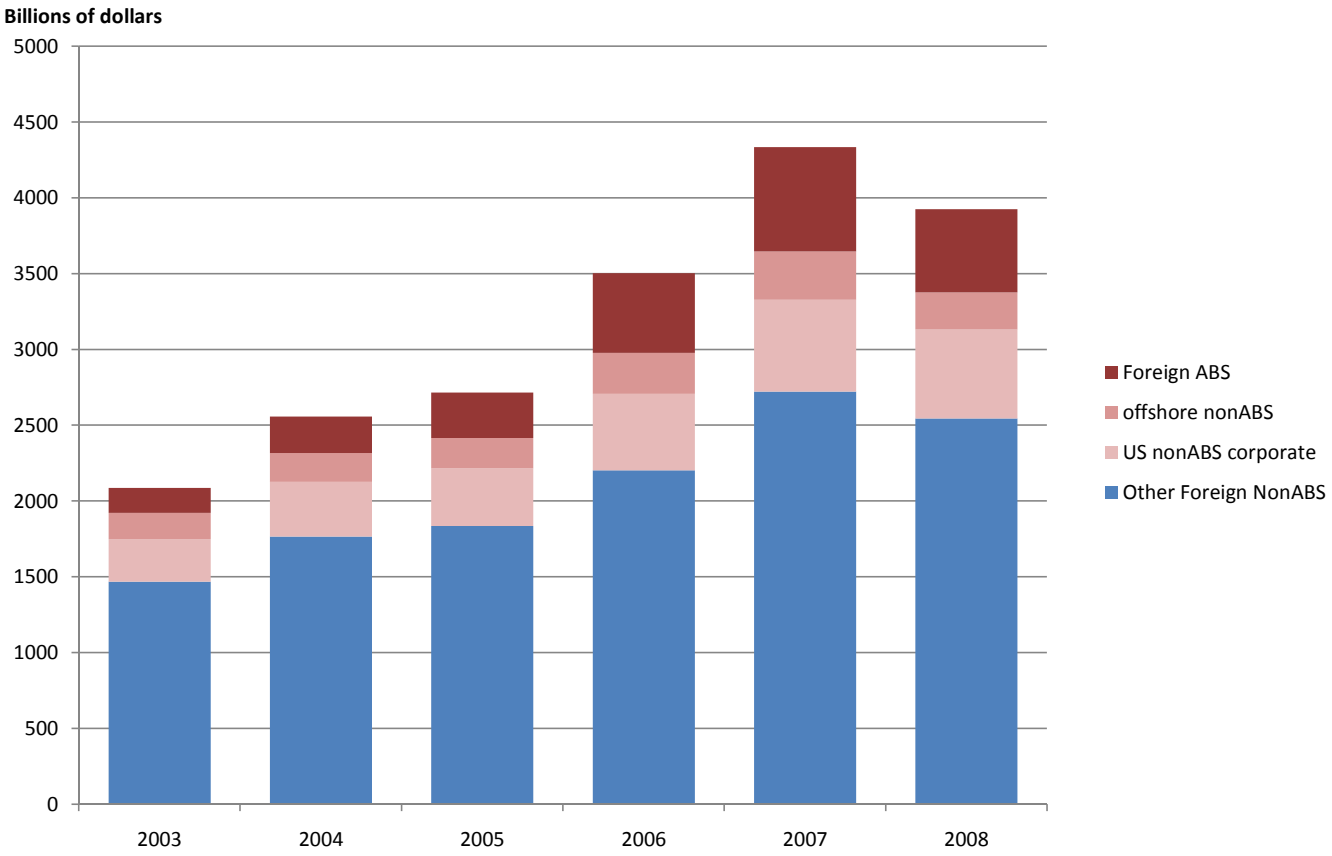

Cumulated foreign inflows to U.S. securities, 2003 to June 2007
Selected regions
Billions of dollars
Equities
Private ABS
Other corporate debt securities
Treasuries and agencies
Emerging Asia and the Middle East
Europe
Offshore
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0

Figure 4a

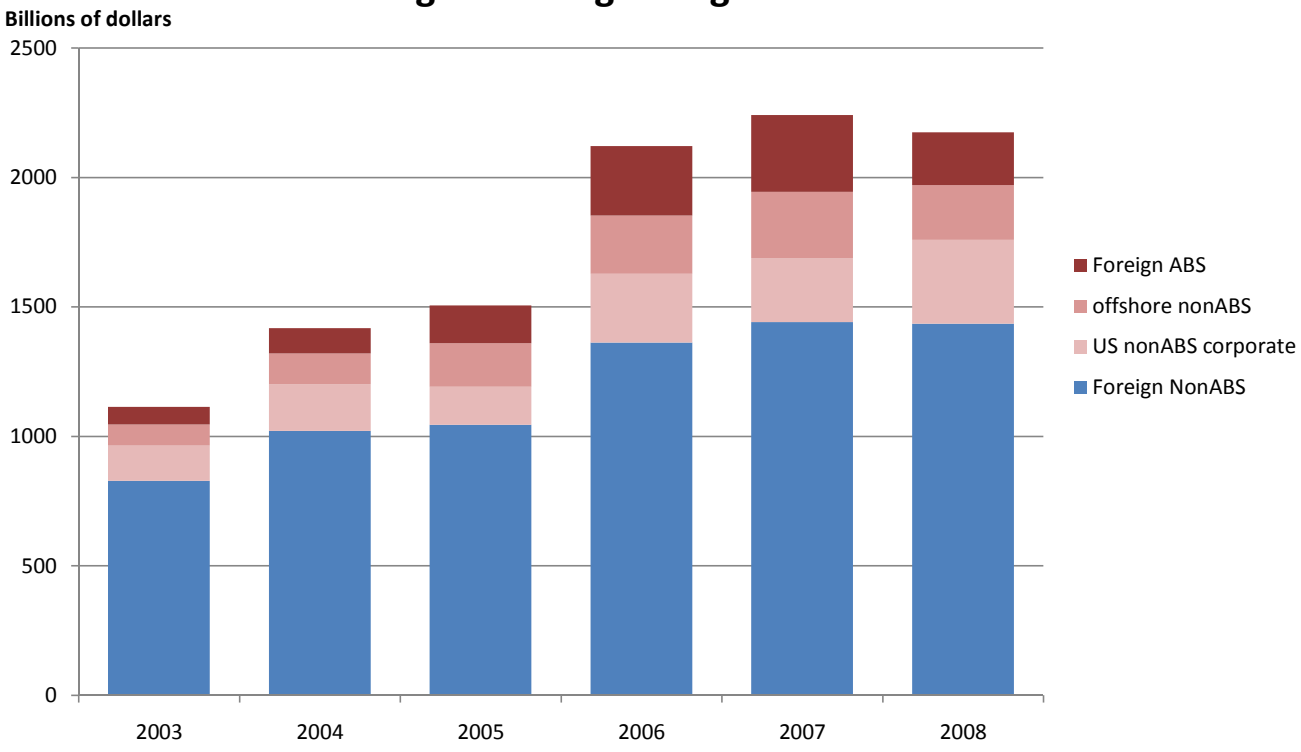
Euro area holdings of foreign long-term debt securities



Source: Staff estimates based on CPIS, euro area international investment position, and TIC.

Figure 4b

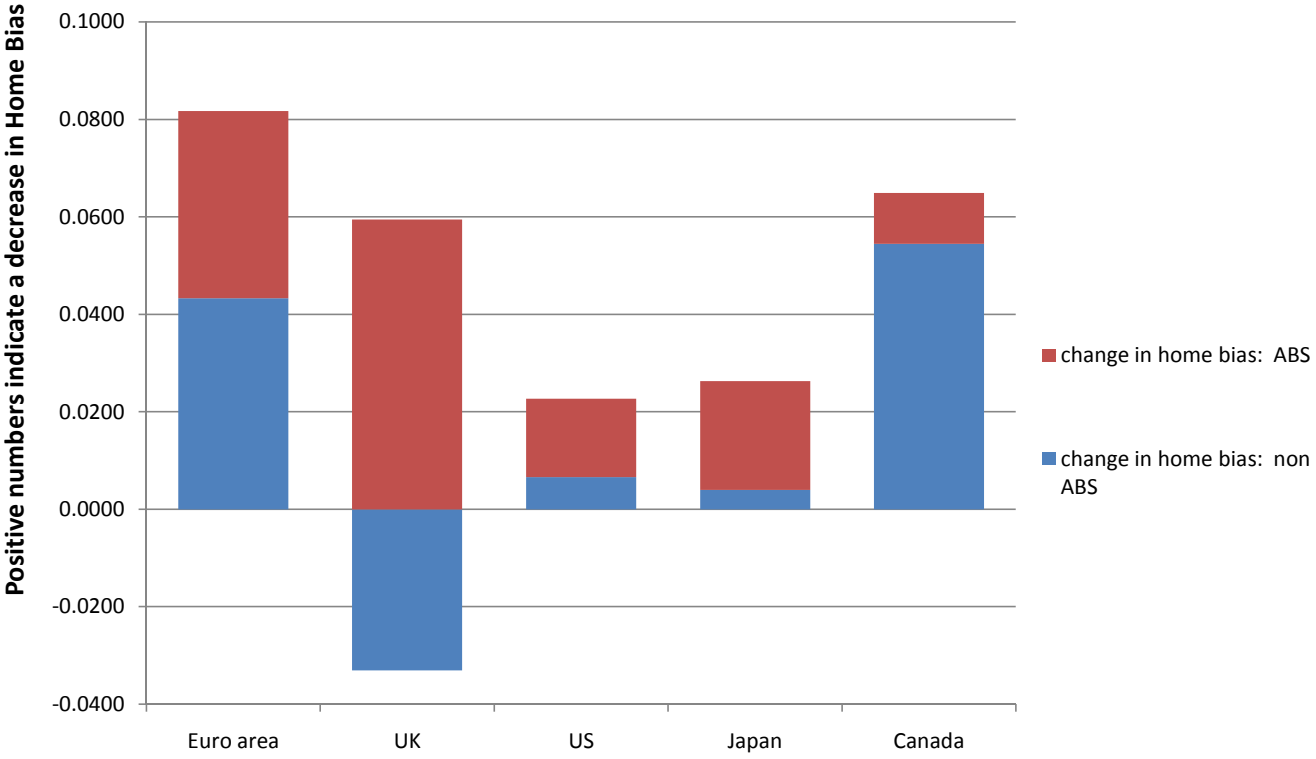
UK Holdings of Foreign Long-Term Debt Securities



Source: Staff estimates based on CPIS, UK international investment position, and TIC.

Figure 5

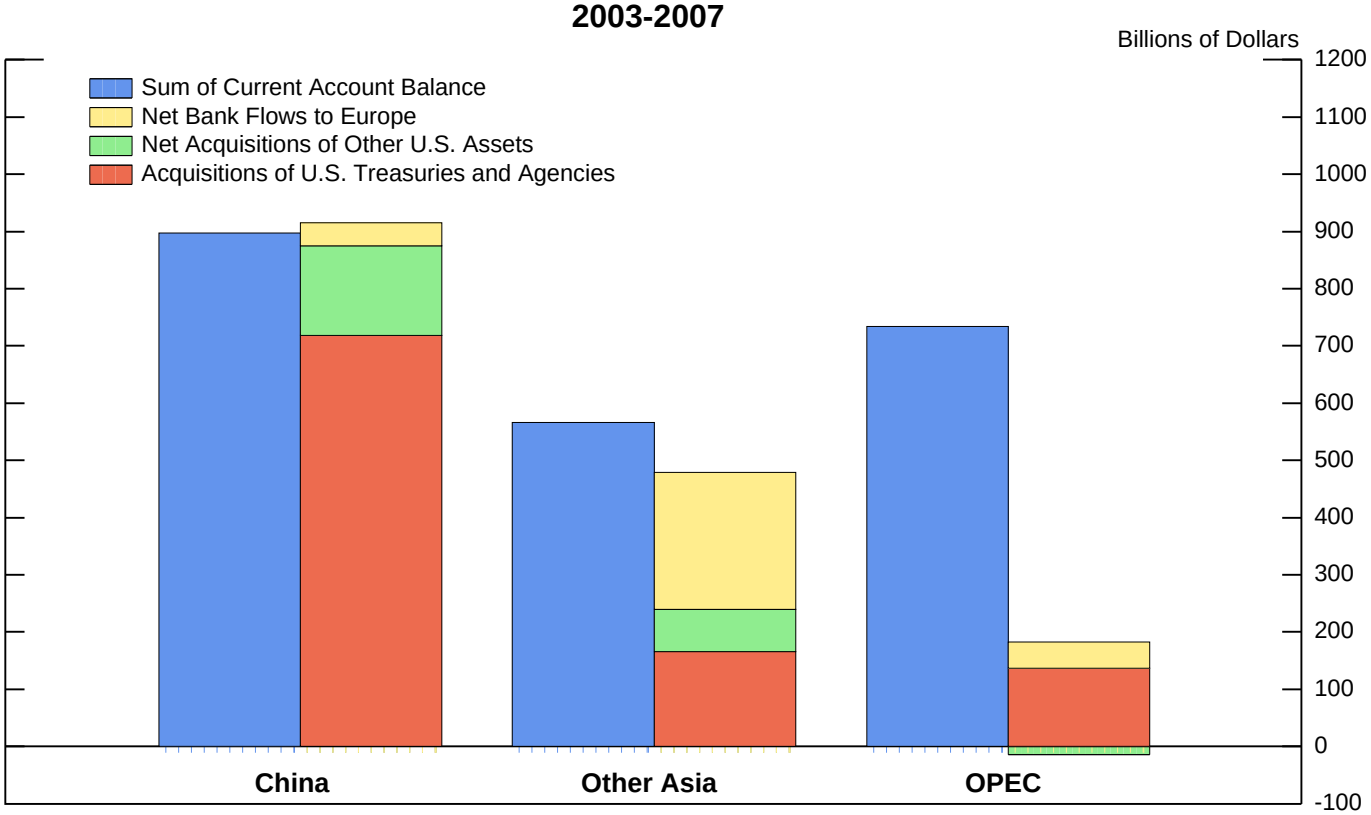
Decrease in "Home Bias" arising from ABS and nonABS cross-border investment: Dec. 2003 to Dec. 2007



Source: Staff estimates based on CPIS and TIC.

Figure 6

Current Account Surpluses and Financial Acquisitions of Certain Surplus Regions, 2003-2007



Source: For current account balance, Haver Analytics and BEA, for balance of payments accounts, staff estimates based on TIC and BIS banking data.

Figure 7

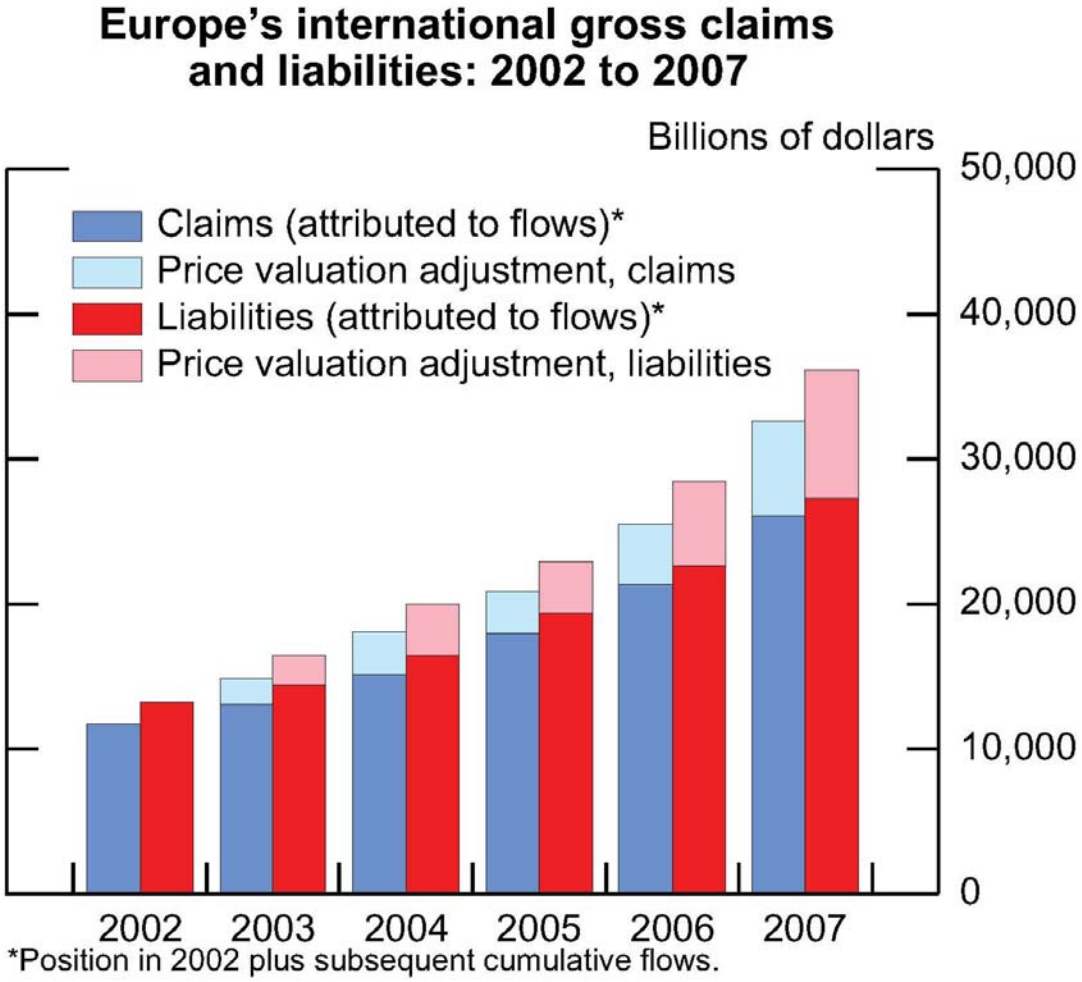

Europe's international gross claims and liabilities: 2002 to 2007
Billions of dollars
50,000
40,000
30,000
20,000
10,000
0
Claims (attributed to flows)*
Price valuation adjustment, claims
Liabilities (attributed to flows)*
Price valuation adjustment, liabilities
2002
2003
2004
2005
2006
2007
*Position in 2002 plus subsequent cumulative flows.

Figure 8

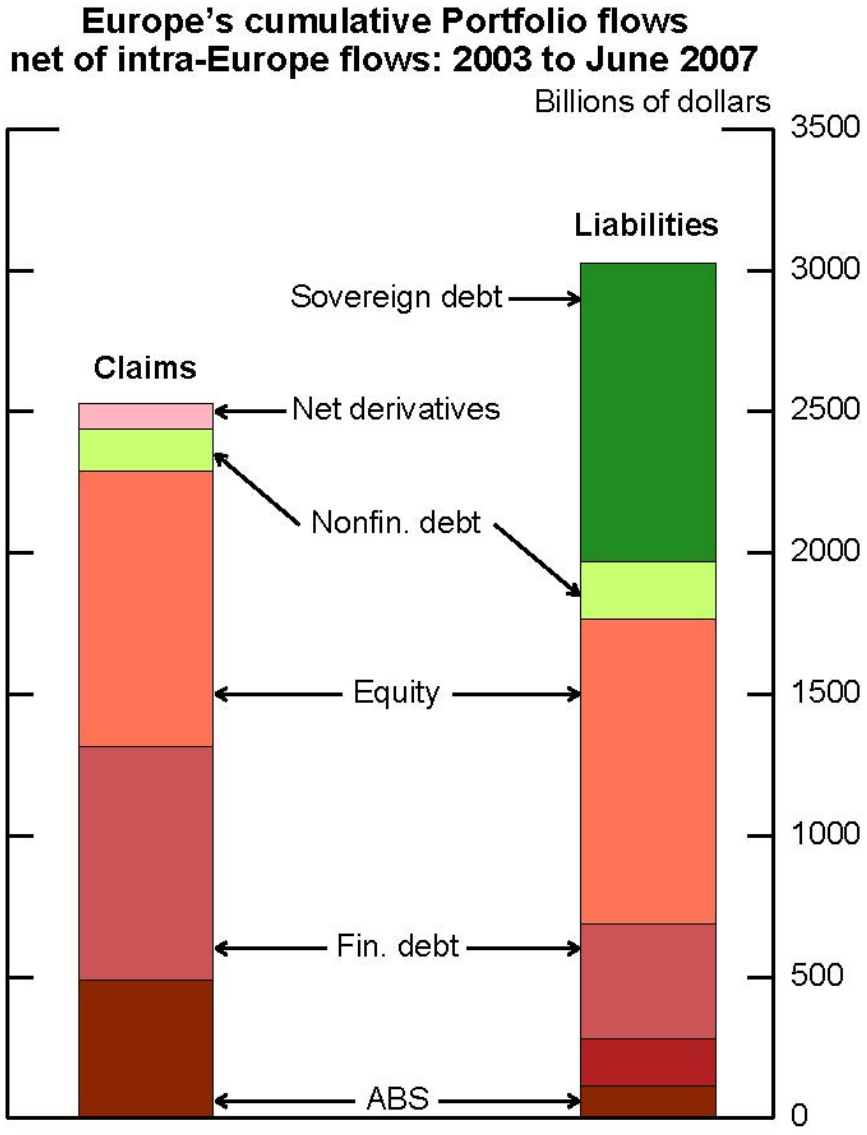
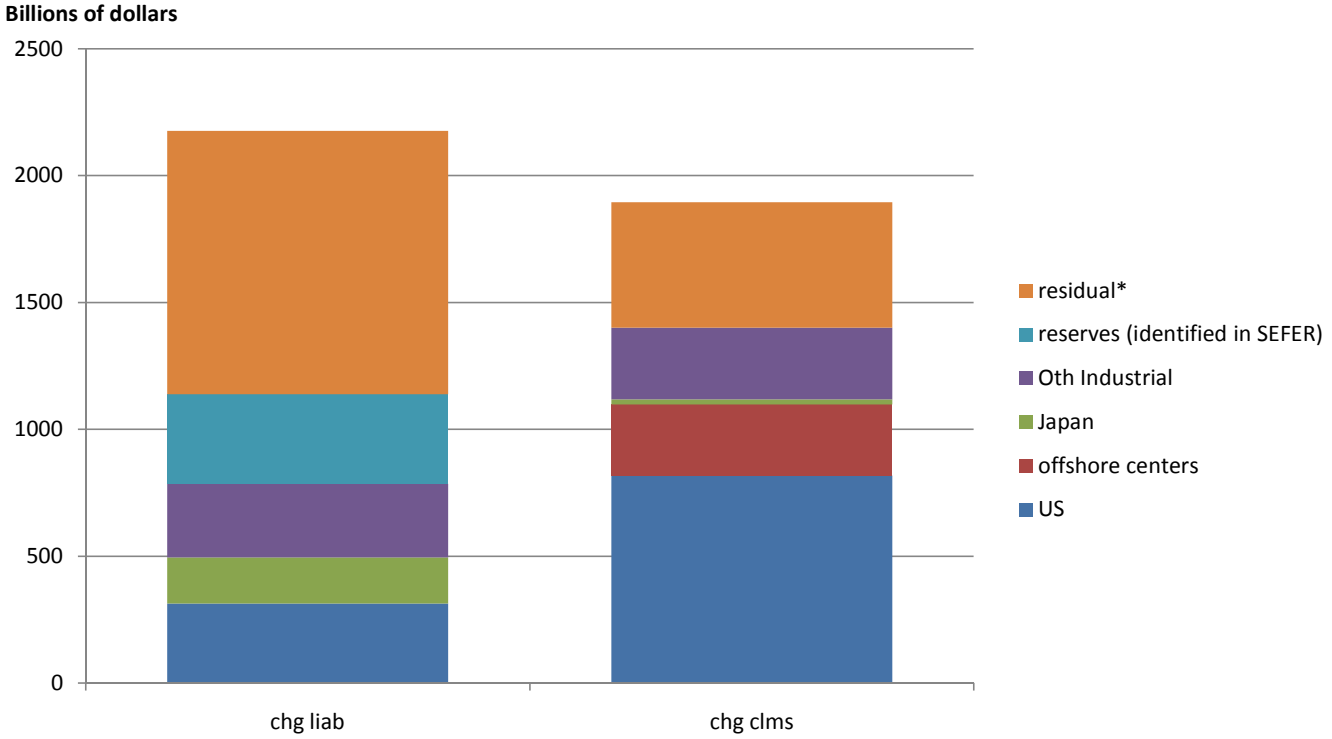

Europe's cumulative Portfolio flows
net of intra-Europe flows: 2003 to June 2007
Billions of dollars
3500
3000
2500
2000
1500
1000
500
0
Liabilities
Claims
Sovereign debt
Net derivatives
Nonfin. debt
Equity
Fin. debt
ABS

Figure ϕ

Change in cross border liabilities vs claims: euro area + UK; long-term debt securities; 2003 - 2007



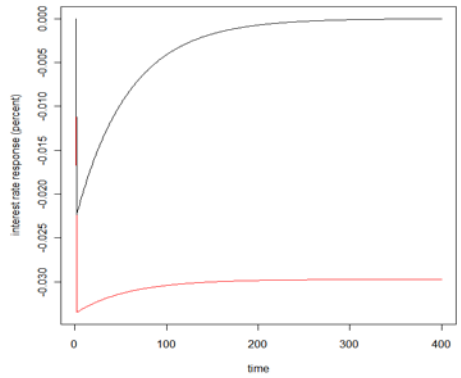
Source: Staff estimates based on CPIS, euro area and UK international investment positions, and TIC.

***Residual liabilities are with EMEs and Offshore centers; residual claims are mainly with EMEs, including eastern Europe**

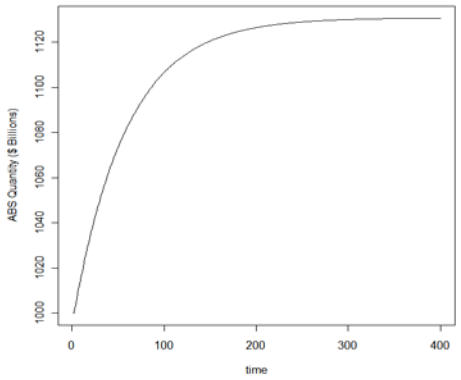
Figure 10: Interest rate and ABS supply responses from the portfolio balance model, medium elasticites

China wealth shock

1. interest rate responses



2. ABS supply response

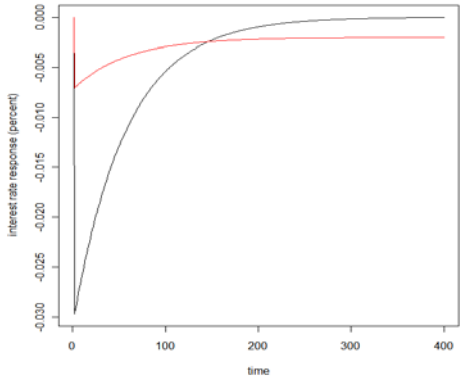


red= Tbill response

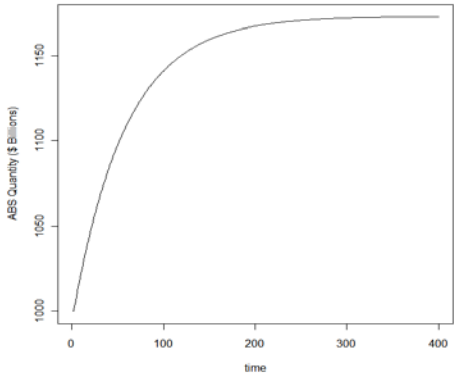
black=ABS response

European ABS demand shock

3. interest rate responses



4. ABS supply response

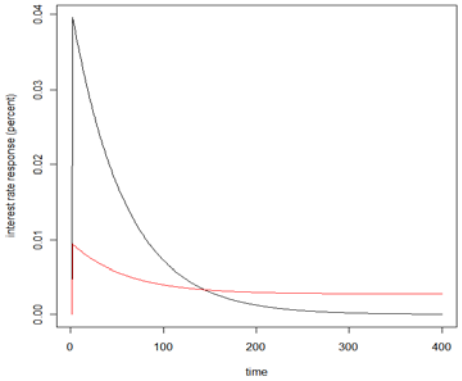


red= Tbill response

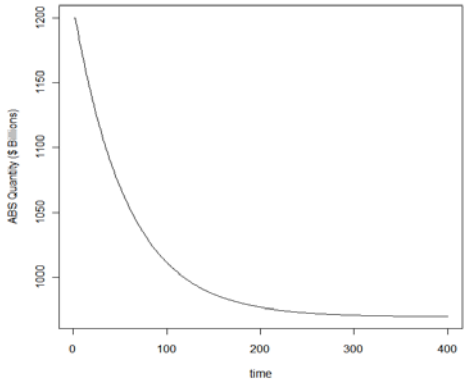
black=ABS response

Exogenous ABS supply shock

5. interest rate responses



6. ABS supply response



red= Tbill response

black=ABS response

Figure 11. Rates on Subprime and Conforming ARMS, and Subprime ARM issuance

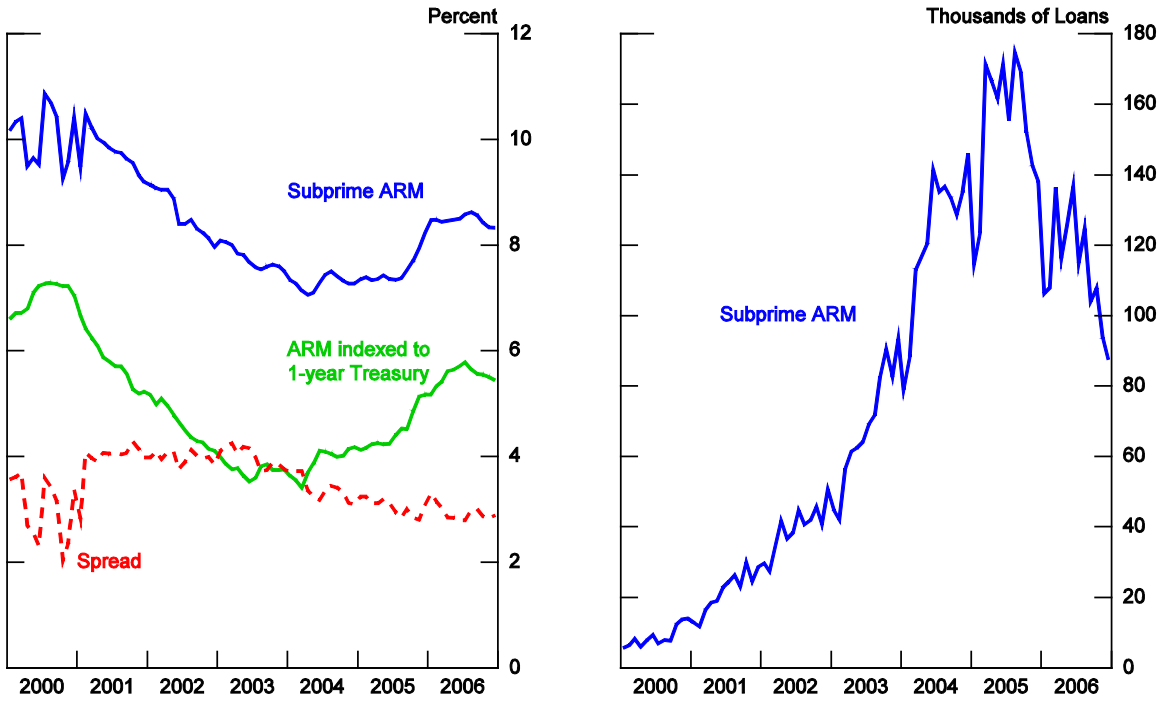


Figure 12. Rates on Alt-A and Conforming ARMS, and Alt-A ARM issuance