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## Sterilization, Monetary Policy, and Global Financial Integration

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### Abstract:

This paper investigates the changing patterns and efficacy of sterilization within emerging market countries as they liberalize markets and integrate with the world economy. We estimate the marginal propensity to sterilize foreign asset accumulation associated with net exports and various forms of capital flows, across countries and over time. We find that the extent of sterilization of foreign reserve inflows has risen in recent years to varying degrees in Asia as well as in Latin America, consistent with greater concerns about the potential inflationary impact of reserve inflows. We also find that sterilization depends on the composition of balance of payments inflows.

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## 1. Introduction

In the late 1980s and early 1990s, emerging market countries embraced growing financial liberalization and openness. However, by trying to maintain both exchange rate fixity and monetary independence, they experienced severe financial crises. In the aftermath of these crises, many developing countries have adopted a policy configuration involving greater, though still managed, exchange rate flexibility, together with ongoing financial integration and some degree of domestic monetary independence. Hoarding of international reserves has become a key ingredient enhancing the stability of this new pattern. Concerns about the cost of maintaining monetary stability with this new policy mix suggest the need to support hoarding international reserves with more aggressive sterilization. Apprehensions about the opportunity costs of accumulating reserves and the fiscal and distortionary financial costs of sterilization, in turn, have raised questions about the long-run viability of this new policy mix, particularly the efficacy of sterilization.

In this paper we evaluate these considerations by estimating the marginal propensity to sterilize foreign asset accumulation over time for selected countries in Asia and Latin America. We also analyze how sterilization depends on the underlying source of reserve accumulation, i.e., association with net exports and various forms of capital inflows.

Our results confirm that the greater accumulation of foreign reserves in recent years has been associated with a greater intensity of sterilization by developing countries in Asia as well as in Latin America. In particular, we show that there has been a significant increase in the coefficient of sterilization following the 1997-98 Asian crisis. Thus, notwithstanding concerns about sterilization costs, the policies of hoarding international reserves and sterilizing the potential inflationary impact have complemented each other during recent years. In addition, we find that sterilization of foreign direct investment (FDI) inflows typically is less than that for current account surpluses and for non-FDI inflows, suggesting that misgivings about monetary instability depend on the composition of balance of payments inflows.

We also discuss the benefits and costs of sterilization. For many countries the costs of sterilization appear to be below the perceived benefits associated with monetary stability and reserve accumulation. However, we also present evidence suggesting that relative benefits to China have fallen in recent quarters. This implies limits to the sustainability of the new policy configuration in the near term.

Finally, we outline a model explaining how the ability to sterilize depends on imperfect substitutability of assets in a world where the costs of trading assets varies systematically across agents (due to possible scale effects) and across asset classes (due to varying liquidity and risk characteristics).

## **2. Background**

A major lesson of the past decade or so has been the downside risk of combining international financial integration with soft exchange rate pegs. Each of the major international financial market-related crises since 1994 -- Mexico, in 1994, Thailand, Indonesia, and Korea in 1997, Russia and Brazil in 1998, and Argentina and Turkey in 2000—has in some way involved a fixed or pegged exchange rate regime. At the same time, countries that did not have pegged rates—among them South Africa, Israel in 1998 and Mexico in 1998—avoided crises of the type that afflicted emerging market countries with pegged rates. This was the message of well-known papers by Obstfeld and Rogoff (1995) and Fischer (2001). Related papers have raised the possibility that a pegged exchange rate is a trap in the era of greater financial integration (e.g., Eichengreen, 2001; Frankel, 1999; Edwards and Levy-Yeyati, 2005; Aizenman and Glick, 2005). As a result, most emerging market countries have adopted a policy mix of managed exchange rates, while still trying to maintain domestic monetary control and growing financial integration. They have accomplished this with a policy combination of massive reserve hoarding and sterilization.

A useful perspective for understanding the changing configuration of monetary policy by developing countries is provided by applying the framework of the impossible trinity dilemma – the trilemma. The trilemma states that a country simultaneously may choose any two, but not all, of the following three goals: monetary independence, exchange rate stability and financial integration ( see Obstfeld, Shambaugh, and Taylor, 2005 for further discussion and references dealing with the trilemma).

Figure 1a illustrates the trilemma problem. In terms of the triangle depicted in the figure, each of the three sides -- monetary independence, exchange rate stability, and financial integration -- has an attraction, but it is not possible to be simultaneously on all three sides of the triangle and thus attain all three goals. At the top vertex – labeled “closed capital markets” -- a country can have monetary policy control and a fixed exchange rate, but not financial integration. This was the preferred policy choice of most developing countries in the mid to late

1980s, as they maintained a combination of exchange rate stability and monetary independence, with relatively closed capital accounts.

As depicted in Figure 1b, in the late 1980s and early 1990s countries such as Mexico, Korea, and several other Asian economies, embraced growing financial liberalization and openness. However, as they opened more financially, they found that the goals of greater financial integration, exchange rate stability, and monetary independence were simultaneously unattainable. The inconsistent policy goals resulted in severe financial crises, in Mexico during 1994-5 and in Asia during 1997-8. In the early 1990s Argentina adopted another trilemma configuration corresponding to the vertex labeled “hard peg,” involving exchange rate fixity, supported by a version of a currency board, and complete financial integration. Argentina also experienced a crisis when ceding monetary policy independence became no longer viable.

Post crisis, most emerging markets have opted for a policy configuration involving more exchange rate flexibility, domestic monetary independence, and growing financial integration. But they are still engaging in a great degree of exchange rate management. So, in the face of pressures for their currencies to appreciate, they have been accumulating reserves and sterilizing. China vividly displays this policy mix, by slowly allowing more financial integration and exchange rate flexibility, while also accumulating and sterilizing massive amounts of foreign reserve inflows.

Econometric evaluations suggest several structural changes in the patterns of reserves hoarding by developing countries. This first occurred around the early 1990s, increasing the international reserves/GDP ratios, a trend that intensified shortly after the East Asian crisis of 1997-8, but subsided by 2000. Another structural change seems to have taken place in the early 2000s, mostly driven by the unprecedented increase in hoarding of international reserves by China (see Aizenman and Marion, 2003; Aizenman and Lee, 2007, and Cheung and Ito, 2007).

There are several reasons for the massive foreign reserve accumulation that has occurred. First, some countries may acquire reserves to satisfy precautionary demand needs. Reserves provide self insurance against sudden stops of foreign capital inflows, thereby offsetting the downside risk of greater financial integration. Secondly, they may cushion the effects of terms of trade shocks on a country’s real exchange rate and its exports, smoothing the adjustment of the current account. In addition, they allow countries to avoid relying on the IMF, World Bank, and other international financial organizations etc. for implicit insurance. Lastly, reserve

accumulation may occur as a byproduct of managing exchange rates to promote exports by undervaluing domestic currency.

### 3. Reserve Accumulation and Sterilization Response

Reserve accumulation has monetary implications. When a central bank purchases foreign reserve assets, it must decide whether to fund it by increasing the reserve money base, which is potentially inflationary, or by reducing its net domestic assets, which sterilizes the impact on the domestic reserve money base. Central banks may offset the effects of reserve accumulation on the monetary base in a number of ways, including selling market instruments, such as government bonds or central bank bills or by using swaps or repurchase operations. With foreign exchange swaps, the central bank typically agrees to buy foreign exchange forward, while with repurchase operations (“repos”) the central bank sells securities with an agreement to buy them back in the future. When markets are thin, some authorities rely on non-market instruments, such as transferring the deposits of government and public financial institutions from the commercial banking system to the central bank or selling foreign exchange reserves to the government (perhaps to allow it to reduce external sovereign debt).<sup>1</sup>

#### Some Plots

Figure 2 plots 4-quarter changes in net foreign assets and in net domestic assets, each scaled by the reserve money stock ( $RM$ ) at the end of the period four quarters earlier, for selected Asian countries.<sup>2</sup> Net foreign assets are defined by taking the dollar-denominated level of reserves and adjusting them for exchange rate changes, to give a valuation-adjusted measure of changes in net foreign assets in domestic currency.<sup>3</sup> Net domestic assets ( $NDA$ ) are defined as the reserve monetary base ( $RM$ ) minus net foreign assets ( $NFA$ ). Positive values of net foreign asset accumulation by the central bank correspond to foreign reserve inflows. Negative values of net domestic assets correspond to reductions in domestic assets held by the monetary authorities.

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<sup>1</sup> Monetary authorities also may seek to sterilize the effects of reserve inflows, not just on the reserve money base, but also on the broader money supply by, for example, increasing compulsory reserve requirements on bank deposits. China, for example, has raised reserve requirements significantly in recent years.

<sup>2</sup> Using four-quarter changes helps to smooth the data by eliminating much of the quarter to quarter noise.

<sup>3</sup> Specifically, we define  $\Delta NFA_t = (S_{LC/\$})_t (R\$_t - R\$_{t-1}) - (FL_t - FL_{t-1})$ , where  $R\$$  (IMF line 11.d), denotes the local currency price of foreign exchange,  $FL$  denotes financial liabilities of the central bank (IMF line 16c),  $S_{LC/\$}$  is the local currency price of the dollar, and “ $\Delta$ ” is the change operator. Accordingly, we define  $\Delta NDA = \Delta RM - \Delta NFA$ .

In the case of China, the extent of sterilization was relatively limited until the early 2000s, as the monetary impact of reserve inflows (i.e. positive levels of  $\Delta NFA/RM$ ) was generally augmented by monetary stimulus from central bank acquisition of domestic assets (i.e. positive levels of  $\Delta NDA/RM$ ).<sup>4</sup> Since mid-2002, however, as China experienced sharply rising foreign reserve inflows, these inflows were accompanied by negative changes in domestic asset holdings by the central bank, primarily through sales of PBC bills, implying the reserve inflows were being sterilized. The increase in the extent of sterilization in the early 2000s implies a possible break from China's prior sterilization behavior.

Other countries in Asia also have experienced significant reserve inflows in the aftermath of the Asia crisis. In the case, of Korea, for example, reserve inflows increased in 1999 and 2000, subsided somewhat, and then rose again in the period 2002-2005 around the time China began accumulating reserves at a rising rate. Korea's monetary authorities responded to the monetary impact of these inflows by sterilization. A similar pattern of inflows and sterilization is apparent for other countries in Asia, particularly in Thailand, Malaysia, and India.

For comparison, we also show results for selected Latin American countries -- Argentina, Brazil, and Mexico.<sup>5</sup> In the case of Argentina, modest reserve inflows emerged in 2003 in the aftermath of the country's financial crisis of 2001-02; however, these inflows were not evidently sterilized until the latter half of 2004 when changes in the domestic asset holdings of the central bank turned negative. In Brazil, reserve inflows began increasing in the latter half of 2004, accompanied by sterilization. A similar pattern of reserve inflows and offsetting declines in central bank domestic assets occurred in Mexico in 1996 in the aftermath of its 1994-95 peso crisis.

#### Estimation of Sterilization Response

We now turn to quantitatively estimating changes in the degree of sterilization. Our specification is very simple. We estimate the extent of sterilization by a simple regression of the monetary authorities' change in net domestic assets on the change in net foreign assets, where change is measured over four quarters, and scaled by the level of the reserve money stock four

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<sup>4</sup> The exception is the period 1993 when China sterilized the effects of foreign reserve outflows by expanding the reserve money stock by increasing domestic asset holdings.

<sup>5</sup> The sample period for Argentina and Brazil begins 4 quarters after the implementation of their monetary reforms – 1992 Q1 for Argentina and 1995 Q1 for Brazil.

quarters ago. We also include the four-quarter growth rate of nominal GDP on the righthand side to control for other explanatory variables,  $Z$ , that might influence the demand for money:<sup>6</sup>

$$(1) \quad \Delta NDA / RM_{-4} = \alpha + \beta \Delta NFA / RM_{-4} + Z$$

We estimate the sterilization coefficient,  $\beta$ , with OLS using 40-quarter rolling samples.<sup>7</sup> A unitary coefficient, i.e.  $\beta = -1$ , on the variable  $\Delta NFA / RM$  represents full monetary sterilization of reserve changes, while  $\beta = 0$  implies no sterilization. The results are plotted in Figure 3. Coefficient observations correspond to the calendar date of the 40<sup>th</sup> quarter in each rolling sample.<sup>8</sup>

In the case of China, observe that the sterilization coefficient began rising (in absolute value) from roughly 0.6 in 2000, a trend that accelerated in the latter half of 2002 and continued into 2006 when it peaked at almost 1.5, suggesting the presence of a break in behavior.<sup>9</sup> The plot also indicates a reversal of China's sterilization behavior beginning in the fourth quarter of 2006. This evident decline in China's degree of sterilization can be attributed to two possibilities. First, China's foreign reserve accumulation in recent periods may be overstated to the extent that the reported figures have not been adjusted to take account of swaps and shifts of foreign reserve assets to China's nascent sovereign wealth fund.<sup>10</sup> Second, China may indeed have reached limits to the extent of its ability to sterilize its massive reserve inflows.

In Korea a break in sterilization behavior is evident after the financial crisis of 1997-98, with the sterilization coefficient increasing from 0.9 to more than 1.0 by 1999. Increases in sterilization, though to lesser extent, are observable in Thailand and Malaysia, while no change is evident in the case of Singapore. In the case of India, a modest increase in sterilization appears to have occurred in the mid 1990s after its financial crisis of 1991, followed by a further increase after 2002.

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<sup>6</sup> We imputed quarterly GDP growth for some countries in our sample from a moving average of the prior year, current, and following year observations.

<sup>7</sup> We begin with the sample period 1984 Q2 to 1994 Q1, roll to 1984 Q3 – 1994 Q2, etc., ending with 1997 Q3 - 2007 Q2, depending on data availability.

<sup>8</sup> For clarity, we omit standard error bands. It may be stated, however, that the coefficients are always significantly different from 0. Regression results for the full sample and tests of the null hypotheses that the sterilization coefficient differs from 0 or -1 are presented in tables below.

<sup>9</sup> Central bank balance sheet data for China is available only from 1985 Q3, implying that the first 4-quarter change observation begins in 1986 Q2, and the first 40-quarter rolling sample period is 1986 Q2 – 1996 Q1.

<sup>10</sup> China's sovereign wealth fund, the China Investment Corporation, was not formally established until the latter half of 2007 with an initial capitalization of \$200 billion out of China's total reserve holdings of more than \$1.3 trillion. But there are indications of central bank asset shifts to its predecessor institution, Huijins Investment, and to some Chinese commercial banks before then. Netting these amounts against reported foreign reserve holdings would reduce the magnitude of foreign reserve inflows and raise the implied level of central bank domestic assets, resulting in a lower estimated degree of sterilization.

For comparison we also present rolling regression results for our three Latin America countries. As before, the sample ranges are limited to the period after the stabilization of monetary policy in 1991 in Argentina and 1994 in Brazil; in both cases some increases in sterilization is observable over the period.<sup>11</sup> In the case of Mexico, sterilization increased modestly in 1996 and later around 2005.

Formal regressions assessing the significance of breaks in sterilization behavior are reported in Table 1. There we estimate equation (1) for the full sample period by also including a term interacting  $\Delta NFA/RM$  with a dummy variable *DumBreak*, defined with a value of unity for all periods beginning with each country's designated break date. We identified break dates for each country by the first observation after the 1997-98 Asia crisis (after the 1994-95 peso crisis in the case of Mexico) in which reserve inflows were positive and net domestic assets were reduced for at least two quarters in a row.<sup>12</sup> A variant regression, reported in column (3), controls separately for sterilization behavior during a country's most recent period of significant foreign reserve outflows, denoted by *DumCrisis*.<sup>13</sup>

The break date and crisis periods for each country are reported in Table 1. Our methodology identifies a break date of 2002 Q2 for China, 1998 Q4 for Korea, Thailand, Malaysia, and Singapore, and 2000 Q4 for India. The break dates for Argentina, Brazil, and Mexico are 2004 Q3, 2003 Q3, and 1996 Q4, respectively.

Observe that the coefficients on the net foreign reserve inflow variable and on the interactive term are always negative for all countries, implying the inflows were sterilized by reduction of central bank domestic assets and that this sterilization increased (i.e., the change in domestic asset holdings is more negative) after the break date. The coefficient on the interaction term is significant in the cases of China, Korea, and India, as well as in Argentina, Brazil, and Mexico. This supports the observation drawn from the rolling regression plots that sterilization behavior has intensified in recent years for emerging countries in Asia as well as in Latin

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<sup>11</sup> For Argentina, monetary policy was initially stabilized with the adoption of its currency board in 1991 Q2, implying that the first 4-quarter change observation begins in 1992 Q1, and the first 40-quarter rolling sample period is 1992 Q1 – 2001 Q4. For Brazil, the first 40-quarter rolling sample is 1995 Q2 - 2005 Q1.

<sup>12</sup> We are aware of the potential biases inherent in using prior knowledge to pick break dates. For this reason we deliberately avoided choosing break dates based on the inflection points of our rolling regression plots. We do not feel that our general conclusions would be affected by use of more sophisticated time series approaches to identifying breaks.

<sup>13</sup> Our use of quarterly observations of 4 quarter changes data may introduce serial correlation in the error terms. Our use of Newey-West robust standard errors mitigates this problem by taking such possible correlation into account.

America.<sup>14</sup> Also note that the coefficient on nominal GDP growth is positive, implying that the central bank supplies liquidity to the economy by increasing its claims in response to greater economic activity.

The rolling regressions suggest increases in sterilization in most countries in our sample after the Asia crisis or at the time that China began sterilizing significantly in 2002. To assess the extent to which countries are cooperatively pursuing greater sterilization, we make a cross-country comparison of sterilization behavior over time. Figure 4 reports the coefficient of variation of the sterilization coefficients for countries in Asia and Latin America as well as the two regions pooled together. We augment the sample of countries: in Asia, to our original sample of China, Korea, Thailand, Malaysia, Singapore, and India, we add Indonesia, Pakistan, and the Philippines; in Latin America, to our original sample of Argentina, Brazil, and Mexico, we add Chile, Colombia, and Peru.<sup>15</sup> Observe that the coefficient of variation declined substantially in Asia over the period 2000 – 2005, after which it began to rise somewhat.<sup>16</sup> In Latin America, the coefficient of variation fell, beginning in 2000. These results suggest the timing of the increase in the extent of sterilization across countries may have a common component.

### Sterilization and Inflation

Table 2 separates out the effects of inflation from real GDP changes on the central bank's management of its domestic asset holdings. It also examines the extent to which the response to inflation has changed over time and whether any changes in this response has affected the sterilization of foreign reserve inflows.

Columns (1) and (2) of Table 3 report the separate effects of inflation without and with real GDP as an explanatory variable. Observe that the coefficients on inflation and real GDP growth are generally positive and significant, consistent with the positive sign on nominal GDP

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<sup>14</sup> We have abstracted from several econometric issues. For example, we have not taken account of possible simultaneity bias because net foreign asset changes may respond to domestic monetary policy, particularly when the central bank intervenes and affects the exchange rate. However, prior work seeking to control for the possible endogeneity of the explanatory variables in sterilization regressions through instrumental estimation has not found much effect on coefficient magnitudes and their standard errors as compared to OLS (e.g., Ouyang, Rajan, and Willett). We also abstract from any dynamics in the sterilization response. An alternative approach employed by Mohanty and Turner (2006) includes the lagged dependent variable on the right-hand side, enabling estimation of short run and long run sterilization responses (though from an obviously very restricted specification; see Glick and Hutchison (2003) for an unconstrained approach to estimating sterilization dynamics).

<sup>15</sup> We only include Argentina and Brazil in the sample only ten years after the implementation of their monetary reforms, 2002 Q1 for Argentina and 2005 Q2 for Brazil.

<sup>16</sup> In addition to the decline in sterilization in recent quarters noted above in the case of China, sterilization in the Philippines has declined notably as well.

observed earlier (the exceptions are the negative coefficients on real GDP for Korea and Thailand, though they are not significant). Note also that the magnitude of the coefficient of net foreign assets interacted with our break dummies are smaller (in absolute value) and in some cases less significant than those reported in Table 1. Column (3) augments the regression in column (2) by including an interaction variable involving the inflation rate with the break date dummies. For several countries – notably Korea, Thailand, Malaysia, Singapore, Argentina, and Brazil -- the coefficient on this variable is negative, suggesting an increase in anti-inflation monetary management by the central bank in recent years (though the coefficient is not significant for Korea and Singapore). Note also that we still find an increase in the sterilization response in most countries, as indicated by a negative coefficient on the interactive variable with foreign reserve inflows (the exceptions are Malaysia, Argentina, and Brazil).<sup>17</sup> Thus, our result that developing countries have increased their degree of sterilization in recent years appears to be robust to allowing for any direct response to inflation pressures.

#### Sterilization and the Composition of Balance of Payments Inflows

Table 3 shows the evolution of current account balances, direct investment inflows, and other capital inflows, as well as reserve accumulation for emerging market countries as a whole, several regional groupings, and selected individual countries. The figures reported are annual averages of flows for subperiods before and after recent major financial crises, specifically the Mexican crisis of 1994-95 and the Asian and Russian crises of 1997-99.

Observe that the magnitude of reserve accumulation in Asia has steadily increased over time, consistent with our earlier observations based on central bank balance sheet data.<sup>18</sup> Observe also that in the most recent period, 2000-2006, these inflows primarily have reflected current account surpluses, rather than large capital inflows. This is the opposite of the pattern seen in the late 1980s and 1990s, when most regions of the world experienced current account deficits and large capital inflows. Observe also that average direct foreign investment inflows have risen steadily for all emerging market regions over time. In contrast, average portfolio and other

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<sup>17</sup> The increase in sterilization was significant for both Argentina and Brazil in Table 1, where we controlled for other determinants of domestic monetary policy with nominal GDP, but did not allow for any break in the response to this variable. Evidently, allowing a break in the response to inflation, as in column (3) in Table 3, soaks up the effect of a break in sterilization behavior. The result in Table 3 for Argentina is particularly problematic as the coefficient on the interactive term with reserve inflows is significant and positive; in this case the coefficient on the interactive inflation term is unusually large (in absolute value) as well as significant.

<sup>18</sup> Note that the figures reported here are changes expressed in dollar terms, as compared to changes in terms of local currency reported in earlier tables and charts.

capital inflows ceased or declined dramatically after the Asia and Russian crises for almost all emerging markets.<sup>19</sup>

Does the sterilization response to reserve inflows vary according to the source of inflows, i.e., does the extent to which the central bank manage its domestic asset holdings depend on whether reserve inflows are associated with “cold” money flows” like FDI, or “hot” money inflows associated with other components of the balance of payments? Table 4 reports the results of estimating the sterilization response of the central bank to whether reserve inflows come from current account surpluses, foreign direct investment inflows, or non-FDI capital inflows. We also investigate whether these responses have varied at the same time as the break dates in sterilization behavior identified earlier. Consistent with our prior regression analysis, we measure variables in 4 quarter change terms, scaled by the lagged reserve money stock.<sup>20</sup>

As shown in column (2) of Table 4, the sterilization response to foreign direct investment is lower (in absolute magnitude, i.e.  $|\beta_1| < |\beta_0|$ ,  $|\beta_1| < |\beta_2|$ ) in several countries, including China, Korea, Thailand, Malaysia, and Singapore, as well as Brazil and Mexico (the latter in the case of the response relative to the current account). These differences are significant in China (relative to non-FDI inflows), Thailand (relative to the current account surplus), Malaysia, Singapore (relative to the current account), and Brazil. Column (3) of Table 4 interacts the individual balance of payments components with our break date dummies to detect whether there is more or less sensitivity to these components in recent years. Consistent with our findings in Table 3, we find greater sensitivity (i.e. more negative coefficient values) in the cases of China, Thailand, Malaysia (though not to the current account balance in Malaysia), and India (though not in response to FDI flows, where the response fell significantly).

Summarizing our empirical evidence on sterilization: The extent of sterilization of foreign reserve inflows has risen in recent years to varying degrees in Asia as well as in Latin America. This is consistent with greater concerns about the potential inflationary impact of reserve inflows. Sterilization depends on the composition of balance of payments inflows, i.e., for some countries the response to foreign direct investment inflows is less than that to the current account surplus or non-FDI inflows. This is consistent with the view that these countries are less anxious about the monetary impact of direct investment flows.

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<sup>19</sup> Hong Kong and Singapore had net portfolio outflows during 2000-06, offsetting the net capital inflows to other smaller East Asian countries, including Malaysia, the Philippines, Indonesia, and Thailand.

<sup>20</sup> The quarterly data on dollar-denominated balance of payments flows are converted into local currency terms using the average local currency price of the dollar for each quarter.

#### 4. Costs, Benefits, and Sustainability of Sterilization Policy

Growing financial integration is an unavoidable outcome of deeper trade integration by developing countries. A byproduct of growing financial integration is greater exposure to financial instability. Concerns about financial and monetary instability have increased the complementarity between the extent of reserve hoarding and sterilization: The extent to which individual countries may continue to accumulate reserves and sterilize and the stability of this policy mix depends on the associated benefits and costs.

While providing useful services, international reserve management is subject to serious limitations. First, there are direct opportunity costs of reserves associated with the marginal productivity of public capital and/or the cost of external borrowing. Second, sterilization has fiscal costs associated with the difference between, on the one hand, the return paid on central bank liabilities issued to sterilize domestic liquidity (or the opportunity cost from foregone returns on domestic assets, such as government bonds, sold to the private sector) and, on the other hand, the return earned on foreign reserve assets.

Figure 5 plots a proxy for the fiscal costs of sterilization in the case of China, given by the difference between the 1-year People's Bank of China and U.S. Treasury bill rates (the spread is the vertical difference between the two plotted lines).<sup>21</sup> Observe that the interest rate spread was positive, but shrinking in 2003 and 2004, and actually turned negative in 2005, implying China then was earning money on balance from its sterilization operations. The narrowing of this differential in recent quarters (it actually turned positive again in December 2007, however, implies that China's sterilization costs have been rising.

Sterilization and hoarding international reserves also involve macro and micro moral hazard costs. The macro moral hazard arises when reserve hoarding encourages opportunistic spending in regimes characterized by political instability and limited monitoring (see Aizenman and Marion (2004), who show that countries characterized by greater political instability and polarization opt to hold less international reserves). Micro moral hazard arises when reserve hoarding subsidizes risk taking. (Levy-Yeyati (2005) calls for liquid reserve requirement on banks, and an ex-ante suspension-of-convertibility clause.) Lastly, reserve accumulation and sterilization can encourage financial sector distortions. For example, greater use of non-market instruments (e.g. reserve requirements, direct credit controls) can hinder the development of

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<sup>21</sup> Note that this proxy ignores the adverse valuation effects from continued appreciation of the yuan and other Asian currencies.

corporate bond market and alter the behavior of banks. Also it may hinder financial development by segmenting the public debt market through the issuance of central bank liabilities instead of Treasury securities.<sup>22</sup>

This discussion suggests that the extent to which a country may continue to sterilize depends also on the degree to which it is willing to tolerate financial repression and other distortions to its economy. In the appendix we outline a model explaining how the ability to sterilize depends on imperfect substitutability of assets in a world where the costs of trading assets varies systematically across agents (due to possible scale effects) and across asset classes (due to varying liquidity and risk characteristics). Within this framework we show that policies fostering greater domestic financial repression also reduce the costs of sterilization. This suggests that countries able and willing to engage in greater financial sterilization will be able to sustain the policy configuration of reserve hoarding and sterilizing for a longer period of time.

The stability of the current policy mix is further complicated by the extent to which each country's cost-benefit calculation depends on the actions of other countries. Countries following export-oriented growth strategies may choose to engage in competitive reserve accumulation to improve and maintain their competitiveness in exporting to industrial countries. Thus, for example, as long as China and its East Asian neighbors are trying to maintain competitiveness in exporting to the United States, there is an unstable equilibrium depending on their relative abilities to avoid competitive appreciations and limits to sterilization. Those countries with lower costs of sterilization, due for example to greater willingness to distort their financial systems, might end up hoarding increasingly large amounts of international reserves, winning the hoarding game at least in the short run. Arguably, this interpretation explains China's unprecedented increase in foreign reserves from 2002, now amounting to almost 50 percent of GDP and well above the levels of other East Asia countries (see Aizenman and Lee, 2006). Yet, this outcome may be fragile if it induces a country to accumulate to levels where the costs of sterilization exceed the benefit. These observations are consistent with the World Economic Outlook (2007), finding that resisting nominal exchange rate appreciation through sterilized intervention is likely to be ineffective when the influx of capital is persistent and large. Indeed, China's recently rising costs of sterilization may account for its recent decline in sterilization and increasing inflation rate.

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<sup>22</sup> Sterilization operations of in this form also have costs. For example, reserve requirements act like a tax on banks which reduces financial intermediation and imposes a form of repression on the financial system.

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Table 1. Has Sterilization Increased in Magnitude Over Time?

$$\Delta NDA / RM_{-4} = \alpha + \beta_0 \Delta NFA / RM_{-4} + \beta_1 (\Delta NFA / RM_{-4})(DumBreak) + \beta_2 (\Delta NFA / RM)(DumCrisis) + \beta_3 \Delta \ln GNP$$

Panel A. Selected Asian Countries

Explanatory Variable	China			Korea			Thailand		
	(1)	(1)	(1)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta NFA / RM$	-0.782 (0.148)***	-0.768 (0.096)***	-0.827 (0.166)***	-0.770 (0.039)***	-0.833 (0.046)***	-0.744 (0.038)***	-0.931 (0.032)***	-1.039 (0.034)***	-0.929 (0.046)***
$(\Delta NFA / RM)(DumBreak)$	-0.345 (0.132)**	-0.301 (0.102)***	-0.256 (0.146)*	-0.252 (0.042)***	-0.132 (0.057)**	-0.193 (0.047)***	-0.099 (0.032)***	-0.034 (0.044)	-0.044 (0.043)
$(\Delta NFA / RM)(DumCrisis)$			0.176 (0.304)			-0.219 (0.064)***			-0.127 (0.053)**
$\Delta \ln(GNP)$		0.889 (0.088)***	0.918 (0.103)***		1.058 (0.324)***	1.198 (0.326)***		1.200 (0.262)***	0.820 (0.282)***
$H_0 : \beta_0 = -1$	2.183	5.837**	1.083	34.299***	13.181***	44.776***	4.639**	1.319	2.431
$H_0 : \beta_0 + \beta_1 = -1$	2.194	1.046	1.223	0.55	1.226	3.892	0.839	0.024	0.659
Adjusted R-squared	0.674	0.837	0.835	0.952	0.957	0.96	0.971	0.978	0.979
Break date		2002 Q2			1998 Q4			1998 Q4	
Crisis period		1992 Q3 - 1993 Q3			1997 Q1 - 1998 Q3			1997 Q1-98 Q3	
Sample period		1986 Q2 - 2007 Q2			1985 Q1- 2007 Q2			1985 Q1-2007 Q2	
Observations		85			90			90	

Panel B. Selected Asian Countries

Explanatory Variable	Malaysia			Singapore			India		
	(2)	(3)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta NFA / RM$	-0.858 (0.140)***	-0.880 (0.137)***	-0.874 (0.152)***	-0.935 (0.018)***	-0.984 (0.019)***	-0.993 (0.024)***	-0.822 (0.108)***	-0.805 (0.090)***	-0.770 (0.099)***
$(\Delta NFA / RM)(DumBreak)$	-0.193 (0.141)	-0.191 (0.142)	-0.196 (0.153)	-0.044 (0.011)***	-0.018 (0.011)	-0.014 (0.013)	-0.208 (0.108)*	-0.144 (0.087)*	-0.169 (0.092)*
$(\Delta NFA / RM)(DumCrisis)$			-0.077 (0.299)			0.052 (0.083)			-0.363 (0.181)**
$\Delta \ln(GNP)$		1.732 (0.416)***	1.748 (0.442)***		0.567 (0.120)***	0.584 (0.129)***		0.924 (0.152)***	0.919 (0.147)***
$H_0 : \beta_0 = -1$	1.036	0.761	0.689	12.596***	0.767	0.083	2.722	4.744**	5.386***
$H_0 : \beta_0 + \beta_1 = -1$	3.791*	8.940***	9.081***	1.888	0.006	0.182	0.837	2.606*	3.231*
Adjusted R-squared	0.829	0.851	0.849	0.983	0.986	0.986	0.849	0.892	0.893
Break date		1998 Q4			1998 Q4			2000 Q4	
Crisis period		1997 Q3 - 1998 Q3			1997 Q4 - 1998 Q3			1990 Q4 - 1991 Q4	
Sample period		1985 Q1 - 2007 Q2			1985 Q1- 2007 Q2			1985 Q1- 2006 Q4	
Observations		90			90			88	

Table 1. Has Sterilization Increased in Magnitude Over Time? (cont'd)

## Panel C. Selected Latin American Countries

Explanatory Variable	Argentina			Brazil			Mexico		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta NFA/RM$	-0.989 (0.033)***	-1.006 (0.030)***	-0.783 (0.089)***	-0.861 (0.136)***	-0.938 (0.135)***	-0.569 (0.186)***	-0.959 (0.027)***	-0.975 (0.018)***	-0.934 (0.036)***
$(\Delta NFA/RM)(DumBreak)$	-0.019 (0.102)	-0.257 (0.123)**	-0.282 (0.107)**	-0.419 (0.183)**	-0.284 (0.180)	-0.539 (0.217)**	-0.233 (0.056)***	-0.077 (0.038)**	-0.103 (0.043)**
$(\Delta NFA/RM)(DumCrisis)$			-0.262 (0.102)**			-0.828 (0.246)***			-0.071 (0.040)*
$\Delta \ln(GNP)$		1.272 (0.352)***	0.936 (0.310)***		0.138 (0.021)***	0.131 (0.025)***		0.394 (0.057)***	0.399 (0.061)***
$H_0 : \beta_0 = -1$	0.103	0.047	5.756**	1.045	0.213	5.402**	2.36	1.826	3.45*
$H_0 : \beta_0 + \beta_1 = -1$	0.175	5.820**	0.653	4.957**	3.386	0.956	17.411***	2.518	1.097
Adjusted R-squared	0.949	0.968	0.972	0.591	0.64	0.683	0.958	0.979	0.98
Break date		2004 Q3			2003 Q3			1996 Q4	
Crisis period		2000 Q4 – 2003 Q1			1998 Q3 -1999 Q4			1994 Q2 - 1995 Q4	
Sample period		1992 Q1 -2007 Q2			1995 Q2 - 2007 Q2			1985 Q1- 2007 Q2	
Observations		62			49			90	

Note: The table reports coefficients of regressing central bank net domestic assets on net foreign assets, measured as 4-quarter changes, scaled by the lagged reserve money stock ( $RM$ ).  $\Delta \ln(GNP)$  is the 4 quarter percent change in nominal GDP,  $DumBreak$  is a dummy variable denoting break point in sterilization behavior, and  $DumCrisis$  is a dummy variable denoting the most recent period of significant reserve outflows. Robust standard errors in parentheses. F statistic for null hypothesis tests. Significance at 1%, 5%, 10% indicated by \*\*\*, \*\*, and \*, respectively. Constant not reported.

Table 2. Does Sterilization Depend on Inflation?

$$\Delta NDA / RM_{-4} = \alpha + \beta_0 \Delta NFA / RM_{-4} + \beta_1 (\Delta NFA / RM_{-4})(DumBreak) + \beta_2 \Delta \ln(INFL) + \beta_3 \Delta \ln(INFL)(DumBreak) + \beta_4 \Delta \ln(RGNP)$$

Panel A. Selected Asian Countries

Explanatory Variable	China			Korea			Thailand			
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	
$\Delta NFA / RM$	-0.786 (0.130)***	-0.778 (0.122)***	-0.778 (0.123)***	-0.767 (0.035)***	-0.758 (0.038)***	-0.760 (0.039)***	-0.925 (0.031)***	-0.930 (0.030)***	-0.936 (0.029)***	
$(\Delta NFA / RM)(DumBreak)$	-0.176 (0.126)	-0.191 (0.117)	-0.214 (0.123)*	-0.216 (0.045)***	-0.223 (0.046)***	-0.215 (0.052)***	-0.069 (0.042)	-0.066 (0.042)	-0.030 (0.044)	
$\Delta \ln(INFL)$	0.816 (0.117)***	0.795 (0.108)***	0.791 (0.109)***	1.79 (0.705)**	1.631 (0.717)**	1.644 (0.711)**	1.051 (0.644)	1.145 (0.684)*	1.176 (0.719)	
$\Delta \ln(INFL)(DumBreak)$			0.350 (0.597)			-0.324 (1.057)			-1.687 (0.604)***	
$\Delta \ln(RGNP)$		0.180 (0.453)	0.181 (0.455)		-0.813 (0.685)	-0.741 (0.711)		-0.385 (0.38)	-0.240 (0.389)	
$H_0 : \beta_0 = -1$	2.710*	3.314*	3.274*	45.496***	39.8***	38.146***	5.946**	5.345**	4.712**	
$H_0 : \beta_0 + \beta_1 = -1$	0.264	0.188	0.009	0.241	0.295	0.433	0.019	0.011	0.898	
Adjusted R-squared	0.804	0.802	0.799	0.955	0.955	0.954	0.972	0.972	0.975	
Break date		2002 Q2			1998 Q4			1998 Q4		
Sample period		1987 Q1 – 2007 Q2			1985 Q1 – 2007 Q2			1985 Q1 – 2007 Q2		
Observations		82			90			90		

Panel B. Other Selected Asian Countries

Explanatory Variable	Malaysia			Singapore			India			
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	
$\Delta NFA / RM$	-0.861 (0.135)***	-0.930 (0.141)***	-0.961 (0.137)***	-0.959 (0.019)***	-0.977 (0.020)***	-0.978 (0.018)***	-0.816 (0.102)***	-0.751 (0.086)***	-0.733 (0.087)***	
$(\Delta NFA / RM)(DumBreak)$	-0.183 (0.134)	-0.082 (0.147)	0.039 (0.138)	-0.025 (0.014)*	-0.022 (0.013)*	-0.021 (0.019)	-0.152 (0.098)	-0.200 (0.081)**	-0.314 (0.098)***	
$\Delta \ln(INFL)$	2.719 (2.438)	4.623 (1.795)**	5.152 (1.690)***	1.274 (0.620)**	0.534 (0.673)	0.562 (0.497)	0.462 (0.214)**	0.422 (0.169)**	0.486 (0.171)***	
$\Delta \ln(INFL)(DumBreak)$			-7.55 (2.551)***			-0.104 (1.995)			0.854 (0.445)*	
$\Delta \ln(RGNP)$		2.395 (1.029)**	1.783 (1.168)		0.691 (0.225)***	0.688 (0.229)***		0.596 (0.098)***	0.629 (0.108)***	
$H_0 : \beta_0 = -1$	1.049	0.244	0.083	4.518**	1.281	1.476	3.266	8.403***	9.423***	
$H_0 : \beta_0 + \beta_1 = -1$	3.406*	0.175	5.859**	1.256	0.001	0.003	0.545	1.397	0.696	
Adjusted R-squared	0.831	0.840	0.857	0.984	0.985	0.985	0.855	0.888	0.890	
Break date		1998 Q4			1998 Q4			2000 Q4		
Sample period		1985 Q1 – 2007 Q2			1985 Q1 – 2007 Q2			1985 Q1 – 2006 Q4		
Observations		90			90			88		

Table 2. Does Sterilization Depend on Inflation? (cont'd)

## Panel C. Selected Latin American Countries

C. Explanatory Variable	Argentina			Brazil			Mexico		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta NFA/RM$	-0.956 (0.040)***	-1.032 (0.054)***	-1.04 (0.055)***	-0.932 (0.164)***	-0.69 (0.165)***	-0.736 (0.171)***	-0.975 (0.019)***	-0.975 (0.019)***	-0.976 (0.019)***
$(\Delta NFA/RM)(DumBreak)$	-0.145 (0.097)	-0.262 (0.113)**	0.837 (0.345)**	-0.285 (0.246)	-0.130 (0.216)	0.044 (0.227)	-0.067 (0.040)*	-0.059 (0.05)	-0.174 (0.063)***
$\Delta \ln(INFL)$	1.713 (0.275)***	1.377 (0.334)***	1.352 (0.338)***	0.603 (0.875)	1.077 (0.904)	1.017 (-0.838)	0.561 (0.079)***	0.566 (0.081)***	0.582 (0.081)***
$\Delta \ln(INFL)(DumBreak)$			-7.488 (2.415)***			-2.448 (0.937)**			0.862 (0.399)**
$\Delta \ln(RGNP)$		2.184 (1.031)**	2.434 (1.052)**		-13.796 (3.838)***	-11.265 (4.258)**		0.208 (0.488)	0.456 (0.448)
$H_0 : \beta_0 = -1$	1.201	0.343	0.534	0.172	3.525	2.398	1.677	1.785	1.594
$H_0 : \beta_0 + \beta_1 = -1$	1.366	5.071**	5.570**	2.152	1.857	4.740*	1.471	0.567	6.293**
Adjusted R-squared	0.965	0.967	0.968	0.593	0.669	0.686	0.981	0.980	0.982
Breakdate		2004 Q3			2003 Q3			1996 Q4	
Sample period		1992 Q1 – 2007 Q2			1995 Q2 – 2007 Q2			1985 Q1 – 2007 Q2	
Observations		62			49			90	

Note: The table reports coefficients of regressing central bank net domestic assets on net foreign assets, measured as 4 quarter changes, scaled by lagged reserve money stock ( $RM$ ).  $\Delta \ln(INFL)$  is the 4 quarter percent change in the CPI,  $\Delta \ln(RGNP)$  is the 4 quarter change in real GDP, and  $DumBreak$  is a dummy variable denoting break point in sterilization behavior. Constant not reported. Significance at 1%, 5%, 10% indicated by \*\*\*, \*\*, and \*, respectively.

Table 3. Balance of Payments Inflows to Emerging Markets, Annual Averages, in billions U.S.\$

	Current Account Balance				Net Foreign Direct Investment				Net non-Foreign Direct Investment				Reserve Inflows			
	1985-89	1990-93	1995-96	2000-06	1985-89	1990-93	1995-96	2000-06	1985-89	1990-93	1995-96	2000-06	1985-89	1990-93	1995-96	2000-06
Asia	7	-3	-26	206	5	18	49	81	9	20	53	-34	18	28	49	250
China	-5	5	4	100	2	9	36	58	5	0	3	-8	1	6	27	152
India	-6	-4	-6	-1	0	0	2	5	5	5	6	14	-1	2	0	20
Korea	7	-3	-16	14	0	0	-2	1	-4	5	23	10	3	1	4	25
Taiwan	13	10	8	24	-2	-2	-2	-4	0	-5	-7	2	11	2	-1	24
Other Asia	-2	-10	-17	69	4	11	15	20	2	16	28	-52	5	17	19	29
Latin America	-7	-21	-34	6	5	9	31	51	-19	25	22	-29	-1	18	24	20
Argentina	-2	-2	-6	4	1	2	5	4	-2	3	4	-11	0	3	2	1
Brazil	0	0	-21	-2	1	1	8	15	-11	0	24	-3	0	6	11	8
Mexico	-1	-18	-2	-12	2	4	9	20	-3	20	-8	1	0	5	6	6
Other LA	-3	-1	-5	16	1	2	9	11	-3	2	2	-15	-1	5	5	6
Central Europe	-2	-3	-6	-20	0	2	10	19	-4	-2	7	7	0	3	11	6
Russia			9	64			2	1			-14	-5			4	46
Middle East	-5	-22	5	86	-1	1	-2	-1	3	26	4	-61	-3	-2	5	13
Total	-6	-48	-52	342	9	30	90	151	-11	70	71	-122	14	47	92	335

Notes: Net non-foreign direct investment inflows include portfolio and other capital flows in the financial account. Other Asia includes Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Other Latin America includes Chile, Colombia, Peru, and Venezuela. Central Europe includes Czech Republic, Hungary, and Poland. Middle East includes Kuwait, Libya, Oman, Qatar, and Saudi Arabia.. Blank cells indicate values less than \$500 million. Source: IMF Balance of Payments Statistics.

Table 4. Does Sterilization Depend on the Composition of Balance of Payments Inflows?

$$\Delta NDA / RM_{-4} = \alpha + \beta_0 \sum_{k=1}^4 CA_{-k} / RM_{-4} + \beta_1 \sum_{k=1}^4 NFDI_{-k} / RM_{-4} + \beta_2 \sum_{k=1}^4 non - NFDI_{-k} / RM_{-4} + \beta_3 \Delta \ln(GNP) + \beta'_0 \left( \sum_{k=1}^4 CA_{-k} / RM_{-4} \right) (DumBreak) + \beta'_1 \left( \sum_{k=1}^4 NFDI_{-k} / RM_{-4} \right) (DumBreak) + \beta'_2 \left( \sum_{k=1}^4 non - NFDI_{-k} / RM_{-4} \right) (DumBreak)$$

Panel A. Selected Asian Countries

Explanatory Variable	China			Korea			Thailand			
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	
$\sum CA_{-k} / RM$	-1.728 (0.160)***	-1.416 (0.106)***	-0.798 (0.194)***	-0.881 (0.058)***	-0.867 (0.067)***	-0.887 (0.112)***	-1.482 (0.186)***	-1.434 (0.204)***	-1.011 (0.309)***	
$\sum NFDI_{-k} / RM$	-0.173 (0.207)	-1.098 (0.251)***	-0.924 (0.246)***	-0.806 (0.326)**	-0.759 (0.333)**	-1.052 (0.561)*	-0.963 (0.221)***	-0.938 (0.216)***	-0.744 (0.266)***	
$\sum non-NFDI_{-k} / RM$	-0.572 (0.228)**	-1.606 (0.207)***	-0.931 (0.321)***	-1.052 (0.074)***	-1.037 (0.088)***	-1.087 (0.144)***	-1.260 (0.121)***	-1.188 (0.150)***	-0.937 (0.220)***	
$\Delta \ln(GNP)$		1.241 (0.155)***	1.121 (0.184)***		0.510 (0.607)	0.693 (0.617)		-0.860 (0.683)	-2.340 (0.998)**	
$(\sum CA_{-k} / RM)(DumBreak)$			-0.438 (0.239)*			0.004 (0.106)			-1.216 (0.472)**	
$(\sum FDI_{-k} / RM)(DumBreak)$			-0.859 (0.319)***			0.335 (0.734)			-0.359 (0.269)	
$(\sum non-FDI_{-k} / RM)(DumBreak)$			-0.329 (0.487)			0.185 (0.162)			-0.655 (0.302)**	
$H_0 :  \beta_1  <  \beta_0 $	28.538***	1.129	>	0.043	0.087	>	2.918**	2.614*	1.035	
$H_0 :  \beta_1 + \beta'_1  <  \beta_0 + \beta'_0 $			>			0.134			10.471***	
$H_0 :  \beta_1  <  \beta_2 $	2.097*	5.372**	0.001	0.459	0.562	0.004	1.577	1.001	0.835	
$H_0 :  \beta_1 + \beta'_1  <  \beta_2 + \beta'_2 $			>			0.001			3.445**	
Adjusted R-squared	0.558	0.742	0.787	0.837	0.837	0.835	0.743	0.743	0.773	
Break date		2002 Q2			1998 Q4			1998 Q4		
Sample period		1986 Q2 – 2006 Q2			1985 Q1 - 2007 Q2			1985 Q1– 2007 Q1		
Observations		81			90			89		

Note: The table reports coefficients of regressing central bank net domestic assets on 4-quarter cumulative current account surplus (CA), net foreign direct investment inflows (NFDI), and non-NFDI capital inflows (non-NFDI) expressed in local currency terms, all scaled by the lagged reserve money stock (RM).  $\Delta \ln(GNP)$  is the 4 quarter percent change in nominal GDP, and *DumBreak* is a dummy variable denoting break point in sterilization behavior. Robust standard errors in parentheses. F statistic for null inequality hypotheses, with one-tail significance test results; results not reported when (the absolute value of the) coefficient on FDI inflows exceeds that on current account surplus or non-FDI inflows, as indicated by “>”. Constant not reported. Significance at 1%, 5%, 10% indicated by \*\*\*, \*\*, and \*, respectively.

Table 4. Does Sterilization Depend on the Composition of Balance of Payments Inflows? (cont'd)

Panel B. Other Selected Asian Countries

Explanatory Variable	Malaysia			Singapore			India		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\sum CA_{-k} / RM$	-0.968 (0.065)***	-0.973 (0.077)***	-1.060 (0.350)***	-1.120 (0.184)***	-0.872 (0.191)***	-0.807 (0.342)**	-1.152 (0.056)***	-1.109 (0.058)***	-0.799 (0.114)***
$\sum NFDI_{-k} / RM$	-0.227 (0.268)	-0.268 (0.352)	-0.131 (0.444)	-0.882 (0.174)***	-0.510 (0.186)***	-0.985 (0.354)***	-1.531 (0.226)***	-1.332 (0.241)***	-1.856 (0.260)***
$\sum non-NFDI_{-k} / RM$	-1.139 (0.071)***	-1.137 (0.073)***	-1.092 (0.467)**	-0.837 (0.153)***	-0.532 (0.184)***	-0.897 (0.339)**	-0.721 (0.100)***	-0.796 (0.096)***	-0.742 (0.152)***
$\Delta \ln(GNP)$		0.183 (0.683)	0.020 (0.998)**		-3.585 (1.463)**	-3.598 (1.769)**		0.420 (0.125)***	0.458 (0.129)***
$(\sum CA_{-k} / RM)(DumBreak)$			0.260 (0.388)			0.031 (0.296)			-0.581 (0.161)***
$(\sum FDI_{-k} / RM)(DumBreak)$			-1.461 (0.546)***			0.568 (0.389)			0.787 (0.384)**
$(\sum non-FDI_{-k} / RM)(DumBreak)$			-0.118 (0.497)			0.421 (0.361)			-0.340 (0.141)**
$H_0 :  \beta_1  <  \beta_0 $	10.355***	5.819***	3.134**	>	2.698*	>	>	>	>
$H_0 :  \beta_1 + \beta_1'  <  \beta_0 + \beta_0' $			2.839**			1.891*			0.413
$H_0 :  \beta_1  <  \beta_2 $	10.929***	5.659***	1.705*	0.105	0.030	>	>	>	>
$H_0 :  \beta_1 + \beta_1'  <  \beta_2 + \beta_2' $			0.691			0.112			0.001
Adjusted R-squared	0.627	0.623	0.635	0.508	0.528	0.548	0.892	0.897	0.912
Break date	1998 Q4			1998 Q4			2000 Q4		
Sample period	1985 Q1 – 2006 Q4			1995 Q4 – 2006 Q4			1985 Q1 – 2006 Q4		
Observations	88			45			88		

Note: The table reports coefficients of regressing central bank net domestic assets on 4-quarter cumulative current account surplus (*CA*), net foreign direct investment inflows (*NFDI*), and non-NFDI capital inflows (*non-NFDI*) expressed in local currency terms, all scaled by the lagged reserve money stock (*RM*).  $\Delta \ln(GNP)$  is the 4 quarter percent change in nominal GDP, and *DumBreak* is a dummy variable denoting break point in sterilization behavior. Robust standard errors in parentheses. F statistic for null inequality hypotheses, with one-tail significance test results; results not reported when (the absolute value of the) coefficient on FDI inflows exceeds that on current account surplus or non-FDI inflows, as indicated by “>”. Constant not reported. Significance at 1%, 5%, 10% indicated by \*\*\*, \*\*, and \*, respectively.

Table 4. Does Sterilization Depend on the Composition of Balance of Payments Inflows? (cont'd)

## Panel C. Selected Latin American Countries

C. Explanatory Variable	Argentina			Brazil			Mexico		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\sum CA_{-k} / RM$	-1.590 (0.421)***	-1.431 (0.452)***	-1.765 (0.766)**	-1.435 (0.165)***	-1.386 (0.214)***	-2.292 (0.439)***	-0.928 (0.176)***	-0.963 (0.171)***	-0.858 (0.275)***
$\sum NFDI_{-k} / RM$	-1.565 (0.393)***	-1.567 (0.396)***	-1.779 (0.502)***	-0.375 (0.395)	-0.270 (0.501)	-0.626 (0.587)	-0.885 (0.168)***	-0.791 (0.183)***	-0.430 (0.515)
$\sum_{k=1}^4 non-NFDI_{-k} / RM$	-1.319 (0.287)***	-1.265 (0.292)***	-1.448 (0.426)***	-0.887 (0.138)***	-0.867 (0.154)***	-1.133 (0.172)***	-0.800 (0.115)***	-0.786 (0.116)***	-0.768 (0.153)***
$\Delta \ln(GNP)$		-0.938 (0.564)	-0.747 (0.490)		0.021 (0.036)	-0.030 (0.043)		0.255 (0.204)	0.057 (0.269)
$(\sum CA_{-k} / RM)(DumBreak)$			2.070 (1.160)*			3.110 (0.648)***			0.083 (0.321)
$(\sum FDI_{-k} / RM)(DumBreak)$			-1.936 (1.405)			-0.280 (0.693)			-0.406 (0.544)
$(\sum non-FDI_{-k} / RM)(DumBreak)$			0.937 (0.480)*			0.494 (0.315)			0.230 (0.173)
$H_0 :  \beta_1  <  \beta_0 $	>	>	>	11.547***	9.627***	27.678***	0.098	1.445	1.572
$H_0 :  \beta_1 + \beta_1  <  \beta_0 + \beta_0 $			>			>			>
$H_0 :  \beta_1  <  \beta_2 $	>	>	>	2.078*	1.905*	1.123	>	>	0.608
$H_0 :  \beta_1 + \beta_1  <  \beta_2 + \beta_2 $			>			>			>
Adjusted R-squared	0.508	0.508	0.53	0.67	0.663	0.724	0.685	0.687	0.699
Break date	2004 Q3			2003 Q3			1996 Q4		
Sample period	1992 Q1 - 2007 Q1			1995 Q2 - 2006 Q4			1985 Q1 - 2007 Q2		
Observations	61			47			90		

Note: The table reports coefficients of regressing central bank net domestic assets on 4-quarter cumulative current account surplus ( $CA$ ), net foreign direct investment inflows ( $NFDI$ ), and non- $NFDI$  capital inflows ( $non-NFDI$ ) expressed in local currency terms, all scaled by the lagged reserve money stock ( $RM$ ).  $\Delta \ln(GNP)$  is the 4 quarter percent change in nominal GDP, and  $DumBreak$  is a dummy variable denoting break point in sterilization behavior. Robust standard errors in parentheses. F statistic for null inequality hypotheses, with one-tail significance test results; results not reported when (the absolute value of the) coefficient on FDI inflows exceeds that on current account surplus or non-FDI inflows, as indicated by “>”. Constant not reported. Significance at 1%, 5%, 10% indicated by \*\*\*, \*\*, and \*, respectively.

Figure 1a: The Trilemma Framework

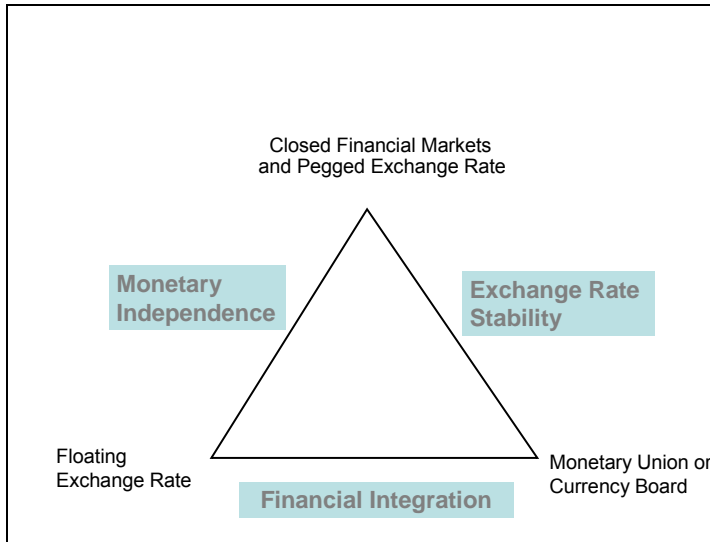
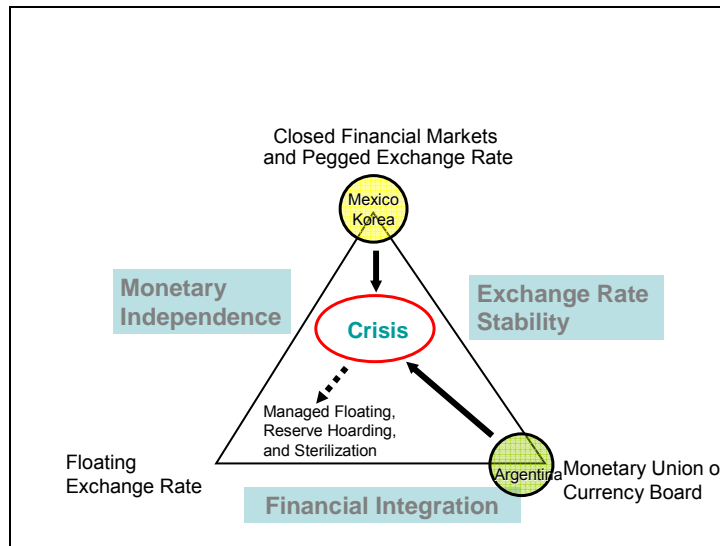


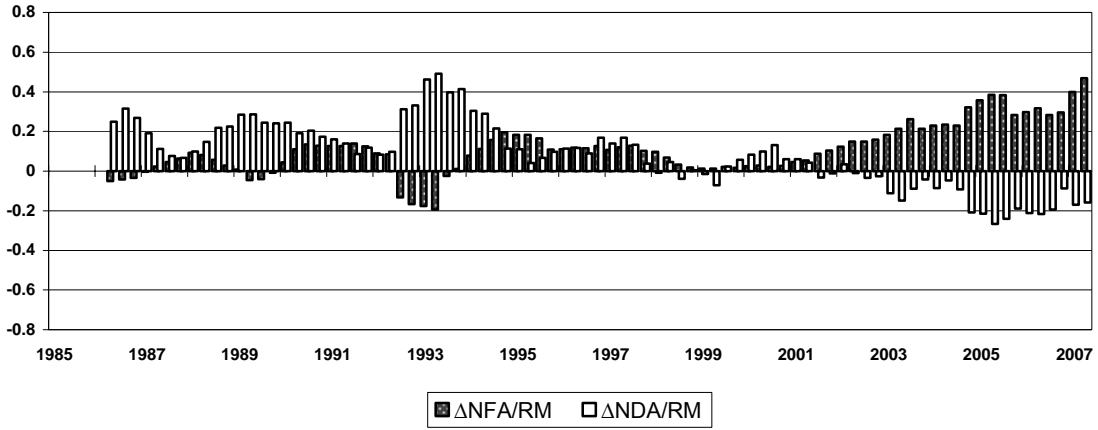
Figure 1b: Unstable Trilemma Configurations



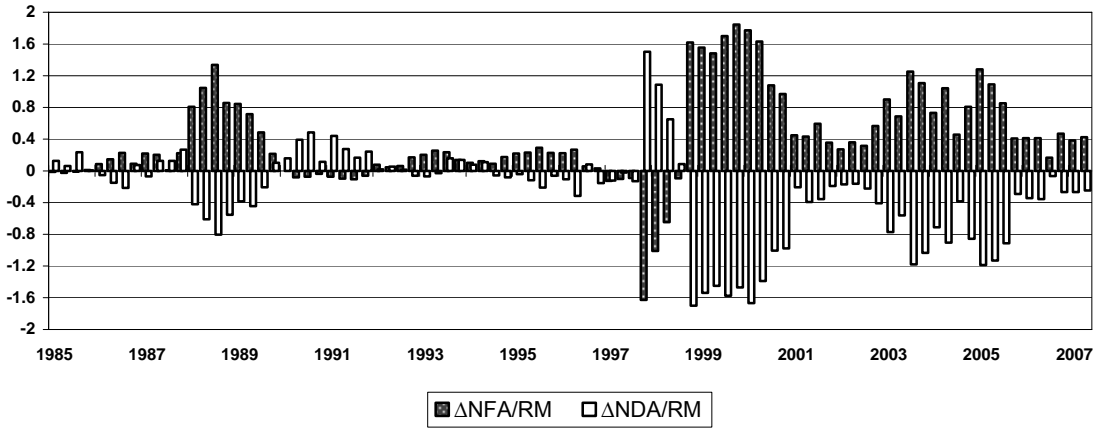
Note: Argentina, Korea, and Mexico (and other countries) experienced financial crises in the 1990s as they became more integrated with global financial markets and converged to policy configurations involving greater exchange rate flexibility, reserve hoarding, and sterilization in the aftermath of their respective crises.

Figure 2. Net Foreign Asset and Net Domestic Asset Changes of Central Bank,  
 Panel A. Selected Asian Countries  
 (4 quarter changes relative to stock of reserve money lagged 4Q, in percent)

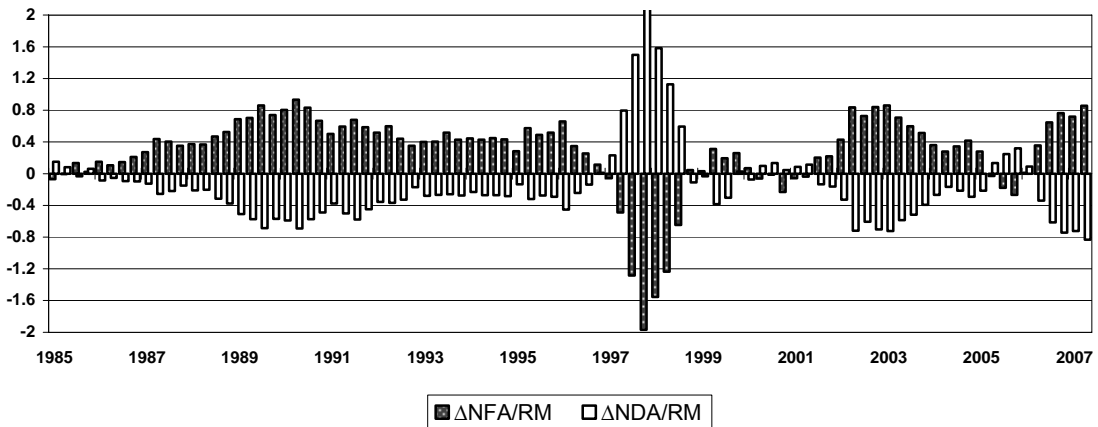
CHINA



KOREA



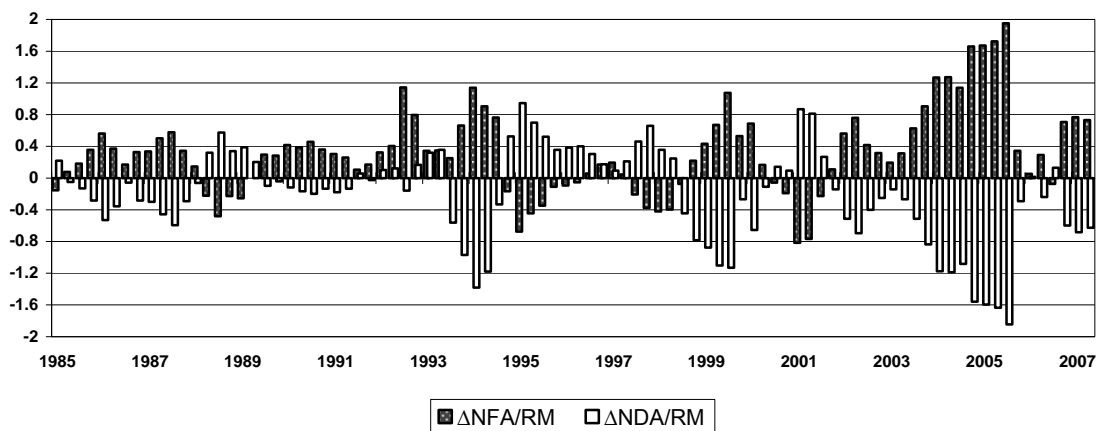
THAILAND



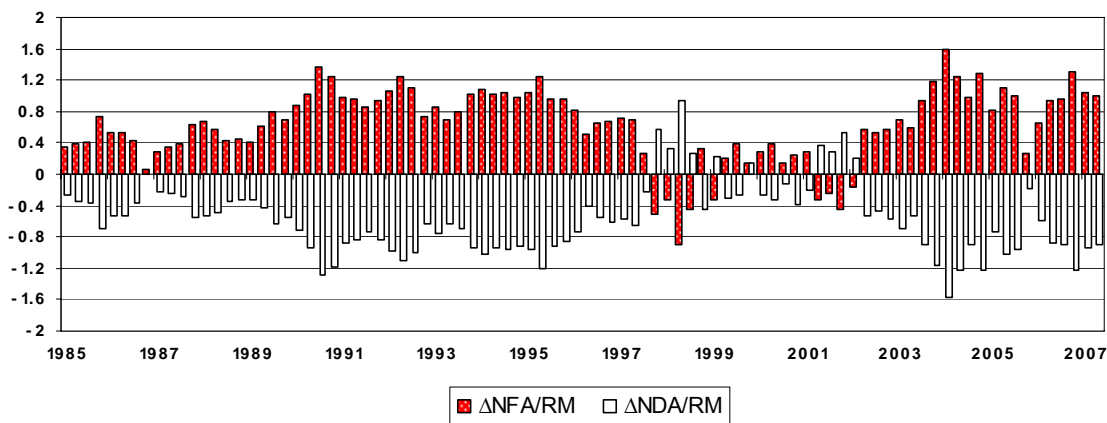
Note: positive values correspond to foreign reserve inflows or domestic asset increases.

Figure 2. Net Foreign Asset and Net Domestic Asset Changes of Central Bank,  
 Panel B: Other Selected Asian Countries  
 (4 quarter changes relative to stock of reserve money lagged 4Q, in percent)

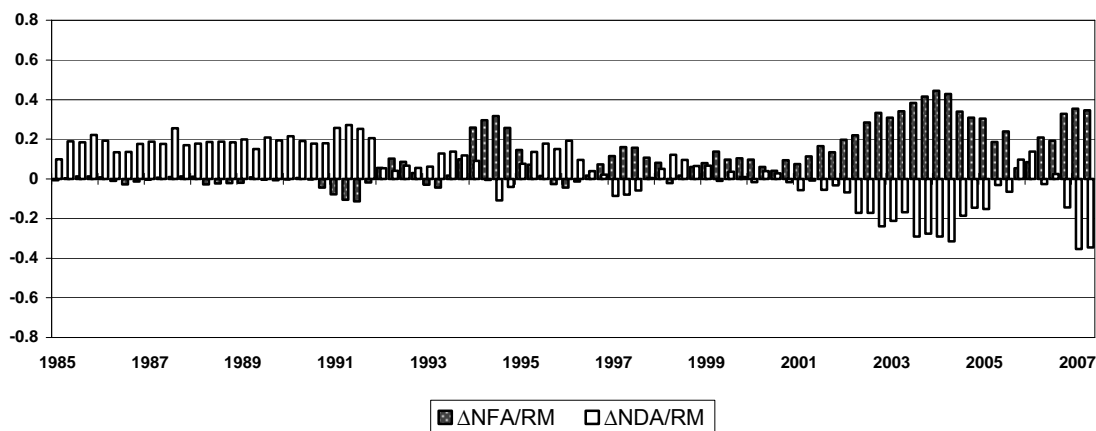
**MALAYSIA**



**SINGAPORE**



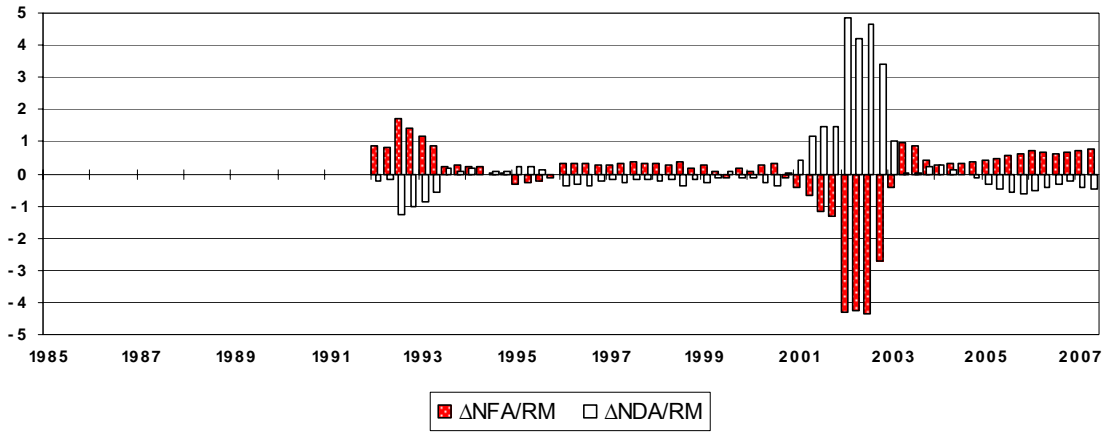
**INDIA**



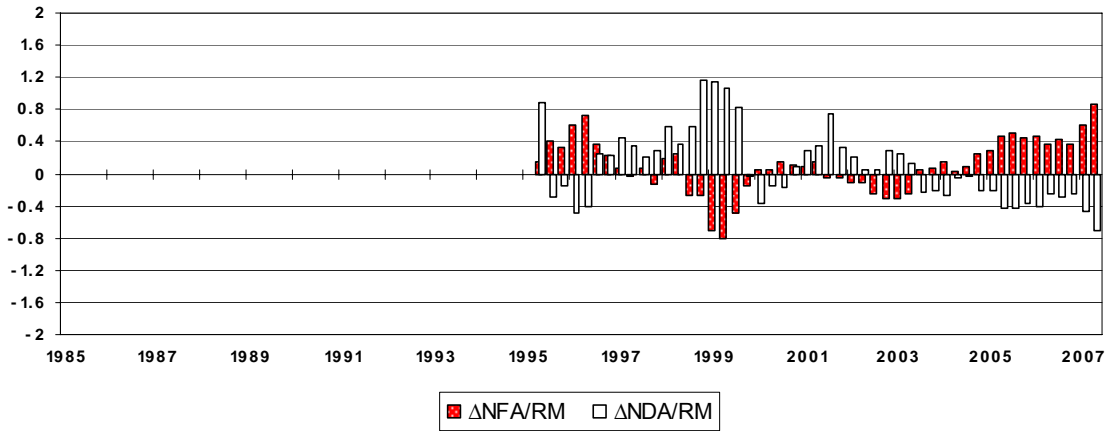
Note: positive values correspond to foreign reserve inflows or domestic asset increases.

Figure 2. Net Foreign Asset and Net Domestic Asset Changes of Central Bank,  
 Panel C: Selected Latin American Countries  
 (4 quarter changes relative to stock of reserve money lagged 4Q, in percent)

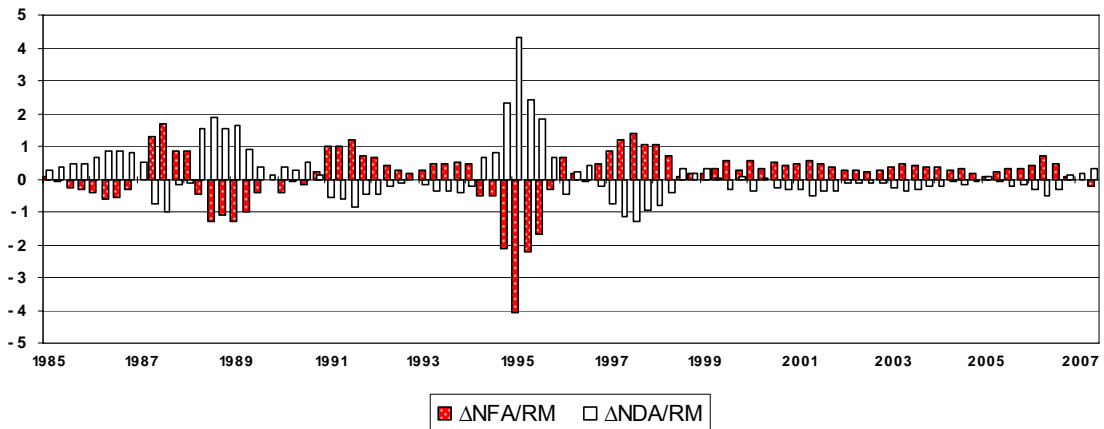
**ARGENTINA**



**BRAZIL**

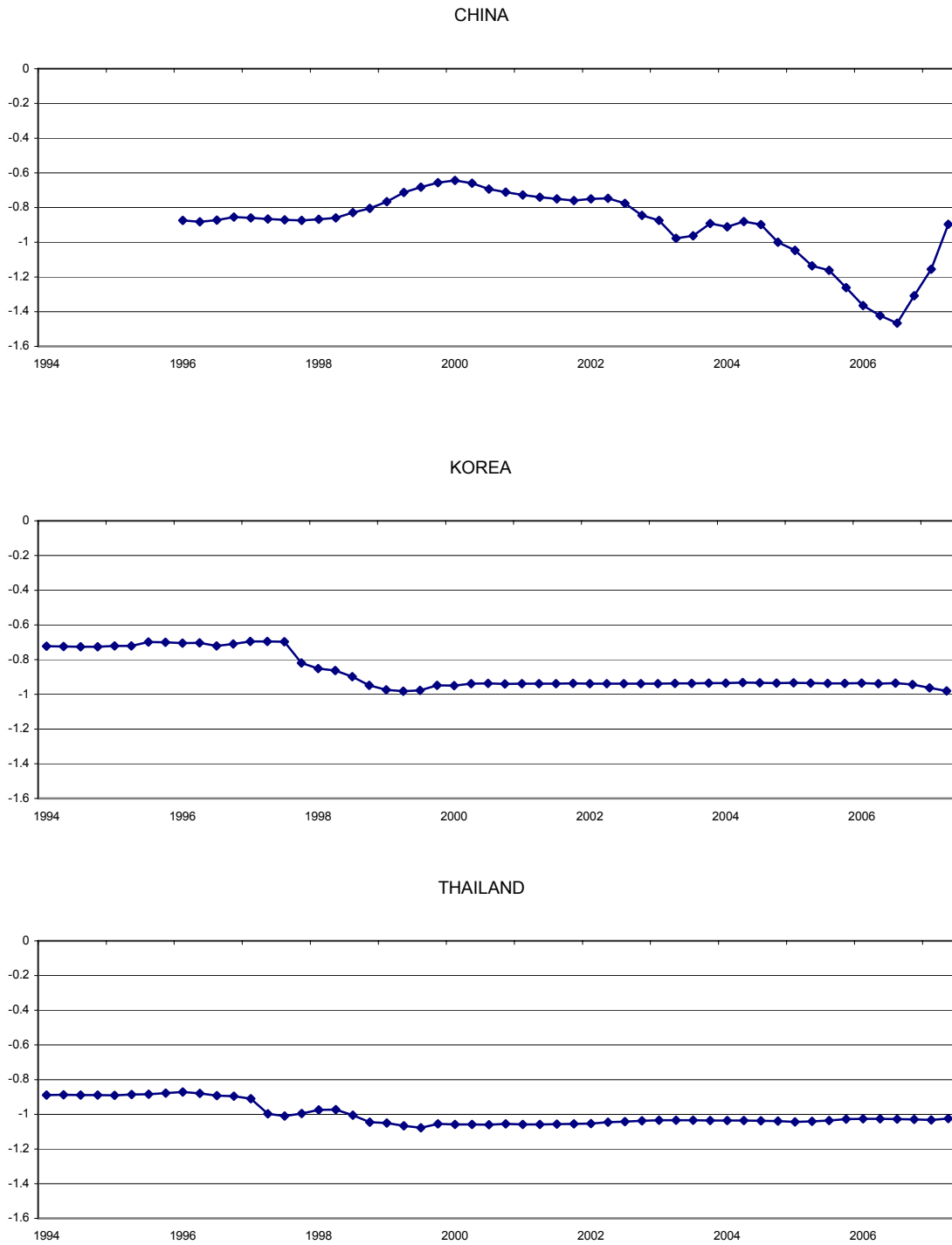


**MEXICO**



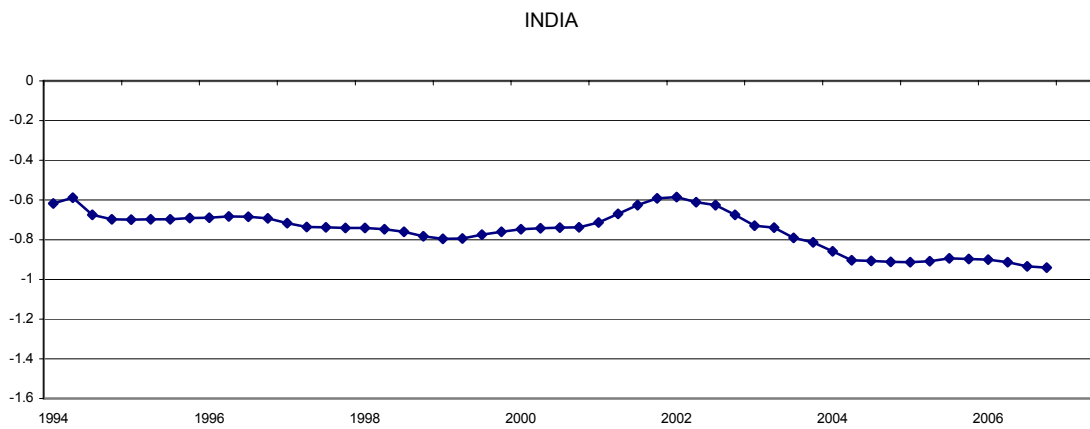
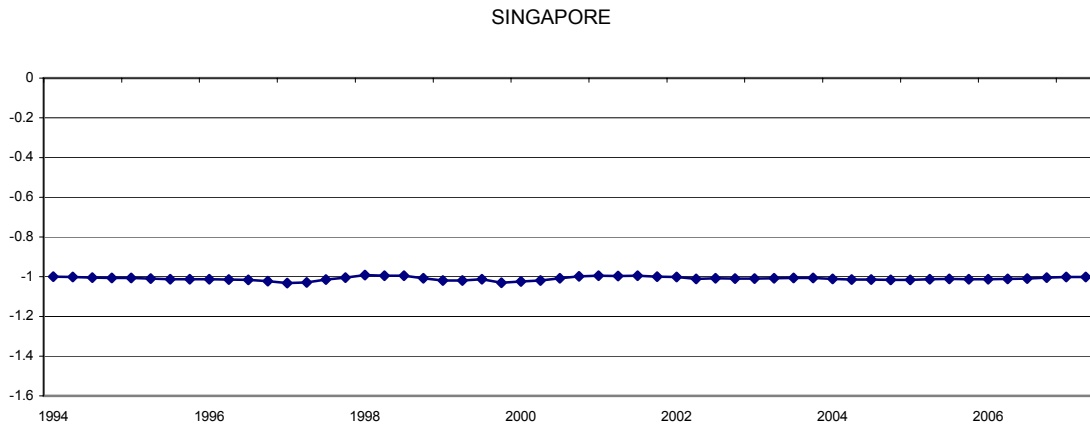
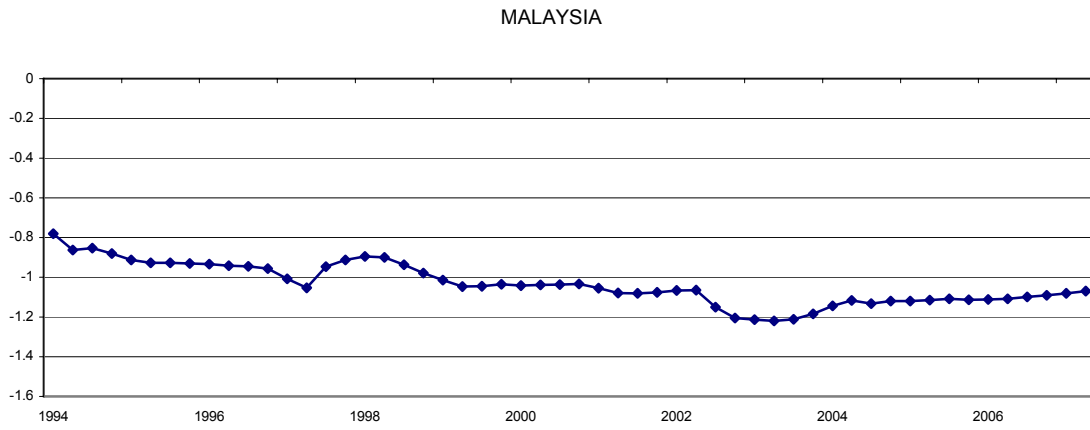
Note: positive values correspond to foreign reserve inflows or domestic asset increases.

Figures 3. Sterilization Coefficients from 40-quarter rolling regressions  
Panel A: Selected Asian Countries



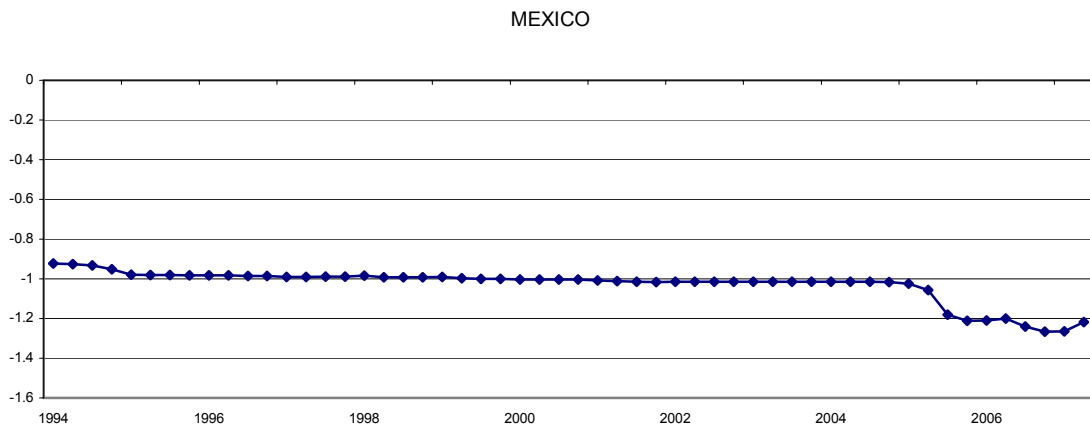
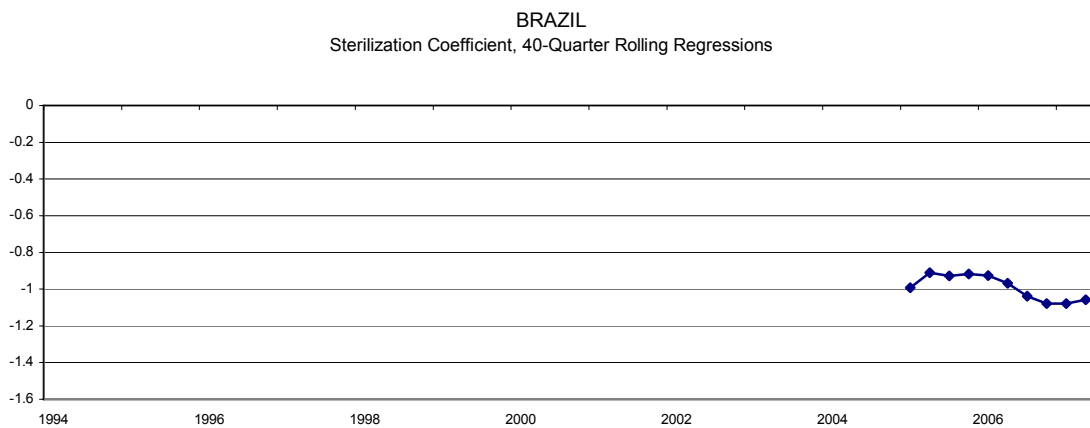
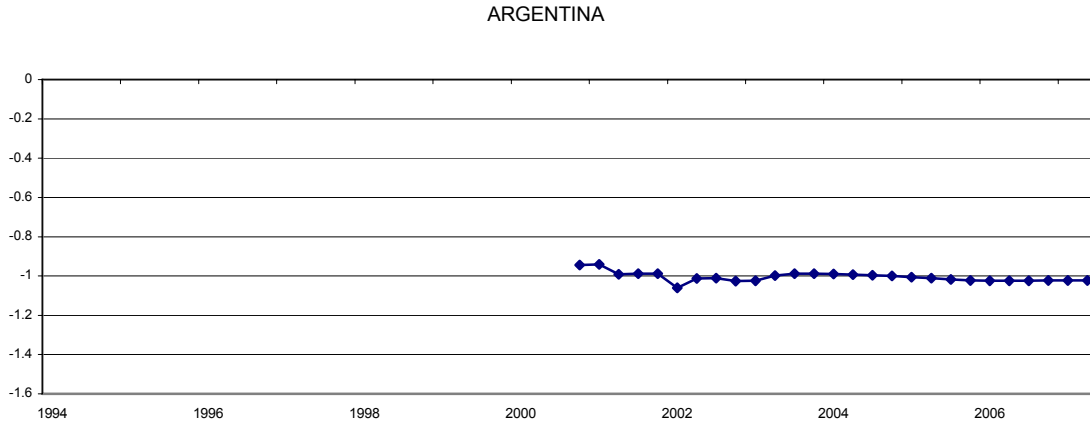
Note: Coefficient estimates from regression of net foreign asset change on net domestic asset change and nominal GDP growth. Coefficient observation correspond to calendar date of 40<sup>th</sup> quarter of rolling sample period.

Figures 3. Sterilization Coefficients from 40-quarter rolling regressions  
 Panel B: Other Selected Asian Countries



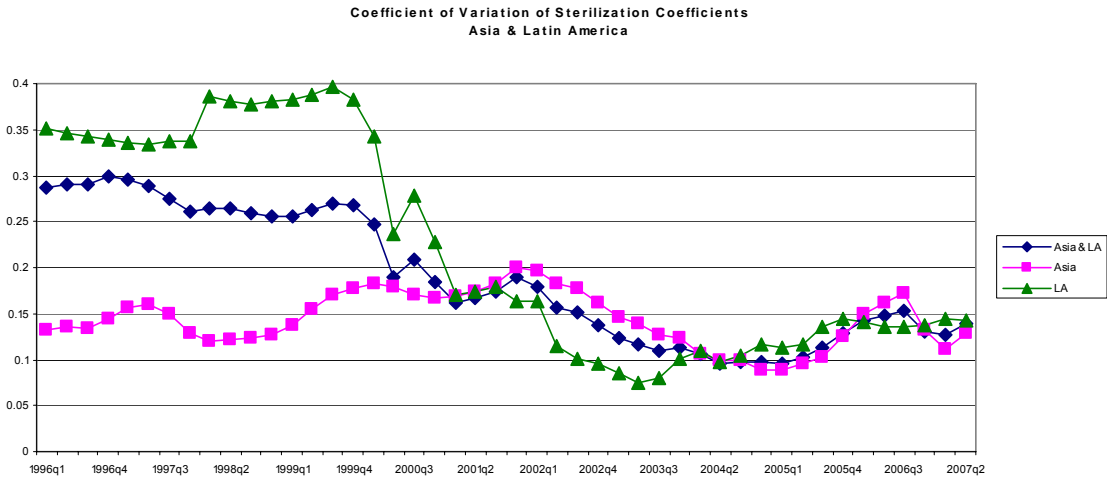
Note: Coefficient estimates from regression of net foreign asset change on net domestic asset change and nominal GDP growth. Coefficient observations correspond to calendar date of 40<sup>th</sup> quarter of rolling sample period.

Figures 3. Sterilization Coefficients from 40-quarter rolling regressions  
 Panel C: Selected Latin American Countries



Note: Coefficient estimates from regression of net foreign asset change on net domestic asset change and nominal GDP growth. Coefficient observations correspond to calendar date of 40<sup>th</sup> quarter of rolling sample period.

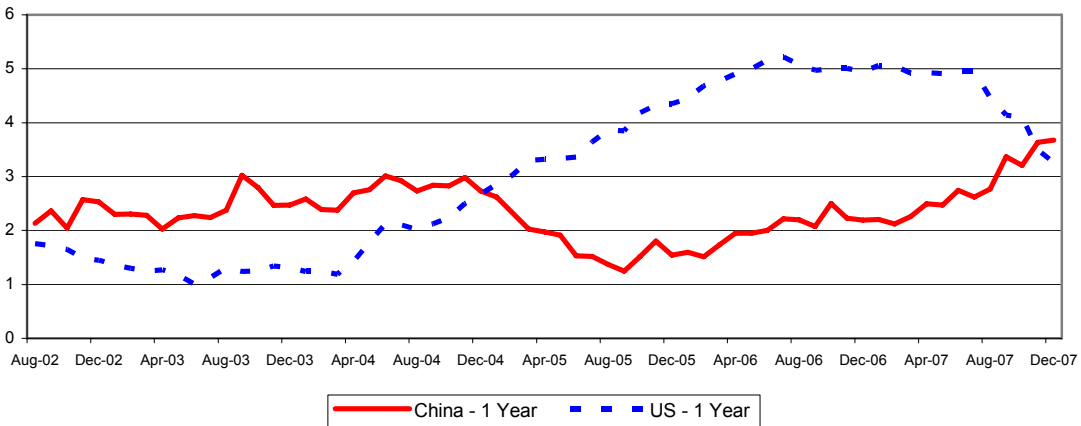
Figure 4. Coefficient of Variation of Sterilization Coefficients



Note: Calculations based on coefficient estimates from regression of net foreign asset change on net domestic asset change and nominal GDP growth for countries in Asia (China, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Singapore, Thailand) and Latin America (Argentina, Brazil, Chile, Colombia, Mexico, Peru). Coefficient observations correspond to calendar date of 40<sup>th</sup> quarter of rolling sample period.

Figure 5. China and U.S. Interest Rates

China Central Bank and U.S. Treasury  
1-Year Interest Rates (in percent)



## Appendix

This Appendix analyzes the costs of sterilization by formulating a model of the determinants of the substitutability between domestic and foreign bonds as characterized by the marginal increase in the interest rate differential associated with reducing the share of foreign bonds in private portfolios.

We consider a country where agents face financial repression and uncertainty about domestic price inflation, currency depreciation, and tax rate on returns. The real yield to domestic residents to holding domestic and foreign bonds ( $B, B^*$ ) are

$$(A1) \quad r = i - \pi .$$

$$(A2) \quad r^* = i^* + e - t^* - \pi ,$$

where  $i, i^*$  denote nominal interest returns,  $\pi$  is the domestic inflation rate,  $e$  is the depreciation rate of domestic currency, and  $t^*$  is the tax on returns to holding foreign assets, reflecting the realized costs of financial repression;  $\pi, e$ , and  $t^*$  are all stochastic. The tax rate  $t^*$  reflects the de-facto degree of financial repression, which may include regulations inhibiting or penalizing the holding of foreign assets.

We assume agents are risk averse, with mean variance preferences:

$$(A3) \quad U = U[E[W], \sigma_W^2]; \quad W = s(1+r) + (1-s)W(1+r^*).$$

The expected real yield differential can be solved as

$$(A4) \quad E[r^*] - E[r] = \theta \sigma_{r-r^*}^2 \left( \frac{B^*}{W} - \gamma \right)$$

where  $\gamma = \frac{\sigma_r^2 - 2\rho_{r,r^*}\sigma_r\sigma_{r^*}}{\sigma_{r-r^*}^2}$ ;  $\theta = -U_2W/U_1$ ;  $\sigma_{r-r^*}^2 = \sigma_r^2 + \sigma_{r^*}^2 - 2\rho_{r,r^*}\sigma_r\sigma_{r^*}$ .

Hence, sterilized intervention that reduces the share of foreign assets in the private portfolio,  $B^*/W$ , increases the expected interest rate differential,  $E[r] - E[r^*]$ , by the degree of risk aversion times the variance of the real interest rate differential,  $\theta \sigma_{r-r^*}^2$ .

The variables  $\pi$ ,  $e$ , and  $t^*$  are all stochastic. Specifically, we denote by  $a'_k, \varepsilon_k$  the constant and the shock associated with variables  $k$ ,  $k = \pi, e, t^*$  as

$$\pi = a'_\pi + \varepsilon_\pi; \quad e = a'_e + \varepsilon_e; \quad t^* = a'_t + \varepsilon_t.$$

We further assume (i) expected domestic inflation and the depreciation rate are correlated, (ii) shocks are zero mean and may be correlated and (iii) there are two types of agents ( $i = l, h$ ), with differential costs of holding foreign assets potentially different degree of risk aversion, with the “favored” type  $i = l$  having a low  $t^*$ , implying

$$\pi = a_\pi e + \varepsilon_\pi; \quad e = a_e + \varepsilon_e; \quad t^* = c_i (a_{t^*} + \varepsilon_{t^*}), i = l, h, c_h > c_l$$

where  $E[\varepsilon_\pi] = E[\varepsilon_e] = E[\varepsilon_{t^*}] = 0$ .

Noting that  $r - r^* = i - i^* + t^* - e$ , it follows that

$$(A5) \quad \sigma_{r-r^*}^2 = \sigma_{t^*}^2 + \sigma_e^2 - 2\rho_{t^*,e} \sigma_{t^*} \sigma_e = (c_i)^2 \sigma_{\varepsilon_{t^*}}^2 - 2c_i \rho_{\varepsilon_{t^*}, \varepsilon_e} \sigma_{\varepsilon_{t^*}} \sigma_{\varepsilon_e} + \sigma_{\varepsilon_e}^2.$$

Consequently,

$$(A6) \quad \frac{d\sigma_{r-r^*}^2}{dc_i} = 2c_i \left( \sigma_{\varepsilon_{t^*}}^2 - \rho_{\varepsilon_{t^*}, \varepsilon_e} \sigma_{\varepsilon_{t^*}} \sigma_{\varepsilon_e} \right)$$

We presume that the correlation between depreciation and the financial repression tax is positive, i.e.  $\rho_{\varepsilon_{t^*}, \varepsilon_e} > 0$  (see Giovannini and De Melo, 1993).

Expression (A6) implies that a higher correlation between the exchange rate depreciation rate and financial repression tax reduces the cost of sterilization. This effect is larger the greater is the extent of financial repression (i.e., the higher is  $c$ , and the greater is the share of agents facing higher  $c$ ). In the limiting case when the correlation approaches 1, it follows that  $\varepsilon_{t^*} \equiv k\varepsilon_e$ , where  $k$  is a constant, and

$$(A7) \quad \sigma_{r-r^*}^2 \xrightarrow{\rho_{t^*,e} \rightarrow 1} (1 - c_i k)^2 \sigma_{\varepsilon_e}^2.$$

Consequently, the ability to sterilize depends on imperfect substitutability of assets in a world where the costs of trading assets varies systematically across agents (due to possible scale effects) and across asset classes (due to varying liquidity and risk characteristics). Policies fostering greater domestic financial repression also reduce the costs of sterilization. This suggests that countries able and willing to engage in greater financial sterilization will be able to sustain the policy configuration of reserve hoarding and sterilizing for a longer period of time.

## Current account patterns and national real estate markets

by

Joshua Aizenman and Yothin Jinjarak\*

### Abstract

This paper studies the association between the current account and real estate valuation across countries, subject to data availability [43 countries, of which 25 are OECD], during 1990-2005. We find robust and strong positive association between current account deficits and the appreciation of the real estate prices/(GDP deflator). Controlling for lagged GDP/capita growth, inflation, financial depth, institution, urban population growth and the real interest rate; a one standard deviation increase of the lagged current account deficits is associated with a real appreciation of the real estate prices by 10%. This real appreciation is magnified by financial depth, and mitigated by the quality of institutions. Intriguingly, the economic importance of current account variations in accounting for the real estate valuation exceeds that of the other variables, including the real interest rate and inflation. Among the OECD countries, we find evidence of a decline overtime in the cross country variation of the real estate/(GDP deflator), consistent with the growing globalization of national real estate markets. Weaker patterns apply to the non-OECD countries in the aftermath of the East Asian crisis.

**Keywords:** Current account, real estate, appreciation, financial depth

**JEL Classification:** F15, F21, F32, R21, R31

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## 1. **Introduction and overview**

The financial liberalization wave in emerging markets during the 1990s has frequently led to boom-bust cycles, when the initial boom had been often followed by a financial crisis. Significant literature has focused on the dynamics of financial liberalization in emerging markets, accounting for some of these boom/bust dynamics, as a reflection of the “Overborrowing syndrome” [McKinnon and Pill (1996)]. Accordingly, financial liberalization has led to large inflows of capital, bankrolling growing current account deficits, investment and consumption booms. Frequently, these booms were manifested in sizable real estate and real exchange rate appreciations, and in the buildup of balance sheet vulnerabilities. These vulnerabilities had been magnified in countries using a fixed exchange rate, where occasionally incipient capital flights and sudden stops led to financial crises, abrupt real depreciation, and to a bust in the real estate market and to V type recessions. Observers frequently noted that the real estate market played a key role in the propagation of the boom and bust cycle. A frequent concern has been that capital inflows tend to magnify the welfare costs of preexisting distortions (like moral hazard), as they may increase the size of the distorted activities, deepening the bust at the end of the cycle.<sup>1</sup>

Most of the above literature dealt with East Asia and Latin America, implicitly presuming that the US and Europe are less exposed to the vulnerabilities that come with such cycles. The ability of OECD countries to borrow in their currency, the greater reliance on flexible exchange rate regimes, and the presumption of better institutions suggests that the potential volatility induced by real estate boom/bust cycles is indeed larger in developing countries. Yet, there is little evidence regarding the degree to which countries share similar qualitative links between current account patterns and national real estate markets. The purpose of our paper is to provide evidence on the robustness of the current account/real estate channel across all countries, subject

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<sup>1</sup> See Kyotaki and Moore (1997) and Aghion et al. (2001) for models of credit cycles in the closed and open economy, respectively. For further discussion of the association between capital inflows, asset valuation and financial fragility, see Calvo, Leiderman and Reinhart (1996), Krugman (1998), Edison, Luangaram and Miller (1998) Quigley (2001), Kim and Lee (2002). See Aizenman (2004) for an overview of the policy challenges facing financial opening, and the magnification of domestic distortions associated with capital inflows. See Debelle and Galati (2007), Edwards (2004), Chinn and Ito (2005), Freund (2005) and Faruqee and Lee (2006) for overviews of current account patterns in recent decades.

to data availability. Our main finding is that, indeed, this channel is potent across all countries, subject to interactions with other domestic variables.

We don't pertain to deal with causality, as we don't model and control for the factors that may induce capital flows. Instead, we take the view that current real estate valuation has a sizable dependence on lagged macroeconomic variables. This is consistent with the notion that adjustment to changing macro conditions is more protracted in real estate markets than in stock markets [see Glaeser and Gyourko (2007) and Case and Shiller (1989)].<sup>2</sup> We study regressions that account for the real appreciation of the housing stock, controlling for lagged variables, including GDP per capita, real interest rate, inflation, and the current account. We find that lagged current account patterns are important in accounting for the real appreciation of the real estate market. In addition, the current account changes interacted with other macro variables are important in accounting for future real valuation of housing. Specifically, a one standard deviation increase of the lagged current account deficits [by 4% in our sample] is associated with real appreciation of real estate prices by about 10%. This real appreciation is magnified by financial depth [about 2%], and mitigated by the quality of institutions [about 3%]. Intriguingly, the economic importance of current account variations in accounting for the real appreciation of real estate prices exceeds that of the other variables, including the real interest rate -- a one standard deviation drop of the lagged real interest rate [by 2.5% in our sample] is associated with real appreciation of real estate prices by about 7%. Among the OECD we find evidence of decline overtime in the cross country variation of the relative real estate prices, consistent with the deeper globalization of national real estate market. Weaker patterns apply to the non-OECD countries in the aftermath of the East Asian crisis.

Section 2 overviews the data; section 3 outlines the univariate t-tests; the multivariate panel tests are summarized in section 4. Section 5 closes the paper with concluding remarks.

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<sup>2</sup> Adjustments in the real estate markets are subject to significant transaction costs on behalf of consumers, and time consuming installation costs on behalf of producers. These features imply that demand-side factors play important and persistent roles in explaining protracted adjustment in the real estate market. See Brock (1988) for an open economy analysis of these issues. For empirical studies of the determinants of the real estate prices see Englund and Ioannides (1997), Case, Goetzmann and Geert (2000), Case, Quigley, and Shiller (2005), da Mata (2007), and Shiller (2007).

## 2. Sample

National real estate price indices are taken from the Datastream and the Global Property Guide (see the Data Appendix for details). While the collection methods of the primary indices are admittedly much different across countries, these indices are representative of the level of appreciation in the corresponding national markets. More than half of the indices are compiled by the government agencies, and the rest by private consulting firms. We have data for 43 countries, of which 25 are OECD countries. The sample is unbalanced, covering 1990 to 2005. The raw data of real estate indices are given in nominal term, whereas it is more relevant from a cross-country perspective to consider the appreciation of real estate prices in real term. We therefore deflate the indices with the local GDP deflator, and call the resultant series “appreciation of real estate prices” or “real estate/(GDP deflator) appreciation.” We choose the GDP deflator over the consumer price index mainly to maximize the sample size, due to the lack of continuous CPI series for many developing countries at the beginning of the sample period. Another added benefit of using the GDP deflator is that it may control for the changing basket and expenditure patterns across countries.

A major limitation of using one property index per country is that we make no distinction between different types of property markets: residential, industrial, office, and retail. What would be ideal is to use the sectoral international property return data. However, this kind of data is mostly available at city level. In addition, the return data across countries is difficult to obtain, and if available, rather short due to the discontinuity of private collecting agencies and property consulting firms; the existing sources of the return data cover about ten to fifteen industrial countries, starting from early 2000s.<sup>3</sup> The data is also subject to sample selection, as the lack of data in some countries may result from the lack of interest and investment opportunities in the real estate markets there. Another limitation facing us is that we do not have enough city-level information that would allow for an in-depth comparison across countries. For instance, our figures for China seem to understate the trends in major Chinese cities.<sup>4</sup>

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<sup>3</sup> See for example Investment Property Databank (IPD), Knight Frank LLP, Jones Lang LaSalle Research, and the Economist’s global house-price indicators.

<sup>4</sup> Another important consideration is government policy. Zheng and Kahn (2008) find in the case of Beijing that while the land prices and real estate prices decline with distance from the city center, the residential building heights and housing unit sizes do not, indicating some binding

The data on current account deficits and other macroeconomic variables are taken from the World Development Indicators (WDI) and the International Financial Statistics (IFS). Following the literature, we control for the annual growth of population in the urban areas (Urban Population Growth), the annual growth of real GDP per capita (Capita GDP Growth), GDP deflator inflation (Inflation), domestic credit provided by the banking sector as a percentage of GDP (Financial Depth), and the domestic real interest rate. We use the real interest rate from WDI, which is constructed from the bank one year lending interest rate, adjusted for inflation by the GDP deflator. It would be more appropriate to use the mortgage rates, testing both the prime and sub-prime real estate loans. To our knowledge, a panel data on the mortgage rates at that level of disaggregation is not publicly available across the OECD and Non-OECD countries. We also use International Country Risk Guide (ICRG) scores on law & order (the higher the better) as a proxy for quality of institutions. Global and local financial conditions are represented by variable dealing with the nominal interest rates, the appreciation of local stock markets (deflated by GDP deflator), the 3-month US Treasury Bill Rate, Japan Financing Bill Rate, and the London Interbank Offer Rates (pound sterling).<sup>5</sup>

Table 1 provides for each national real estate market the number of observations, sample averages, standard deviations, and the Mackinnon approximate p-value of Dickey-Fuller test for unit root. While the real estate prices/(GDP Deflator) appreciation is available only from 1990-2005, the Current Account Deficits/GDP series go back much further, to 1980 for most of the countries. Missing data is the norm for emerging markets, particularly for several of the Eastern European countries. In our sample, the average number of observations (years available) for Real Estate /(GDP deflator) appreciation is 12 for all countries, 10 for the emerging markets, and 14 for the OECD countries.

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urban planning policies that do not reflect market forces.

<sup>5</sup> Warnock and Warnock (2007) find that countries with stronger legal rights for borrowers and lenders, deeper credit information systems, and a more stable macroeconomic environment have a deeper housing finance system. There are several important financial variables which we lack in the cross-country data, including loan-to-value ratios, credit restrictions, and securitization of housing loans (see also BIS, 2006). Due to the data availability, these figures also miss the recent market turbulences; the credit shock hitting the financial markets in 2007 has generated a decline in securitization of mortgages, which sharply reduces the demand for housing (Deutsche Bank, 2008).

We can see from Table 1 that the average appreciation of real estate prices in some countries is extreme: for the 7-12 year period, the appreciation exceeds 14 % in Estonia and Lithuania whereas the depreciation exceeds 20 % in Bulgaria and Russia. During 1990-2005, the average Real Estate/(GDP deflator) appreciation is .64 % per year for all countries, -1.35 % per year for the emerging markets, and 2.08 % per year for the OECD countries. The emerging markets tend to be more volatile: their average standard deviation of the appreciation is 17.57, compared to 5.90 for the OECD countries. Using the Dickey-Fuller test for unit root with a trend term, we also see that most of the Real Estate/(GDP deflator) appreciation series are non-stationary: the Mackinnon approximate p-value of 35 countries is larger than .005.

For the patterns of the Current Account Deficits/GDP, some of the extreme numbers come from countries running large current account surpluses: for example Singapore and Switzerland run an average 10% surplus over a 25-year period. The average Current Account Deficits/GDP is .25 for all countries, .66 for the emerging markets, and -.04 for the OECD countries. As in the case of the real estate prices, the emerging markets tend to be more volatile: the average standard deviation of the Current Account Deficits/GDP is 4.56, compared to 2.85 for the OECD countries. Using the Dickey-Fuller test for unit root with a trend term, we also find that most of the current account series are non-stationary: the Mackinnon approximate p-value of 41 countries is larger than .005.

Figure 1 provides the unconditional sample distribution of the average Real Estate/(GDP deflator) appreciation between the early 1990s and the early 2000s. From the kernel density estimates, we can see that the cross-sectional distribution of the real estate appreciation has expanded over the recent decade.<sup>6</sup> There is an increase in the dispersion, with the mass of the distribution being less concentrated around the mean of zero (from 1991-95, the average appreciation = 1.2 percent per year) and shifting out toward the higher positive tails (from 2001-05, the average appreciation = 22.5 percent per year). The peakedness, measured by the kurtosis, of the sample distribution suggests that more of the variance is due to infrequent extreme deviations in the early 1990s, as opposed to frequent and modest size deviations in the early 2000s.

Figure 2 shows the trend in the Real Estate/(GDP deflator) appreciation and the Current Account Deficits/GDP during 1990 through 2005, for 18 Non-OECD countries, 24 OECD

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<sup>6</sup> The density estimates are based on Epanechnikov kernel function.

countries excluding the US, and the US. The bust of the global property markets in the early 1990s, and the Asian financial crisis of 1997 are clearly evident. We can also see some positive association between the Real Estate/(GDP deflator) appreciation and the Current Account Deficits/GDP during that period. This relationship is particularly prominent in the case of the US for the past fifteen years.

As a check on whether the cross-country dispersion in the appreciation of real estate prices corresponds to that in the stock markets, Figure 3 depicts the standard deviation of the two for the OECD and the Non-OECD countries. The dispersion among the Non-OECD countries is higher than among the OECD countries, but this difference is varying over time with periodic jumps, i.e. during the Asian Financial Crisis in 1997. A tighter connection between the two markets applies to the OECD countries: the correlation between the standard deviation in the real estate markets and that in the stock market is .77 for the OECD countries, but only .06 for the Non-OECD countries. In the real estate markets, the standard deviation of Real Estate/(GDP deflator) appreciation declines on the order of 0.02 % per year (p-value .05) among all countries, 0.26 % (p-value .06) among the OECD countries, and 0.0004 percent (p-value .99) among the Non-OECD countries.<sup>7</sup> In the stock markets, the standard deviation of Stock Price/(GDP deflator) falls 0.01 % per year (p-value .21) among all countries, 0.02 % (p-value .01) among the OECD countries, and .002 % (p-value .89) among the Non-OECD countries. The observed global convergence in both the real estate markets and the stock markets is quite compelling.

Figure 4 shows the correlations between the Current Account Deficits/GDP and the Real Estate/(GDP deflator) appreciation. To provide a reference for the level of global interest rates, we also plot the 3-month nominal interest rates using the U.S. Treasury Bill, the Japan Financing Bill, and the London Interbank Offer Rate (LIBOR, pound sterling) in the bottom of the figure. During the sample period, the correlations between the appreciation of real estate prices and the current account deficits increase by 0.041 % per year (p-value 0.0) among all countries, 0.029 % (p-value .006) among the OECD countries, and 0.036 % (p-value .283) among the Non-OECD countries.<sup>8</sup> In order to test whether the correlations are associated with the global market interest

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<sup>7</sup> Let  $\sigma$  denote the standard deviation and  $t$  the time trend, the approximate convergence rate ( $b_1$ ) is derived from running the OLS regression of  $\ln(\sigma) = a_1 + b_1t + \omega_1$ ; where  $\omega_1$  is an error term.

<sup>8</sup> Let  $\rho$  denote the correlation and  $t$  the time trend, the approximate convergence rate ( $b_2$ ) is

rates, we regress the correlations on the LIBOR for each country groups. The estimated coefficient is -.061 (p-value .000) for all countries, -.051 (p-value .000) for the OECD countries, and -.048 (p-value .449) for the Non-OECD countries. The results point to the significance of the level of financial depth: the decline in the global market interest rates tend to drive the correlations between the current account deficits and the appreciation of real estate prices upwards, especially for the OECD countries.

Before implementing the econometric tests, we examine in details the stationarity of the real estate and the current account series. Table 2 reports the unit root tests, applying on the individual series for each of the sample countries, and across series in the panels. In the top panel, we can see that the rejection rates from these tests on the individual countries suggest that the stationarity properties of the series are inconclusive.<sup>9</sup> The augmented Dickey-Fuller test and the Phillips-Perron test indicate that more than half of the Real Estate/(GDP deflator) Appreciation and around 90 percent of the Current Account Deficits/GDP are non-stationary. In contrast, the Kwiatkowski-Phillips-Schmidt-Shin (1992) test indicates that most of the two series are stationary.<sup>10</sup> These mixed results highlight the low-power of the unit-root tests on the limited length of time series that we have.

The bottom panel of Table 2 reports the results from applying the panel unit root tests. Because the sample must be a balanced panel in order to perform the existing panel test procedures, we restrict the sample to 12 years (1993-2004) and 25 countries.<sup>11</sup> The test statistics correspond to specifications with time trend. The null hypothesis is non-stationarity for the Levin-Lin-Chu (2002) test and the Im-Pesaran-Shin (2003) test. For the Nyblom-Harvey (2000)

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derived from running the OLS regression of  $\rho = a_2 + b_2t + \omega_2$ ; where  $\omega_2$  is an error term.

<sup>9</sup> The test statistics correspond to specifications with time trend. Except for the Kwiatkowski-Phillips-Schmidt-Shin test, the null hypothesis is non-stationarity. The rejection of stationarity under the Kwiatkowski-Phillips-Schmidt-Shin test is reported as a non rejection of the unit root.

<sup>10</sup> Faruqee and Lee (2006) also find that the Kwiatkowski-Phillips-Schmidt-Shin test tends to not rejecting the null of unit root (88 percent out of 94 countries from 1960-2003).

<sup>11</sup> The countries available for the panel unit-root tests include 19 OECD and 6 Non-OECD: Australia, Austria, Belgium, Bulgaria, Canada, Denmark, Finland, France, Germany, Indonesia, Ireland, Italy, Japan, Korea, Malta, Netherlands, New Zealand, Norway, Singapore, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, and United States.

test, the test statistic can be considered as the generalization of the Kwiatkowski-Phillips-Schmidt-Shin test, and a failure to reject the null hypothesis of zero common stochastic trends is an indication that the series do not form a cointegrated combination. Applying to the panel of Real Estate/(GDP deflator) appreciation that we have, the Levin-Lin-Chu and the Im-Pesaran-Shin tests reject the null of non-stationarity. The Nyblom-Harvey test rejects the null of zero common trends for the panels of OECD and Non-OECD, but not for the whole sample. For the Current Account Deficits/GDP panels, the results are also inconclusive: the Levin-Lin-Chu test rejects, but the Im-Pesaran-Shin test cannot reject the null of panel unit root. The mixed results seem to underline a number of limitations with the existing panel unit root tests.<sup>12</sup>

### 3. Univariate t-tests

Table 3 provides the t-tests for the hypothesis that the national real estate markets are correlated through the current account patterns.<sup>13</sup> We first remove the effects of a country's own current account deficits on its real estate/(GDP deflator) appreciation series using a linear regression of the real estate/(GDP deflator) appreciation on the contemporaneous current account deficits to GDP:

$$(1) \left( \frac{\text{Real Estate}}{\text{GDP Deflator}} \text{ appreciation} \right)_{i,t} = \phi_1 + \phi_2 \left( \frac{\text{Current Account Deficits}}{\text{GDP}} \right)_{i,t} + \psi_{i,t}$$

Then we compare the correlation matrices of the raw appreciation of real estate prices,  $\left( \frac{\text{Real Estate}}{\text{GDP Deflator}} \text{ appreciation} \right)_{i,t}$ , to the regression residuals,  $\psi_{i,t}$ . In the last step, we conduct a paired t-test of the off-diagonal elements in the raw appreciation and the residual correlation matrices to determine whether the difference in the means of correlations is significant. Specifically, let  $\rho_i^j$  denote the correlation of the real estate/(GDP deflator) appreciation in country  $i$  and country  $j$ , and  $\tilde{\rho}_i^j$  denote the correlation of the corresponding residuals from equation (1). The off-diagonal elements for the tests using  $N=43$  countries are:

<sup>12</sup> See Enders, 2004, pp.156-230.

<sup>13</sup> We adopt this test from Case, Goetzmann, and Rouwenhorst (2000), though they apply the test

$$\begin{bmatrix} \cdot & \cdot & \cdot & \cdot & \cdot \\ \rho_2^1 & \cdot & \cdot & \cdot & \cdot \\ \rho_3^1 & \rho_3^2 & \cdot & \cdot & \cdot \\ \rho_*^1 & \rho_*^2 & \rho_*^3 & \cdot & \cdot \\ \rho_N^1 & \rho_N^2 & \rho_N^3 & \rho_N^* & \cdot \end{bmatrix} \text{ and } \begin{bmatrix} \cdot & \cdot & \cdot & \cdot & \cdot \\ \tilde{\rho}_2^1 & \cdot & \cdot & \cdot & \cdot \\ \tilde{\rho}_3^1 & \tilde{\rho}_3^2 & \cdot & \cdot & \cdot \\ \tilde{\rho}_*^1 & \tilde{\rho}_*^2 & \tilde{\rho}_*^3 & \cdot & \cdot \\ \tilde{\rho}_N^1 & \tilde{\rho}_N^2 & \tilde{\rho}_N^3 & \tilde{\rho}_N^* & \cdot \end{bmatrix}$$

If the null hypothesis of equality of the correlations in raw appreciation  $\rho_i^j$  and the correlations in residuals  $\tilde{\rho}_i^j$  is rejected, then this would suggest that the co-movements of the national real estate markets are associated with common factors driving the current account patterns.

Let  $\sigma$  denote standard deviation, the means of correlations of the raw real estate/(GDP deflator) appreciation are .089 ( $\sigma = .382$ ) across all countries, .027 ( $\sigma = .361$ ) across the Non-OECD countries, 0.147 ( $\sigma = .366$ ) across the OECD, and 0.158 ( $\sigma = .438$ ) between the OECD and Non-OECD countries. After removing the effects of the current account deficits, the correlations are 0.024 ( $\sigma = .377$ ) across all countries, -0.030 ( $\sigma = .366$ ) across the Non-OECD countries, 0.058 ( $\sigma = .337$ ) across the OECD countries, and 0.116 ( $\sigma = .446$ ) between the OECD and the Non-OECD countries. The t-tests reject the null of equality of means of correlations for all-country pairs (though the test barely rejects that for the OECD versus Non-OECD countries pairs). Thus, removing the effects of own-country current account deficits results in a statistically significant drop in mean correlation of the real estate/(GDP deflator) appreciation across countries. The most significant drop is for the OECD countries. We can also see that removing the effects of current account deficits decreases the variance of the Real Estate/(GDP deflator) appreciation by 2.7 %.

#### 4. **Multivariate panel tests**

In this section, we use a panel data estimation, controlling for the effects of other macroeconomic variables. The analysis thus far suggests that the contemporaneous current account factor is important in explaining the real estate markets across countries. However, the real estate markets are more likely to adjust to the current account deficits with lags. In addition,

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to sectoral property returns with the GDP factor in a smaller set of countries.

we also need to include relevant macro variables as regression controls. These include Urban Population Growth, Capita GDP Growth, Inflation, Financial Depth, Institution, and Real Interest Rates.

Because the macro variables are cross-country time series, we need to make the following transformation of the variables. First, we include in the panel estimation the lagged values of the Current Account Deficits/GDP and other macro variables. The current account variable enters the panel regressions using annual observations with a maximum of five lags, and other macro variables with one lag. While the choice of five lags is arbitrary, we test with other lags, and it serves our purpose to illustrate the association between the current account patterns and the appreciation in national real estate markets. We also provide the results using the average and the cumulative change of the explanatory variables. These results are not directly comparable because the annual-observation panel data allows for the lag structure and short- to medium-run dynamics, whereas the average and the cumulative change samples do not.

Second, trend and non-stationarity not only characterize the Real Estate  $\Delta$ /(GDP deflator) appreciation and the Current Account Deficits/GDP reported in Table 1, but also apply to other macro time series in the sample. The trends in these series may contain both stochastic and deterministic components: differencing can remove the former, and detrending can remove the latter. We have seen that the results of various individual and panel unit root tests on these series are inconclusive. The maximum length of our time series is sixteen years (1990-2005): though the standard Box-Jenkins methodology recommends differencing as the form of the trend may not be essential for short-term forecasts, but the form of the trend becomes more important as the forecast horizon expands. Yet, some series may have a deterministic trend, a stochastic trend and a stationary component (trend plus noise series). For our panel sample, we adopt a second-best parsimonious approach to the macro series of each country by first-differencing the time-series already in a percentage change format (Real Estate  $\Delta$ /(GDP deflator) appreciation; Urban Population Growth; Capita GDP Growth; Real Interest), or converting to percentage form for those variables not in a percentage change format (Financial Depth; Institution; Current Account Deficits/GDP), and de-trending. This correction is not perfect, but after using these transformations, all of the individual time series of each country pass the Augmented Dickey-Fuller unit-root with trend tests at 5 % level of significance. While we use these transformed series in our baseline estimation, we also provide additional results using a sign-preserving

detrended current account series (to take into account the persistent trend feature of the current accounts) and results using non-transformed series (of which the estimates are not consistent and the statistical inference do not hold). After constructing the lags and transforming the variables, we have 354 observations and 41 countries ready for the panel estimation. Table 4 provides the sample correlations of the variables.

For the panel data estimation, we apply the following dynamic equation on the appreciation of real estate prices ( $y_{i,t}$ ; %change per year of real estate prices/(GDP deflator))

$$(2) \quad y_{i,t} = \alpha y_{i,t-1} + \gamma' x_{i,t-1} + \beta'(L) z_{i,t-1} + \theta' [x_{i,t-1} \times z_{i,t-i}] + \lambda_t + \eta_i + v_{i,t}$$

where  $x$  is a set of controlling variables, including Urban Population Growth, Capita GDP Growth, Inflation, Financial Depth, Institution, Real Interest rate;  $z$  is a vector of past Current Account Deficits/GDP;  $\beta(L)$  a vector of polynomials in the lag operator;  $\lambda_t$  a time effect common to all countries;  $\eta_i$  a permanent but unobservable country-specific effect;  $v_{i,t}$  an error term. To provide a comparison between the equation (2) and other panel specifications, Table 5 reports the benchmark results, with the ‘Dynamic Panel’ regressions (equation (2)) in columns 1-5 using Arellano and Bond’s (1991) GMM estimators; the ‘Fixed Effects’ regressions using the least squares dummy variable (LSDV) estimation in columns 6-7; and the pooled OLS in column 8.

Across the econometric specifications, the lagged Real Estate/(GDP deflator) appreciation is negatively associated with its current value. The lagged Urban Population Growth and the lagged Capital GDP Growth are consistently associated with the appreciation of real estate prices. A higher lagged Inflation is associated with a lower Real Estate/(GDP deflator) appreciation in the next period. The effects of the Financial Depth and the lagged Institution are statistically insignificant. The effect of the lagged real interest is significant with the expected sign: the higher the cost of borrowing, the lower the appreciation of real estate prices.

Most significantly, we find that the lagged Current Account Deficits/GDP is positively associated with the appreciation of real estate prices across the econometric specifications. The effects are stronger for the lags 1-3 according to the benchmark dynamic panel specification. Based on the fixed-effects and the OLS estimation, the positive effects of the Current Account Deficits/GDP on the Real Estate/(GDP deflator) appreciation persist five years, and are

statistically significant. Looking at the interaction between the current account and other key macro variables, we also see that the effects of the current account deficits are magnified by the level of inflation and financial depth. A deeper Financial Depth in itself has no statistical association with the real estate prices, but it fuels the effects of the current account deficits on the real estate market appreciation. The interaction between the CA Deficits and the Institution is negative and significant: the effects of the current account deficits on the real estate appreciation tend to be smaller in a country with a better quality of institution. Overall, the macro models yield a consistent message and are able to explain around 70 % of the variation in the real estate/(GDP deflator) appreciation across countries.

Table 6 provides some additional results. We first split the sample into the appreciation and the depreciation of real estate prices, then use the panel Tobit estimation. We find that the positive effects of the CA Deficits on the real estate prices are more significant in the appreciating or boom period (top left panel, censoring “appreciation of real estate price” <0). We also run a similar dynamic panel estimation using the average and the cumulative change of the explanatory variables. Because these additional regressions ignore the short- to medium-run dynamics and the lag structure of the current account deficits, they are informative, but not comparable to the annual-observation benchmark panel estimation. Nevertheless, using the average and the cumulative change of the explanatory variables, we can see that the negative effects of Inflation and Real Interest hold, as well as the positive effects of the interaction of Inflation and Financial Depth with the Current Account Deficits/GDP.

Two extra features of the current account patterns are reported in Table 7. The first is, as also noted by Faruqee and Lee (2006) and Taylor (2002), that the current account is a persistent series. A resultant possibility is that countries may run current account deficits/surpluses for an extended period, followed by a brief reversal. To account for this trend pattern, we de-trend the current accounts using the sign-preserving trend:

$$(3) \quad \text{sgn}(CA_{i,t-1}) \times \text{trend}; \text{sgn}(CA_{i,t-1}) = \frac{CA_{i,t-1}}{|CA_{i,t-1}|}.$$

Using the sign-preserving detrended current account series, we can see in Table 7 that our main findings continue to hold: the current account deficits are positively associated with the

real estate appreciation, the effects which increase with the rate of inflation, the level of financial depth, and the lower quality of institution. The size of the coefficient estimates on the five lags of the current account deficits are also similar, though somewhat smaller, than those obtained using the normal de-trended current account series.

Another possible feature is that the sustainability of the current account imbalances may be related to the country's size.<sup>14</sup> Figure 5 plots the correlations between the Real Estate/(GDP deflator) appreciation and the Current Account Deficits/GDP, against the countries' GDP Size. The observed association is weak, but excluding large countries uncovers a small and negative correlation between the country size and real estate-current accounts correlations. To account for the size feature more precisely, we include in our base regression the interaction between the Current Account Deficits/GDP with the country's GDP Size. Because our estimation period is 1990-2005, we calculate the GDP Size as the average over the 1980s. Table 7 reports the results from including the GDP Size interactions of five lags, for both the normal de-trended and the sign-preserving de-trended current account series. We can see that the main results continue to hold. The country-size effects are negative at all lags, but only statistically significant at lag one in the regression using the sign-preserving de-trended current account series. Thus, there is tentative evidence that the real estate markets respond more to current account deficits in smaller countries.

#### Factors accounting for real estate/(GDP deflator) variation

We summarize the key factors accounting for real estate/(GDP deflator) variation in our sample by reporting the economic significance of the explanatory variables in our benchmark regression (Table 5, first column). This is done in Figure 7, reporting the association between a one standard deviation change in each of the conditioning variables and the real estate/(GDP deflator). The estimated response of the appreciation of real estate prices ( $y_{i,t}$ ; % change per year of real estate prices/(GDP deflator) in Table 5), are calculated for each macroeconomic variable ( $x_{i,t}$ ;  $z_{i,t}$ ;  $x_{i,t-1} \times z_{i,t-1}$ ) by multiplying a one standard deviation increase ( $\sigma$ ) of the variable with its estimated coefficient ( $\gamma$ ,  $\beta$ ,  $\theta$ ). Figure 6 provides the sample distribution of the lagged current account deficits to GDP used in the panel estimation of Table 5. Note that the distribution for the Non-OECD countries in our sample is more skewed to the left. For the whole sample, the

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<sup>14</sup> Aizenman and Sun (2008) find that, with the exception of the US, the length of current account deficit spells is negatively related to the relative size of the countries' GDP.

mean of the lagged CA Deficits is 3 % and the standard deviation is 4.0 %. The importance of the various factors accounting for variations of the real estate/(GDP deflator) is gauged in Figure 7. A one standard deviation increase of the current account deficit (about 4%) is associated with a cumulative real estate/(GDP deflator) appreciation of about 10%.<sup>15</sup> The impact of the current account deficit on the real estate/(GDP deflator) appreciation is further magnified by financial depth (about 1.8%)<sup>16</sup>, and mitigated by better quality of institutions (about 2.8%). Intriguingly, the most important factor accounting for the appreciation of the national real estate is a one standard deviation increase of the *current account deficit* (associated with 10 % real estate/(GDP deflator) appreciation), exceeding the adjustment to a one standard deviation drop of the *real interest rate* (about 7 % appreciation), and a one standard deviation increase of the *GDP/Capita growth* (about 2% appreciation).

## 5. Concluding remarks and interpretations

Our results are consistent with the notion that for all countries, current account deficits are associated with sizable real appreciation of the real estate. This effect holds controlling for the real interest rate, GDP growth, inflation, and other conditioning variables. We also find evidence consistent with growing globalization of national real estate markets. These findings are consistent with various scenarios explaining patterns of capital flows across countries, including differential productivity trends and varying saving patterns. In the absence of pre-existing distortions, financial inflows are unambiguously welfare improving. Yet, in a second-best environment, public finance considerations imply that inflows of capital may magnify distorted activities, increasing thereby the ultimate costs of these distortions. Arguably, the experience of emerging markets in the aftermath of financial liberalizations during the 1990s illustrated these concerns. Needless to say, this second-best assertion is not an argument against financial integration, but a cautionary tale -- greater financial globalization implies the need to be more assertive in dealing with moral hazard and other pre-existing domestic distortions.

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<sup>15</sup> The 10% change is the product of a one standard deviation current account shock (4%) times the sum of the coefficients of its lags =  $4.0 \times (1.02 + 0.57 + 0.64 + 0.18 + 0.14) \approx 10\%$ .

<sup>16</sup> The 1.8% change is the product of a one standard deviation of (Financial Depth\*CA Deficits), (= .14) times its estimated coefficient =  $0.14 \times 12.76 = .14 * 12.76 \approx 1.8\%$ .

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**Table A.1 – Sources of Real Estate Prices in 43 Countries.**

The real estate series are taken from the Datastream and the Global Property Guide.

No	Country	Real Estate Price Indices	Source Name
1	Australia	House price index, 8 capital cities	AusStat
2	Austria	Residential property price index, Vienna	Oesterreichische (Austria) National Bank
3	Belgium	Residential property price index, Flats	Institut National de Statistique
4	Bulgaria	Dwelling: Avg Price per Sq Meter	National Statistical Institute of Bulgaria
5	Canada	New housing price index	Canadian Statistics
6	China	Property Price Index: Bldg: CM: Residential	National Bureau of Statistics of China
7	Colombia	New housing price index	Departamento Administrativo Nacional de Estadística
8	Croatia	New Dwellings Sold Price Index: 1995=100	Republic of Croatia - Central Bureau of Statistics
9	Czech Republic	Prices of habitable area, multi-dwelling	Cesky Statisticky Urad
10	Denmark	Property Price Index: One Family Houses: All Denmark	Statistics Denmark
11	Estonia	Ave. price per sq.m. of dwellings in satisfactory condition, 2 rooms & kitchen, Tallinn	Statistikaamet
12	Finland	Dwellings in old blocks of Flat, whole country	StatFin
13	France	Index of prices of old residences, France	Institut National de la Statistique et des Etudes Economiques
14	Germany	Prices of owner-occupied flats	BulweinsGesa
15	Greece	Index of prices of dwellings, other urban	Bank of Greece
16	Hong Kong	Property Price Index: 1999=100: Domestic Premise (DP)	差餉物業估價處
17	Hungary	House prices, Budapest - old condominium	Otthon Centrum
18	Indonesia	Residential property price index, new houses, major cities	Bank Indonesia
19	Ireland	Average Property Price: New	Department of the Environment, Heritage and Local Government
20	Israel	Average prices of owner occupied dwellings	Central Bureau of Statistics
21	Italy	Average price for residential, 13 urban areas	Nomisma Spa Real Estate
22	Japan	Urban Land Price Index: REI: Whole Nation: Average	財団法人 日本不動産研究所
23	Korea	House Price Index	Kookmin Bank
24	Lithuania	Ave. price of one- to two-room apartments, Vilnius	Invalda Real Estate
25	Luxemburg	Price of habitable surface	STATEC Luxembourg
26	Malaysia	House Price Index: Malaysia	Valuation and Property Services Department, Ministry of Finance
27	Malta	House Price Index	Central Bank of Malta
28	Netherlands	House price index, nationwide	Nederlandse Vereniging van Makelaars
29	New Zealand	House price index, detached houses	Reserve Bank of New Zealand
30	Norway	House Price Index: New Detached: sa	Statistisk Sentralbyra
31	Philippines	Ave. price of prime 3-bedroom condominiums, Makati CBD	Colliers International
32	Portugal	Bank evaluation on housing, mainland	Instituto Nacional de Estatística de Portugal
33	Russia	Property Price Index: Residential: Primary Sales (PS): YoY	Federal State Statistics Service (Rosstat)
34	Serbia	Avg Price of Dwellings: New Construction: Republic of Serbia	Републички Завод за Статистику
35	Singapore	Property Price Index: Private Residential (PR): All	Urban Redevelopment Authority
36	South Africa	ABSA House Price Index	ABSA
37	Spain	Housing Price Index: Free House	Instituto Nacional de Estadística
38	Sweden	Real estate price index for 1- & 2- dwelling buildings	Statistics Sweden
39	Switzerland	Real Estate Price Index: Single Family Homes	Swiss National Bank
40	Taiwan	Sinyi Residential Property Price Index: Taiwan Area	信義企業集團
41	Thailand	Housing Price Index: Single Detached House: including Land	ธนาคารอาคารสงคราะห์
42	United Kingdom	House Price Index: UK	Nationwide
43	United States	House Price Index: OFHEO: United States	Office of Federal Housing Enterprise Oversight

**Table A.2 – Sources of Macroeconomic Variables.**

The time series of the macro variables cover 1980-2006. WDI = World Development Indicators; IFS = International Financial Statistics. The variable transformation is to correct for unit-root and trend of the time series.

Variables	Definition	Data Source: Code	Transformation
Real Estate/GDP Deflator Appreciation	%change per year of real estate, house, and property prices, deflated by GDP deflator	National sources and government statistics	first differenced; de-trended
Urban Population Growth	Annual growth (%) of population in the urban areas	WDI: SP.URB.GROW	first differenced; de-trended
Capita GDP Growth	Annual growth (%) of GDP per capita (constant price year 2000 US\$)	WDI: NY.GDP.PCAP.KD.ZG	first differenced; de-trended
Inflation	GDP deflator (%)	WDI: NY.GDP.DEFL.KD.ZG	first differenced; de-trended
Financial Depth	Domestic credit provided by banking sector (% of GDP)	WDI: FS.AST.DOMS.GD.ZS	percentage change; de-trended
Institution	Measure of law and order, 0-12 scale (higher=better)	International Country Risk Guide	percentage change; de-trended
Real Interest	Annual real interest rates (%)	WDI: FR.INR.RINR	first differenced; de-trended
Current Account Deficits/GDP	End of year current account of deficits to GDP (%)	WDI: BN.CAB.XOKA.GD.ZS	percentage change; de-trended
Stock Market/GDP Deflator Appreciation	%change per year of the stock market indices, deflated by GDP deflator	Datastream; WDI	none (for reference only)
Nominal Interest (3-month)	US Treasury Bill Rate Constant Maturity (%)	IFS	none (for reference only)
	Japan Financing Bill Rate (%)	IFS	none (for reference only)
	London Interbank Offer Rates (pound sterling, %)	IFS	none (for reference only)
GDP Size	GDP (constant year-2000 trillion US\$)	WDI: NY.GDP.MKTP.KD	average: 1980-1989

**Table 1 – Summary Statistics and Unit Root Tests.**

The statistics are for the period 1980-2005 for the current account deficits/GDP, and 1990-2005 for the real estate/(GDP deflator) appreciation, % per year. Local GDP deflator is chosen over the consumer price index to maximize the sample size and allow for the changing expenditure patterns across countries. The Mackinnon approximate p-value is from the Augmented Dickey-Fuller test for unit-root with trend. The cumulative appreciation sums for the period 2001-2005 the Real Estate/(GDP deflator) Appreciation for each country.

Country	Current Account Deficits/GDP (percent)				Cumulative Deficits (percent)	Real Estate/GDP Deflator Appreciation (percent)				Cumulative Appreciation (percent)
	obs.	avg.	s.d.	p-value	from 2001 to 2005	obs.	avg.	s.d.	p-value	from 2001 to 2005
Australia	26	4.3	1.0	.031	25.8	16	4.7	7.6	.153	37.3
Austria	26	.8	1.8	.573	-5.1	16	2.6	8.0	.295	15.0
Belgium	25	-2.5	2.9	.977	-14.8	15	4.2	4.3	.866	42.9
Bulgaria	26	3.0	4.8	.266	41.8	12	-20.1	101.3	.010	90.1
Canada	26	1.0	2.3	.433	-9.2	16	.1	4.3	.000	19.6
China	23	-1.4	2.4	.098	-16.0	7	-1.8	3.1	.678	-13.1
Colombia	26	2.1	3.2	.356	7.5	9	-4.5	7.8	.001	5.5
Croatia	13	5.2	5.0	.164	34.7	11	-1.0	6.6	.022	-10.6
Czech Republic	13	4.0	2.3	.182	24.9	10	.5	7.8	.013	9.5
Denmark	25	-.2	2.7	.516	-13.9	13	6.4	5.0	.883	39.3
Estonia	14	7.4	4.7	.506	60.2	9	15.2	22.5	.009	108.9
Finland	25	-1.5	5.0	.866	-30.0	16	-.3	11.2	.207	32.9
France	26	-.2	1.3	.949	1.7	16	2.7	8.9	.002	50.3
Germany	26	-1.1	2.3	.929	-17.9	16	-1.0	1.5	.303	-4.6
Greece	24	4.8	2.8	.913	41.0	12	3.6	4.9	.017	24.6
Hong Kong	8	-7.5	3.4	.004	-49.7	12	-.1	16.5	.178	38.0
Hungary	24	4.5	3.6	.080	35.7	5	7.5	8.1	.100	35.9
Indonesia	24	.9	3.4	.092	-8.4	12	-9.5	18.4	.100	-10.9
Ireland	25	1.6	4.2	.967	4.1	16	7.0	5.8	.311	38.1
Israel	25	2.1	3.6	.348	-6.3	8	.0	8.3	.009	-2.4
Italy	25	.3	1.6	.840	4.5	16	1.3	5.6	.377	26.8
Japan	26	-2.5	1.2	.132	-17.4	16	-3.5	4.5	.000	-26.3
Korea	26	-.6	4.3	.191	-9.7	16	-1.8	8.9	.001	25.9
Lithuania	13	7.1	3.3	.641	37.7	7	14.4	16.3	.275	96.4
Luxembourg	11	-10.2	1.7	.001	-53.1	13	1.7	3.0	.347	7.8
Malaysia	25	-.8	8.9	.364	-48.3	5	-.1	2.6	.986	-4.3
Malta	25	2.6	5.1	.106	15.9	15	6.8	5.8	.177	30.0
Netherlands	26	-3.9	2.2	.407	-33.3	16	5.4	5.3	.111	10.6
New Zealand	26	5.7	2.7	.403	33.0	14	5.0	6.0	.663	48.0
Norway	26	-5.5	6.4	.406	-71.9	16	1.0	5.0	.030	8.7
Philippines	25	2.7	3.2	.145	-4.3	10	-6.9	9.4	.000	3.9
Portugal	26	4.6	4.7	.657	41.4	4	.0	2.2	.000	.1
Russia	12	-7.3	5.6	.718	-47.2	8	-22.8	30.2	.001	-68.4
Serbia	6	6.1	2.1	.081	8.8	6	-14.6	31.0	.439	-11.5
Singapore	25	-9.2	11.0	.153	-90.7	16	4.1	17.8	.027	8.5
South Africa	26	.3	2.9	.279	13.7	6	11.8	8.7	.950	74.2
Spain	26	2.3	2.4	.948	28.1	10	6.0	5.1	.982	49.0
Sweden	25	-.9	3.3	.754	-27.2	16	2.8	7.5	.148	36.3
Switzerland	26	-7.3	4.7	.185	-72.1	16	-2.1	4.0	.162	7.3
Taiwan	21	-5.7	3.7	.777	-34.0	14	-2.0	5.3	.023	10.9
Thailand	26	1.8	5.8	.449	-5.9	14	-.7	4.9	.012	6.1
United Kingdom	26	1.3	1.9	.759	10.4	16	3.0	9.6	.355	49.6
United States	26	2.6	1.9	.954	27.9	16	2.8	3.5	.018	31.3

**Table 2 – Unit Root Tests.**

The null hypothesis is non-stationarity for the augmented Dickey-Fuller test and the Phillips-Perron test. For the Kwiatkowski-Phillips-Schmidt-Shin test, the null is stationarity: a rejection of stationarity under the Kwiatkowski-Phillips-Schmidt-Shin test is reported as a non rejection of the unit root. The null hypothesis is non-stationarity for the Levin-Lin-Chu (2002) test and the Im-Pesaran-Shin (2003) test. For the Nyblom-Harvey (2000) test, the test statistic can be considered as the generalization of the Kwiatkowski-Phillips-Schmidt-Shin test, and a failure to reject the null hypothesis of zero common stochastic trends is an indication that the series do not form a cointegrated combination. The test statistics correspond to specifications with time trend. Because the sample must be a balanced panel in order to perform the existing panel test procedures, the sample is restricted to 12 years (1993-2004) and 25 countries (19 OECD and 6 Non-OECD). \*\*\*, \*\*, \* signifies 1, 5, and 10 level of significance.

Testing Procedures	Real Estate/GDP Deflator Appreciation			Current Account Deficits/GDP		
	Whole Sample	OECD	Non-OECD	Whole Sample	OECD	Non-OECD
	percent of rejecting unit roots:					
<u>Individual Country Series</u>						
Augmented Dickey-Fuller	44.2	40.0	50.0	7.0	8.0	5.6
Phillips-Perron	44.2	36.0	55.6	9.3	8.0	11.1
Kwiatkowski-Phillips-Schmidt-Shin	97.7	100.0	94.4	100.0	100.0	100.0
	test statistics:					
<u>Panel of Series</u>						
Levin-Lin-Chu (2002)	-18.296 ***	-12.073 ***	-11.299 ***	-12.002 ***	-10.196 ***	-4.496 *
Im-Pesaran-Shin (2003)	-2.783 ***	-2.586 *	-3.014 **	-2.138	-2.189	-1.769
Nyblom-Harvey (2000)	1.556	1.556 ***	.580 *	1.556	1.556 ***	.561 *

**Table 3 – Univariate t-tests.**

The sample period is 1990-2005. The t-tests are on the hypothesis that the national real estate markets are correlated through the current account patterns. In the first step, we remove the effects of a country's own current account deficits on its real estate/(GDP deflator) appreciation series by running a linear regression of the real estate/(GDP deflator) appreciation on the contemporaneous current account deficits to GDP:

$$\left( \frac{\text{Real Estate}}{\text{GDP Deflator}} \text{ appreciation} \right)_{i,t} = \phi_1 + \phi_2 \left( \frac{\text{Current Account Deficits}}{\text{GDP}} \right)_{i,t} + \psi_{i,t}$$

Then we compare the correlation matrices of the raw appreciation of real estate prices and of the regression residuals. In the last step, we conduct a paired t-test of the off-diagonal elements in the raw appreciation and the residual correlation matrices to determine whether the difference in the means of correlations is significant. A standard deviation of variable is in parenthesis.

	<u>All Countries</u>	<u>Non-OECD</u>	<u>OECD</u>	<u>OECD v.s. Non-OECD</u>
Means of Correlations:				
Appreciation of Real Estate Prices	.089 (.382)	.027 (.361)	.147 (.366)	.158 (.438)
Residuals of the Appreciation after removing the effects of CA Deficits	.024 (.377)	-.030 (.366)	.058 (.337)	.116 (.446)
t-test on the equality of means of correlations:				
t-value	6.367	3.776	5.804	1.646
p-value	.000	.000	.000	.102
Variance Reduction (%)	2.700			

**Table 4 – Sample Correlations.**

Dictated by the construction of lag structure and data availability, there are 354 observations (41 countries) for the panel estimation.

		<u>Correlation with:</u>								
		<u>Obs</u>	Real Estate / GDP Deflator Appreciation	a)	b)	c)	d)	e)	f)	g)
<u>Explanatory Variable</u> (Lagged Annual Observation)										
a)	Urban Population Growth	354	.036	1.000						
b)	Capita GDP Growth	354	.130	-.118	1.000					
c)	Inflation	354	.363	.009	-.117	1.000				
d)	Financial Depth	354	-.368	.018	-.221	-.119	1.000			
e)	Institution	354	-.138	.017	.006	-.098	.065	1.000		
f)	Real Interest	354	-.717	.002	.005	-.773	.314	.137	1.000	
g)	Current Account Deficits	354	.192	.012	.030	-.207	-.103	-.066	-.277	1.000

**Table 5 – Benchmark Estimation.**

The dynamic equation for the appreciation of real estate prices ( $y_{i,t}$ ; %change per year of real estate prices/(GDP deflator)) is

$$y_{i,t} = \alpha y_{i,t-1} + \gamma' x_{i,t-1} + \beta'(L)z_{i,t-1} + \theta' [x_{i,t-1} \times z_{i,t-1}] + \lambda_t + \eta_i + v_{i,t}$$

where  $x = \{\text{Urban Population Growth, Capita GDP Growth, Inflation, Financial Depth, Institution, Real Interest}\}$ ;  $z = \text{Current Account Deficits/GDP}$ ;  $\beta(L)$  a vector of polynomials in the lag operator;  $\lambda_t$  a time effect common to all countries;  $\eta_i$  a permanent but unobservable country-specific effect;  $v_{i,t}$  an error term. The ‘Dynamic Panel’ regressions (columns 1-5) use Arellano and Bond (1991)’s GMM estimators. The ‘Fixed Effects’ regressions use ‘least squares dummy variable’ (LSDV) estimation. The variables are corrected for unit root; first-differenced, de-trended). The sample period is 1990 to 2005. Robust standard errors are in parentheses. \*\*\*, \*\*, \* signifies 1, 5, and 10 level of significance.

Coefficient Estimates of Explanatory Variables	Lag	Dynamic Panel Estimation										Fixed Effects		Pooled OLS		
		5-lag	4-lag	3-lag	2-lag	1-lag	5-lag	3-lag	5-lag	3-lag	5-lag					
Lagged Real Estate/GDP Deflator Appreciation	1	-.49 (.10) ***	-.50 (.10) ***	-.50 (.10) ***	-.41 (.10) ***	-.43 (.10) ***	-.60 (.10) ***	-.63 (.10) ***	-.56 (.13) ***							
Urban Population Growth	1	2.53 (1.53) *	2.47 (1.53)	2.44 (1.52)	2.43 (1.56)	2.43 (1.55)	1.70 (1.64)	1.65 (1.66)	1.53 (1.23)							
Capita GDP Growth	1	.75 (.31) **	.75 (.31) **	.75 (.31) **	.57 (.31) *	.56 (.31) *	.57 (.30) *	.64 (.30) **	.53 (.51)							
Inflation	1	-.33 (.04) ***	-.33 (.04) ***	-.34 (.04) ***	-.31 (.04) ***	-.31 (.04) ***	-.21 (.04) ***	-.24 (.04) ***	-.18 (.07) **							
Financial Depth	1	-4.90 (7.35)	-4.59 (7.34)	-4.52 (7.33)	-6.56 (7.49)	-7.10 (7.41)	4.87 (7.04)	4.35 (7.08)	2.75 (9.45)							
Institution	1	-15.62 (11.24)	-14.53 (11.17)	-14.25 (11.15)	-16.40 (11.41)	-17.04 (11.30)	-16.58 (9.36) *	-13.69 (9.33)	-16.59 (12.03)							
Real Interest	1	-2.65 (.22) ***	-2.64 (.22) ***	-2.63 (.22) ***	-2.62 (.23) ***	-2.55 (.22) ***	-1.75 (.23) ***	-1.80 (.23) ***	-1.77 (.75) **							
CA Deficits	1	1.02 (.28) ***	.98 (.28) ***	.94 (.27) ***	.77 (.27) ***	.81 (.27) ***	.85 (.24) ***	.76 (.24) ***	.77 (.37) **							
	2	.57 (.16) ***	.49 (.14) ***	.45 (.13) ***	.23 (.13) *		-.10 (.16)	-.18 (.16)	-.05 (.24)							
	3	.64 (.15) ***	.56 (.13) ***	.52 (.12) ***			.59 (.12) ***	.44 (.11) ***	.63 (.25) **							
	4	.18 (.14)	.09 (.12)				.33 (.13) **		.38 (.15) **							
	5	.14 (.14)					.22 (.13) *		.27 (.12) **							
Inflation*CA Deficits	1	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.04 (.00) ***	.03 (.00) ***	.04 (.01) ***							
Financial Depth*CA Deficits	1	12.76 (2.67) ***	13.18 (2.63) ***	13.21 (2.63) ***	12.25 (2.69) ***	14.03 (2.47) ***	42.46 (5.47) ***	39.03 (5.33) ***	43.02 (16.37) ***							
Institution*CA Deficits	1	-8.52 (3.10) ***	-8.85 (3.08) ***	-8.86 (3.08) ***	-7.11 (3.13) **	-8.66 (2.98) ***	-4.70 (2.80) *	-5.78 (2.78) **	-4.37 (2.95)							
p-value/R-Square		.00	.00	.00	.00	.00	.73	.72	.74							
Observations		354	354	354	354	354	354	354	354							
Countries		41	41	41	41	41	41	41	41							

**Table 6 – Additional Results.**

The top left panel applies panel Tobit regression to the sample censoring negative appreciation of the real estate prices (including only %change per year of real estate prices/(GDP deflator) greater than zero). The bottom two panels ignore the short- to medium-run dynamics and lagged effects of the current account deficits. The ‘Average Change’ sample uses n-year average %change per year of the explanatory variables. The ‘Cumulative Change’ sample uses n-year cumulative %change per year of the explanatory variables. The sample period is 1990 to 2005. Standard errors are in parentheses. \*\*\*, \*\*, \* signifies 1, 5, and 10 level of significance.

Lagged Explanatory	5-lag	4-lag	3-lag	2-lag	5-lag	4-lag	3-lag	2-lag	
<b>Appreciation/Depreciation of Real Estate/GDP Deflator</b>		<b>"Appreciation of Real Estate Prices" &gt; 0</b>				<b>"Appreciation of Real Estate Prices" &lt; 0</b>			
		<u>Panel Tobit Estimation</u>							
Lagged Real Estate/GDP Deflator Appreciation	-.32 (.09) ***	-.32 (.09) ***	-.32 (.09) ***	-.32 (.09) ***	-.32 (.09) ***	-.42 (.10) ***	-.45 (.08) ***	-.45 (.08) ***	-.46 (.08) ***
Urban Population Growth	.77 (1.23)	.77 (1.24)	.76 (1.24)	.77 (1.24)	.77 (1.24)	1.90 (1.82)	1.53 (1.49)	1.53 (1.49)	1.55 (1.50)
Capita GDP Growth	-.70 (.24) ***	-.70 (.24) ***	-.70 (.24) ***	-.70 (.24) ***	-.70 (.24) ***	-.24 (.47)	-.39 (.29)	-.38 (.29)	-.33 (.27)
Inflation	-.08 (.04) **	-.08 (.04) **	-.08 (.04) **	-.08 (.04) **	-.08 (.04) **	-1.94 (.76) **	-2.39 (.16) ***	-2.38 (.15) ***	-2.34 (.14) ***
Financial Depth	-.73 (5.37)	-.86 (5.38)	-.87 (5.39)	-.89 (5.38)	-.89 (5.38)	-3.50 (6.77)	-3.65 (5.89)	-3.62 (5.88)	-3.40 (5.89)
Institution	-5.16 (6.74)	-4.79 (6.76)	-4.74 (6.75)	-4.64 (6.75)	-4.64 (6.75)	-1.45 (10.29)	-1.79 (8.30)	-1.83 (8.29)	-1.54 (8.37)
Real Interest	-.27 (.21)	-.27 (.21)	-.27 (.21)	-.26 (.21)	-.26 (.21)	-3.06 (.46) ***	-3.32 (.23) ***	-3.31 (.22) ***	-3.30 (.22) ***
CA Deficits (-1)	.20 (.18)	.18 (.18)	.18 (.17)	.18 (.17)	.18 (.17)	.24 (.28)	.15 (.24)	.15 (.23)	.18 (.23)
CA Deficits (-2)	.40 (.11) ***	.39 (.11) ***	.39 (.11) ***	.38 (.11) ***	.38 (.11) ***	.05 (.35)	.14 (.25)	.14 (.25)	.16 (.25)
CA Deficits (-3)	.05 (.14)	.04 (.14)	.04 (.14)			.24 (.49)	-.06 (.11)	-.06 (.10)	
CA Deficits (-4)	.04 (.13)	.02 (.13)				.22 (.33)	-.01 (.10)		
CA Deficits (-5)	.09 (.10)					.22 (.26)			
Inflation*CA Deficits	.02 (.00) ***	.02 (.00) ***	.02 (.00) ***	.02 (.00) ***	.02 (.00) ***	.06 (.02) ***	.07 (.01) ***	.07 (.01) ***	.07 (.01) ***
Financial Depth*CA Deficits	5.66 (4.38)	5.27 (4.39)	5.14 (4.34)	5.16 (4.33)	5.16 (4.33)	11.59 (12.52)	4.14 (5.78)	4.30 (5.50)	4.70 (5.47)
Institution*CA Deficits	-.45 (2.09)	-.60 (2.10)	-.62 (2.10)	-.62 (2.10)	-.62 (2.10)	-4.36 (3.88)	-2.70 (2.25)	-2.69 (2.25)	-3.00 (2.22)
p-value	.00	.00	.00	.00	.00	.00	.00	.00	.00
Observations	354	354	354	354	354	354	354	354	354
Countries	41	41	41	41	41	41	41	41	41
<b>Average/Cumulative Changes of the Explanatory Variable</b>		<b>Average Changes</b>				<b>Cumulative Changes</b>			
		<u>Dynamic Panel Estimation</u>							
Lagged Real Estate/GDP Deflator Appreciation	-.26 (.04) ***	-.20 (.05) ***	-.08 (.05)	-.45 (.06) ***	-.27 (.04) ***	-.20 (.05) ***	-.08 (.05)	-.45 (.06) ***	-.45 (.06) ***
Urban Population Growth	-.42 (5.55)	-.19 (6.00)	-3.07 (4.41)	.58 (2.21)	-.08 (1.10)	-.03 (1.50)	-1.01 (1.47)	.29 (1.10)	
Capita GDP Growth	-2.64 (1.76)	-1.09 (1.37)	-.78 (.97)	.37 (.54)	-.53 (.35)	-.27 (.34)	-.26 (.32)	.18 (.27)	
Inflation	-.46 (.13) ***	-.78 (.11) ***	-.78 (.09) ***	-.62 (.06) ***	-.10 (.03) ***	-.19 (.03) ***	-.26 (.03) ***	-.31 (.03) ***	
Financial Depth	-57.25 (34.00) *	-14.92 (28.60)	8.96 (21.06)	4.26 (13.09)	-11.01 (6.74)	-3.60 (7.14)	3.01 (7.00)	2.13 (6.54)	
Institution	-13.59 (37.63)	.12 (33.82)	-6.96 (25.16)	-9.14 (16.40)	-2.75 (7.46)	-.04 (8.46)	-2.37 (8.39)	-4.61 (8.20)	
Real Interest	-9.53 (.74) ***	-7.91 (.71) ***	-5.85 (.52) ***	-4.80 (.31) ***	-1.94 (.15) ***	-1.98 (.18) ***	-1.95 (.17) ***	-2.40 (.15) ***	
CA Deficits	-.18 (.92)	-1.93 (.70) ***	-1.06 (.77)	.13 (.42)	-.03 (.18)	-.48 (.17) ***	-.36 (.26)	.06 (.21)	
Inflation*CA Deficits	.21 (.03) ***	.35 (.04) ***	.25 (.02) ***	.07 (.01) ***	.01 (.00) ***	.02 (.00) ***	.03 (.00) ***	.02 (.00) ***	
Financial Depth*CA Deficits	118.71 (17.51) ***	52.37 (8.46) ***	6.65 (3.33) **	-.89 (1.15)	4.76 (6.99) ***	3.27 (.53) ***	.74 (.37) **	-.22 (.29)	
Institution*CA Deficits	84.41 (20.00) ***	24.06 (12.99) *	26.96 (9.46) ***	17.17 (3.76) ***	3.45 (.79) ***	1.51 (.81) *	3.00 (1.05) ***	4.29 (.94) ***	
p-value	.00	.00	.00	.00	.00	.00	.00	.00	
Observations	354	354	354	354	354	354	354	354	
Countries	41	41	41	41	41	41	41	41	

**Table 7 – Sign-Preserving Trend Current Accounts and GDP Size Interactions.**

Countries may run current account deficits/surpluses for an extended period, followed by a brief reversal. To account for this trend pattern, the

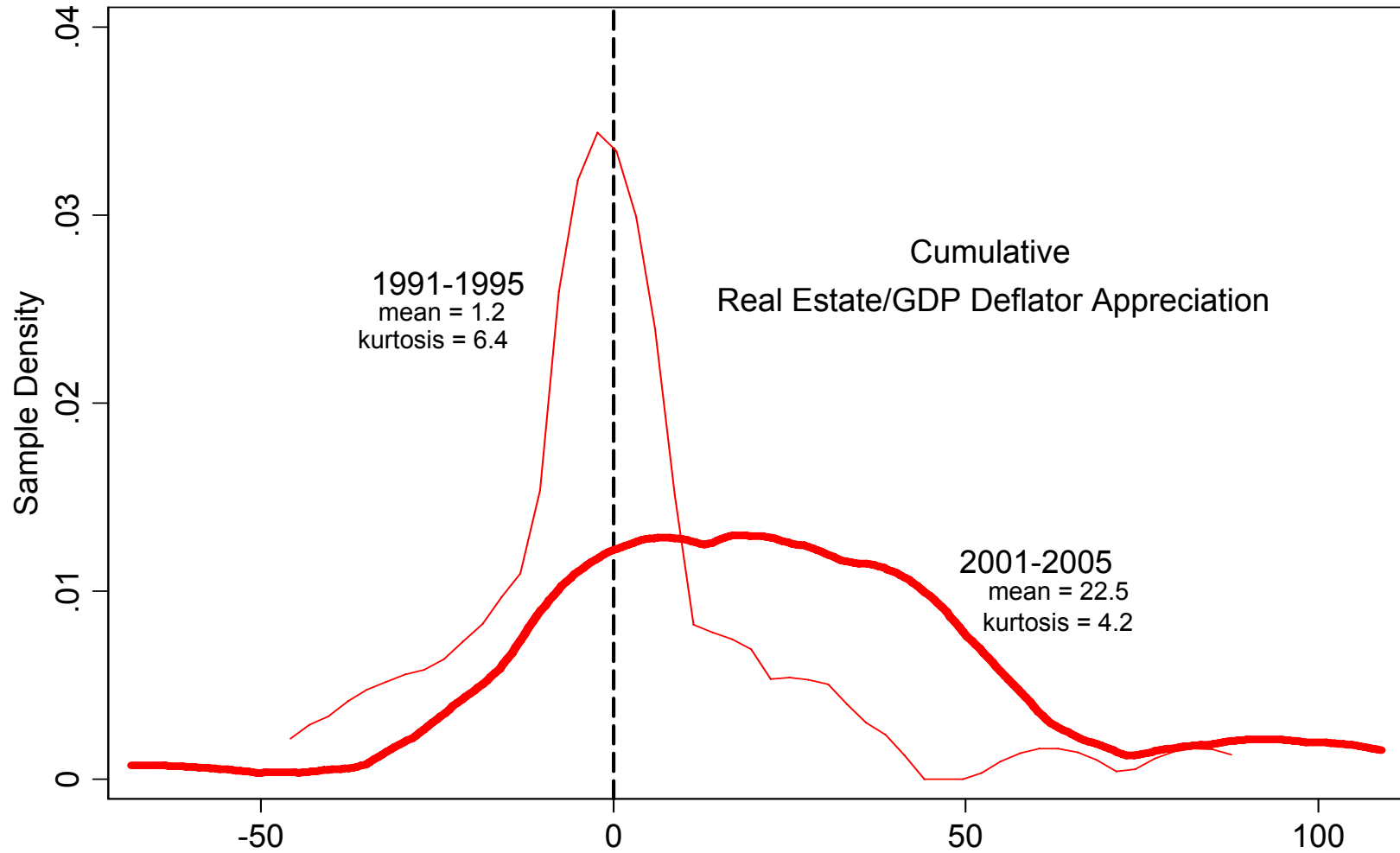
current accounts can be de-trended using the sign-preserving trend:  $\text{sgn}(CA_{i,t-1}) \times \text{trend}; \text{sgn}(CA_{i,t-1}) = \frac{CA_{i,t-1}}{|CA_{i,t-1}|}$ . The GDP Size is the average

over 1980-1989. The sample period for the estimation is 1990 to 2005. Standard errors are in parentheses. \*\*\*, \*\*, \* signifies 1, 5, and 10 level of significance.

Coefficient Estimates of Explanatory Variables	Lag	Sign-Preserving Trend Current Accounts										GDP Size Interactions		No Variable Transformation	
		5-lag	4-lag	3-lag	2-lag	1-lag	Normal Trend	Sign-Preserving Trend	5-lag						
Lagged Real Estate/GDP Deflator Appreciation	1	-.51 (.10) ***	-.51 (.10) ***	-.51 (.10) ***	-.41 (.10) ***	-.43 (.10) ***	-.48 (.10) ***	-.49 (.10) ***	.03 (.02)						
Urban Population Growth	1	2.46 (1.57)	2.40 (1.57)	2.38 (1.57)	2.46 (1.60)	2.46 (1.59)	2.55 (1.54) *	2.32 (1.52)	.03 (1.06)						
Capita GDP Growth	1	.81 (.31) **	.81 (.31) **	.81 (.31) **	.65 (.32) **	.63 (.32) **	.70 (.31) **	.63 (.31) **	1.10 (.19) ***						
Inflation	1	-.33 (.04) ***	-.33 (.04) ***	-.33 (.04) ***	-.30 (.04) ***	-.30 (.04) ***	-.33 (.04) ***	-.33 (.04) ***	-.04 (.06)						
Financial Depth	1	-7.15 (7.52)	-6.63 (7.53)	-6.51 (7.51)	-8.59 (7.68)	-9.20 (7.61)	-4.34 (7.38)	-4.04 (7.32)	.06 (.04)						
Institution	1	-16.29 (11.51)	-15.14 (11.46)	-14.96 (11.44)	-16.21 (11.73)	-16.93 (11.62)	-15.38 (11.29)	-13.08 (11.20)	-3.96 (1.37) ***						
Real Interest	1	-2.76 (.23) ***	-2.75 (.22) ***	-2.75 (.22) ***	-2.73 (.23) ***	-2.66 (.23) ***	-2.64 (.22) ***	-2.63 (.22) ***	.70 (.12) ***						
CA Deficits	1	.93 (.29) ***	.89 (.29) ***	.86 (.29) ***	.74 (.29) **	.85 (.29) ***	1.43 (.42) ***	1.83 (.48) ***	-1.03 (.94)						
	2	.53 (.15) ***	.44 (.13) ***	.41 (.13) ***	.27 (.13) **		.65 (.21) ***	.48 (.20) **	-.54 (.19) ***						
	3	.64 (.14) ***	.55 (.13) ***	.52 (.13) ***			.79 (.18) ***	.78 (.19) ***	.21 (.20)						
	4	.19 (.14)	.09 (.13)				.27 (.17)	.28 (.18)	-.26 (.20)						
	5	.19 (.14)					.20 (.17)	.24 (.19)	-.03 (.19)						
Inflation*CA Deficits	1	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.07 (.02) ***						
Financial Depth*CA Deficits	1	10.22 (2.79) ***	10.87 (2.74) ***	10.87 (2.73) ***	9.24 (2.77) ***	11.47 (2.55) ***	13.77 (2.83) ***	15.33 (2.80) ***	.00 (.00)						
Institution*CA Deficits	1	-5.24 (3.33)	-6.01 (3.27) *	-5.98 (3.27) *	-3.19 (3.27)	-5.14 (3.12) *	-8.50 (3.13) ***	-7.73 (3.12) **	.09 (.18)						
GDP Size*CA Deficits	1						-.36 (.24)	-.68 (.34) **							
	2						-.17 (.19)	-.13 (.26)							
	3						-.29 (.19)	-.38 (.26)							
	4						-.16 (.21)	-.20 (.32)							
	5						-.10 (.22)	-.15 (.33)							
p-value		.00	.00	.00	.00	.00	.00	.00	.00						
Observations		354	354	354	354	354	354	354	354						
Countries		41	41	41	41	41	41	41	41						

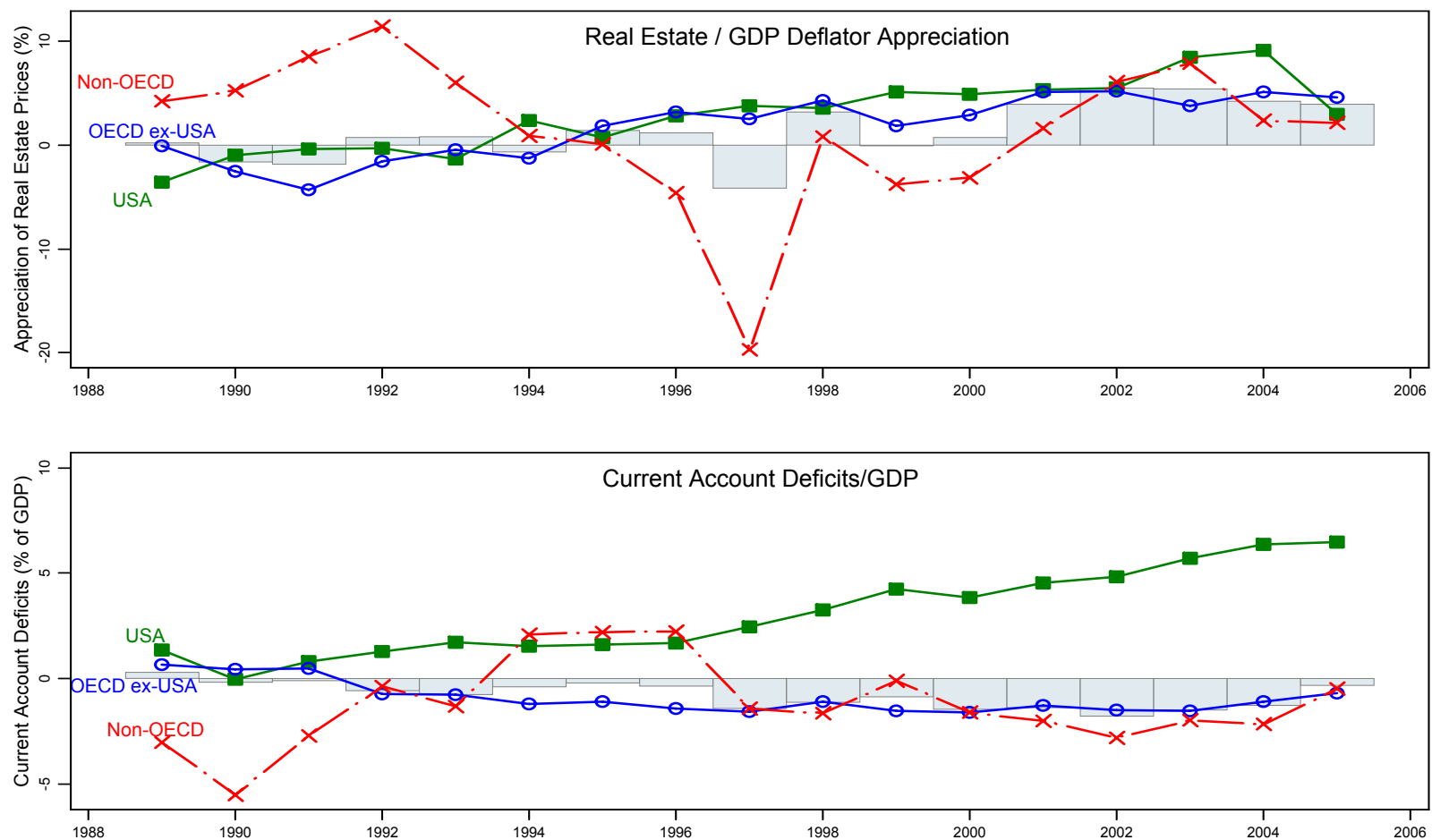
**Figure 1 – Sample Density of Real Estate/(GDP deflator) Appreciation.**

The figure provides the cross-sectional sample distribution. The density estimates are based on Epanechnikov kernel function



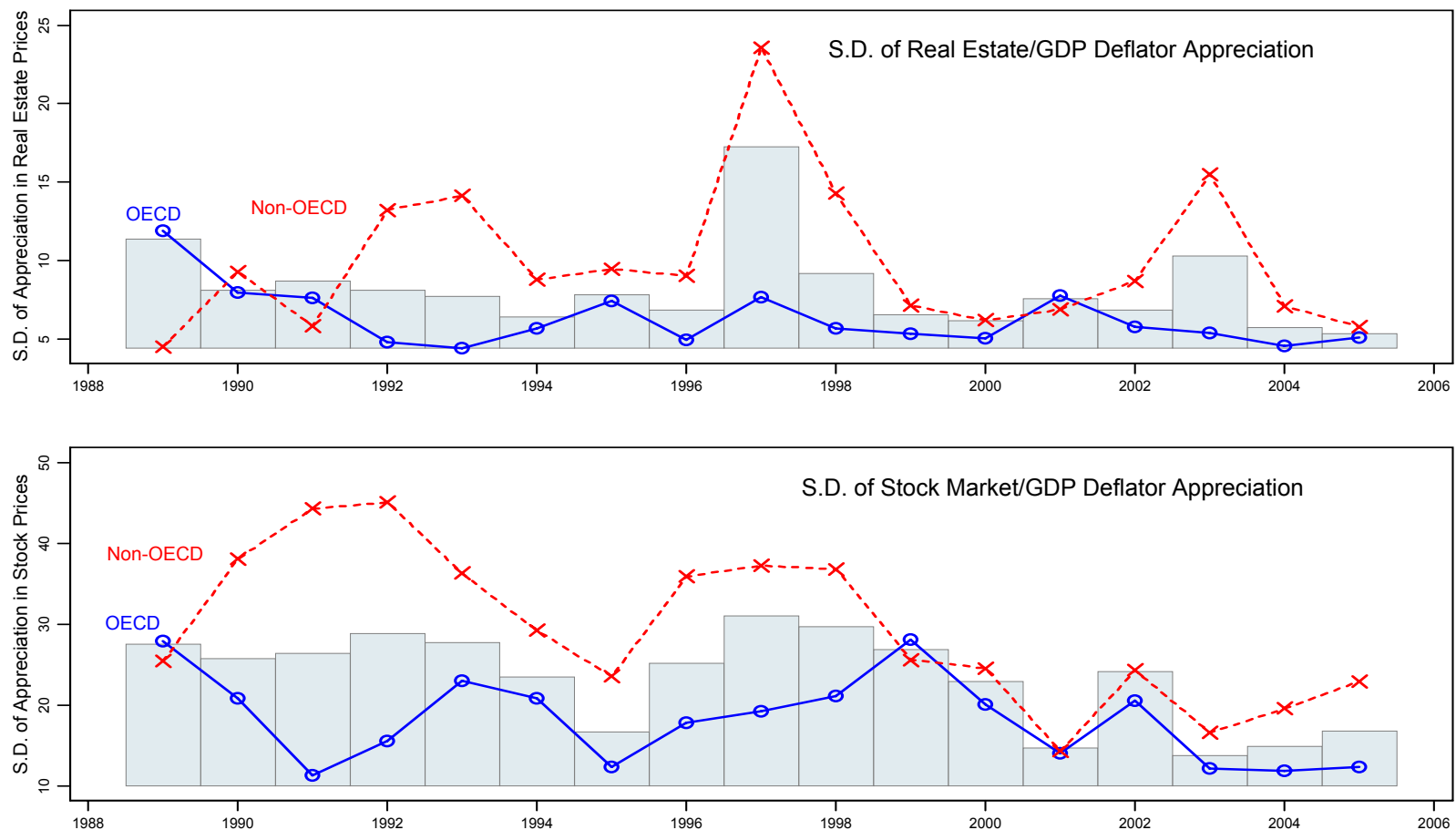
**Figure 2 – Real Estate / (GDP deflator) Appreciation and Current Account Deficits/GDP.**

In the top panel, each bar depicts a cross-country average of the “appreciation of real estate prices” = %change per year of real estate prices/(GDP deflator). In the bottom panel, each bar depicts a cross-country average of current account deficits/GDP. The sample includes USA (solid lines; □), 24 OECD ex-USA (solid lines; o) and 18 Non-OECD (dash lines; x) countries.



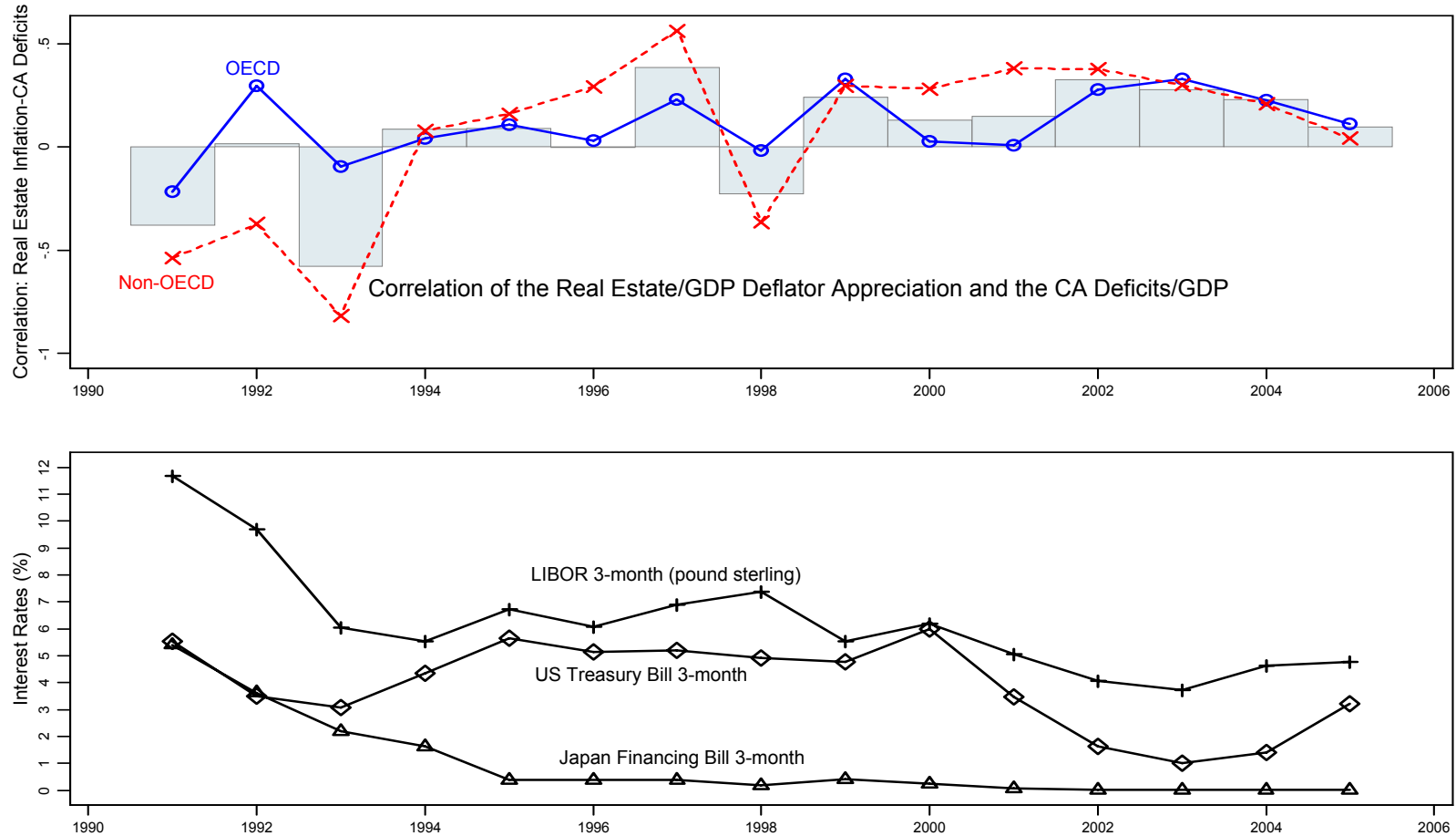
**Figure 3 – Dispersion of the Real Appreciation: Real Estate Markets and Stock Markets.**

In the top panel, each bar depicts standard deviation of the “appreciation of real estate prices” = %change per year of real estate prices/(GDP deflator). In the bottom panel, each bar depicts standard deviation of the %change per year of stock prices/(GDP deflator). The sample includes 25 OECD (solid lines; o) and the 18 Non-OECD (dash lines; x) countries.



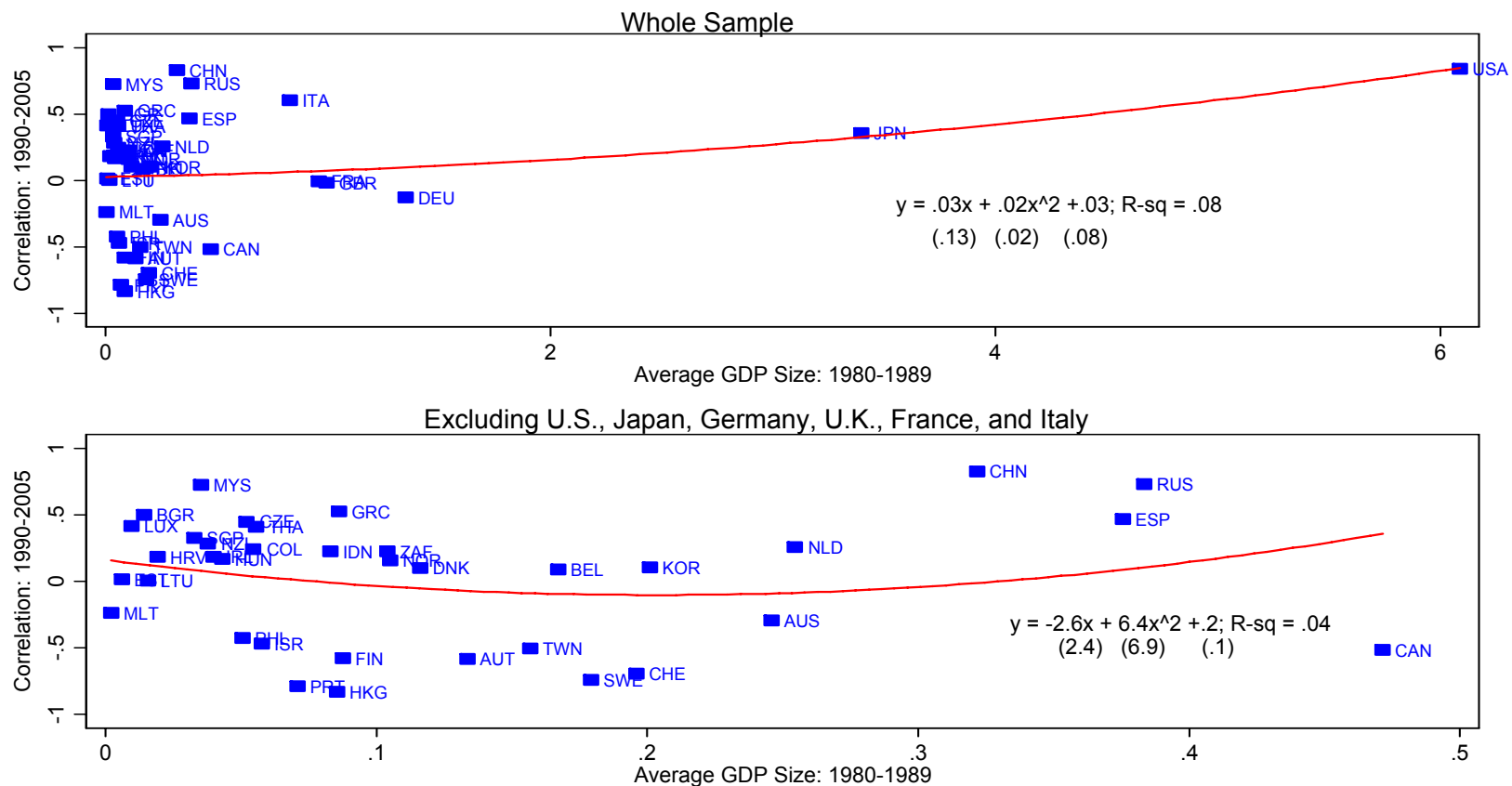
**Figure 4 – Correlations Between Current Account Deficits/GDP and Real Estate /(GDP deflator) Appreciation.**

In the top panel, each bar depicts cross-country correlations between current account deficits (% of GDP) and appreciation of real estate prices (%change per year of real estate prices/(GDP deflator)). The sample includes 25 OECD (solid lines; o) and the 18 Non-OECD (dash lines; x) countries. The bottom panel plots the 3-month market interest rates.

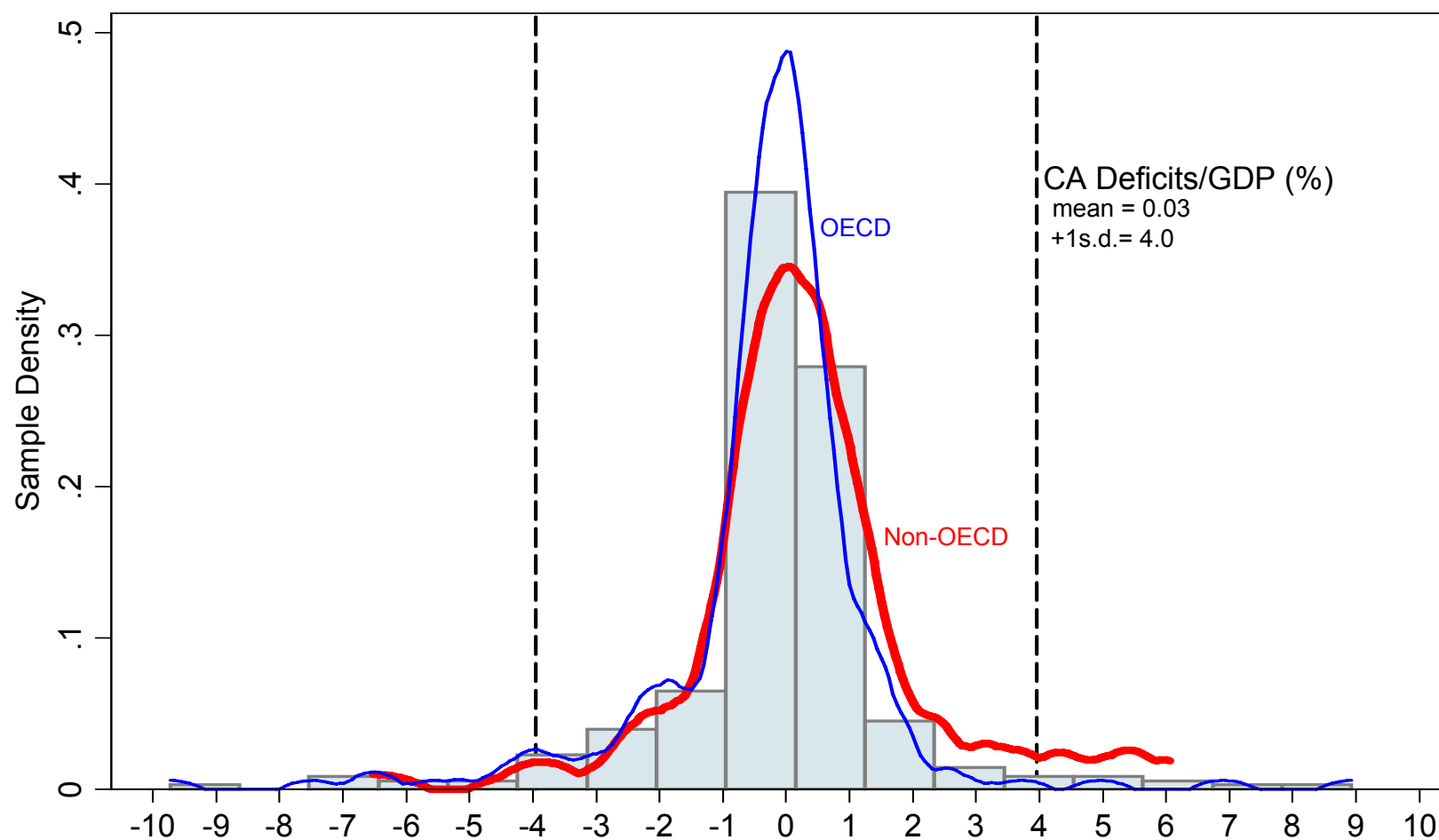


**Figure 5 – Country Size and the Correlations between Real Estate/(GDP deflator) Appreciation and Current Account Deficits/GDP.**

This figure plots for each country on the horizontal axis the GDP Size (constant year-2000 trillion US\$), averaged over the period 1980-1989, against the correlations between the real estate appreciation and the current account deficits during 1990-2005. The bottom panel excludes large countries: U.S., Japan, Germany, U.K., France, and Italy. Robust standard errors are in parentheses.



**Figure 6 – Sample Distribution of the Current Account Deficits/GDP.** The figure depicts the sample distribution of current account deficits to GDP of the 354 observations (41 countries) included in the panel data estimation. The sample period is 1990-2005.



**Figure 7 – Real Estate /(GDP deflator) Appreciation and Macroeconomic Variables.**

Based on the ‘Dynamic Panel’ estimation with lagged 5 years (Table 5, first column). Each bar represents the estimated response of the appreciation of real estate prices ( $y_{i,t}$ ; %change per year of real estate prices/(GDP deflator)), calculated for each macroeconomic variable ( $x_{i,t}$ ;  $z_{i,t}$ ) by multiplying a one standard deviation increase ( $\sigma$ ) of the variable with its estimated coefficient ( $\gamma$ ,  $\beta$ ,  $\theta$ ). For instance, a 10.03% CA Deficits shock is the outcome of (a one s.d. of CA Deficits = 4.0)x(coefficients of its lags) = 4.0x(1.02+0.57+0.64+0.18+0.14)  $\approx$  10 percent. For the economic significance of the interaction between Financial Depth\*CA Deficits: (one s.d. of Financial Depth\*CA Deficits = .14) x 12.76(its coefficient estimate) = .14\*12.76  $\approx$  1.79 percent. The sample comprises 41 countries from 1990-2005. The dynamic equation for the appreciation of real estate prices ( $y_{i,t}$ ) is

$$y_{i,t} = \alpha y_{i,t-1} + \gamma' x_{i,t-1} + \beta'(L)z_{i,t-1} + \theta' [x_{i,t-1} \times z_{i,t-1}] + \lambda_t + \eta_i + v_{i,t}$$

where  $x = \{\text{Urban Population Growth, Capita GDP Growth, Inflation, Financial Depth, Institution, Real Interest}\}$ ;  $z = \{\text{Current Account Deficits/GDP}\}$ ;  $\beta(L)$  a vector of polynomials in the lag operator;  $\lambda_t$  a time effect common to all countries;  $\eta_i$  a permanent but unobservable country-specific effect;  $v_{i,t}$  an error term. All variables are stationary (no unit root; first-differenced and de-trended).

