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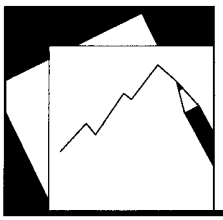

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Shifting Motives: Explaining the Buildup in Official Reserves in Emerging Markets since the 1980s

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Abstract

Why have emerging market economies (EMEs) been stockpiling international reserves? We find that motives have varied over time—vulnerability to current account shocks was relatively important in the 1980s but, as EMEs have become more financially integrated, factors related to the magnitude of potential capital outflows have gained in importance. Reserve accumulation as a by-product of undervalued currencies has also become more important since the Asian crisis. Correspondingly, using quantile regressions, we find that the reason for holding reserves varies according to the country's position in the global reserves distribution. High reserve holders, who tend to be more financially integrated, are motivated by insurance against capital account rather than current account shocks, and are more sensitive to the cost of holding reserves than are low-reserve holders. Currency undervaluation is a significant determinant across the reserves distribution, albeit for different reasons.

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I. INTRODUCTION

Over the past few decades, despite greater exchange rate flexibility, emerging market economies (EMEs) have been accumulating large stocks of international reserves. Reserve holdings, which averaged about 5 percent of GDP in the 1980s, have been doubling every decade since, reaching some 25 percent of GDP by 2010. This has raised concerns that EMEs are uselessly stockpiling reserves, that they are deliberately maintaining undervalued exchange rates, and even that they are imperiling the stability of the international monetary system.[1] Much of the policy debate naturally hinges on why EMEs are accumulating reserves—whether it is precautionary demand in an uncertain world, a by-product of mercantilist growth strategies, or some other motive.[2] Despite a growing number of studies, the literature to date has yet to account for the average rise in EME reserves, let alone the widening dispersion among them. In this paper, therefore, we take a fresh look at what has been driving EME reserves accumulation over the period 1980-2010.

Our take is that several factors are—and have been—at play. Beyond the reserves required to back the operation of fixed exchange rate regimes, EMEs have accumulated reserves for precautionary purposes against both current and capital account shocks, and as a by-product of undervalued currencies. Through the 1980s and early 1990s, developing countries were counseled—by the IMF and others—to hold reserves equivalent to (at least) three months of imports. It took the financial crises of the 1990s (Mexico, 1994; East Asia, 1997/98; and others) to recognize the need to insure against capital account shocks, culminating in the Greenspan-Guidotti rule of holding reserves to cover all of the country's short-term debt.[3] Moreover, in the aftermath of these crises, EMEs with sharply depreciated real exchange rates found their exports booming, which may in turn have helped inspire mercantilist growth strategies. It seems plausible, therefore, that different motives for accumulating reserves applied at different times.

A similar logic may help explain the dispersion across EME reserves holdings at a given point in time. Insurance against current account shocks, for example, requires fewer reserves than capital account shocks as these are "flow" rather than "stock" shocks. While "low" reserves-to-GDP observations are concentrated in the earlier part of our sample, they are by no means exclusive to it: around 40 percent of the below-sample median reserves-to-GDP observations occur in the post-Asian crisis period. Even today, some countries may be primarily concerned about current account shocks because their capital account remains relatively closed, or because potential shocks (e.g., stemming from banking system liabilities) happen to be small. But as EMEs become more financially open, they will typically need to hold more reserves to buffer against capital outflows. Finally, accumulation that is a by-product of mercantilism potentially adds to

[1] Assessments of reserves are relevant both to the IMF's role in bilateral surveillance, as well as its mandate in overseeing the stability of the international monetary system (IMS). On implications of large-scale reserves accumulation for the stability of the IMS, see Ghosh, Ostry, and Tsangarides (2010).

[2] On precautionary demand, see Bastourre, Carrera and Ibarlucia (2010), Obstfeld et al. (2010), Cheung and Qian (2009), and de Beaufort Wijnholds and Kapteyn (2001). On mercantilist motives, see Dooley, Folkerts-Landau and Garber (2003), Bar-Ilan and Marion (2009), Durdu et al. (2009), and Ghosh and Kim (2010).

[3] IMF (2000) and (2001) note the importance of short-term debt as a source of risk but caution against reliance on a single indicator, and the need to complement indicator-based analyses with stress-testing of the balance of payments.

the reserves held for precautionary purposes. Whether in the time series or cross-section, therefore, observed levels of reserves may well correspond to different motives for holding them.

Testing our hypothesis requires three elements: a nested model in which, in addition to the exchange rate regime, insurance against current and capital account shocks, as well as mercantilism can all play a role. Adequate proxies of these various motivations (particularly undervaluation) as well as an empirical strategy that allows the effect of the explanatory variables to vary systematically along the reserves distribution are also needed. Our sense of the existing literature is that while one study or another may incorporate each of these elements individually, none includes all of them. Thus, Obstfeld et al. (2010) make a convincing case that insurance against capital account shocks (specifically, a banking crisis) is an important factor, but only include trade openness for current account shocks, and do not consider mercantilist motives. Aizenman and Marion (2004) use the volatility of export receipts as their measure of current account shocks, and implicitly include external debt and broad money in their analysis, but do not account for possible mercantilism. Aizenman and Lee (2007) and Delatte and Fouquau (2010) try to capture possible mercantilist motives, but neither includes banking system liabilities, and both are constrained to rather crude PPP-based measures of undervaluation, which they do not find to be robust determinants of reserves.[4] None of the above papers allows for the effect of regressors to vary according to the level of reserves.[5]

In our analysis, we put these elements together. First, we adopt a nested model in which each of the various motives for holding reserves is explicitly included. Second, to obtain better proxies for mercantilism, we estimate undervaluation following the methodology used by the IMF in its own assessments;[6] this is based on three distinct approaches and provides a richer assessment of misalignment than simple PPP-based metrics. For robustness, we supplement this with a second proxy—the difference between actual exports and those predicted by a gravity model of trade ("excess" exports below). Third, we use quantile regressions to allow the estimated effect of regressors to vary along the reserves' holding distribution.

These innovations turn out to be critical to gaining a more complete picture of EME reserve accumulation. Our analysis suggests that precautionary and mercantilist motives together can

[4] These authors rely on the deviation of the price level from the trend implied by per capita income for their undervaluation measure, which ignores other fundamental drivers of currency misalignment. Furthermore, while there is a reasonably strong correlation between per capita income and absolute price levels when considering countries of very different income levels (e.g., advanced economies versus low-income countries), the fit is notoriously poor for countries with similar levels of income (Zalduendo, 2008). As Aizenman and Lee (2007) note, their "variables associated with the mercantilist motive often lost statistical significance."

[5] Sula (2011) is an exception, but includes mainly current account related variables in the analysis, and omits banking system liabilities as well as any proxy for mercantilism. If different motives lead to systematically different levels of reserves, then standard OLS regressions, which capture the *average* effects of the explanatory variables on the *average* reserve holder, may yield biased results. Indeed, even if the reason for accumulating reserves does not differ along the reserves distribution, it is plausible that the effect of some variables—such as the carry costs of reserves—will be more pertinent at higher, than at lower, levels of reserves (or vice versa).

[6] The methodology is based on Lee et al. (2008) and encompasses the so-called macroeconomic balance approach, reduced form equilibrium real exchange rate approach, and the external sustainability approach.

explain a large proportion of the sample variation, but that different motives apply at different points in time and at different points along the reserves distribution. Insurance motives for countries that hold low levels of reserves (in relation to GDP) center mainly on current account shocks, whereas those for higher reserve holders (again in relation to GDP) tend to center more on capital account shocks such as banking system liabilities. The carry cost of reserves, which is proportional to the amount of reserves held, is only pertinent for countries with relatively high reserves-to-GDP ratios. Currency undervaluation seems to be relevant across the reserves' distribution, though we suspect that for some low-reserves holders this may be more a reflection of currency crises and collapsed real exchange rates than of deliberate mercantilism.

This pattern is mirrored in how motives for holding reserves have evolved over time. In the first part of the sample (pre-1997), when reserve holdings and financial integration were low, insurance against current account shocks was the most important determinant. Post-Asian crisis, insurance against capital account shocks gains greater importance. It is in this period also that mercantilist motives through undervaluation of the exchange rate becomes relevant.

The rest of this paper is organized as follows. Section II lays out some stylized facts and briefly surveys the literature. Section III describes the variables used to proxy for precautionary and mercantilist motives. Section IV reports our main empirical results, including those for different sub-periods and using quantile regressions. Section V discusses the role of different motives in accounting for the observed trends in EME reserve holdings.

II. Reserves Accumulation by EMEs and Some Stylized Facts

After largely depleting their reserves during the 1980s debt crisis, emerging market economies started accumulating reserves aggressively, doubling the reserves-to-GDP ratio every decade since the 1980s (Figure 1). The dispersion in reserve holdings across EMEs has also risen, with the difference between the top and bottom quartiles widening from 3 percent of GDP in 1990 to 13 percent of GDP by 2010. As such, there is considerable time series and cross sectional variation in reserve holdings.

What accounts for this? Beyond the reserves required to operate a fixed exchange rate regime, the literature has identified two main motives: precautionary and mercantilist. Reserves held for precautionary purposes are intended to buffer absorption against current or capital account shocks. Traditionally, developing countries were counseled to hold reserves equivalent to three months of imports to insure against shortfalls in export earnings (or shocks to output that necessitated higher imports). As EMEs became more financially integrated, the need to buffer absorption against capital account shocks gained greater importance. A sudden net outflow of capital would reduce resources available to finance imports, hence the Greenspan-Guidotti rule of holding reserves against short-term debt.[7] More generally, reserves can reduce both the

[7] In addition to the Greenspan-Guidotti and three-months-of imports cover rules, another metric of reserve adequacy is the coverage of 20 percent of broad money. IMF (2011) argues that each of these metrics focuses exclusively on one particular vulnerability and suggests using a risk-weighted composite index, where the weights are based on empirically observed outflows during balance of payments crises.

likelihood and impact of a sudden stop in capital inflows or a sharp rise in outflows, for example, in a banking crisis that leads to currency flight (Ben-Bassat and Gottlieb, 1992). Optimizing models (Jeanne and Rancière, 2006; Jeanne, 2007; Caballero and Panageas, 2008) treat the decision to hold reserves as an explicit cost-benefit trade-off where the insurance gains of holding reserves must be weighed against their carry costs.[8] Empirically, several studies, including de Beaufort Wijnholds and Kapteyn (2001), Cheung and Qian (2009), Bastourre et al. (2010), and Obstfeld et al. (2010) document the importance of precautionary motives.

A quite different explanation is modern mercantilism—reserves accumulation as a by-product of export-led growth strategies that rely on sterilized intervention to maintain an undervalued currency (Dooley et al., 2003). Ghosh and Kim (2009) consider an economy in which the government has an incentive to maintain an overvalued exchange rate because it is equivalent to an export subsidy (the cost of sterilized intervention being the analogue of the subsidy cost) in an economy where there are positive productivity spillovers, external to the firm, of output in the tradeable sector. Aizenman and Lee (2008) show that, in a two-country game, such mercantilism can lead to the inefficient accumulation of reserves as each country engages in beggar-thy-neighbor competitive depreciations. Durdu et al. (2009) and Bar-Ilan and Marion (2009) combine the precautionary demand for reserves with mercantilist motives, where the latter includes deliberate undervaluation both to boost aggregate demand and to build up reserves. Despite the theoretical plausibility, as well as growing suspicion in policy circles that some EMEs are deliberately undervaluing their currencies to gain competitive advantage, the empirical literature to date (notably Aizenman and Lee, 2007; and Delatte and Fouquau, 2010) has had little success in establishing this link robustly in the data.

Are precautionary and mercantilist motives reasonable explanations for the trends in reserves? Before turning to formal empirics, Figure 2 plots simple bivariate relationships between reserves and proxies of insurance against current account shocks (import of goods and services), capital account shocks (broad money and short-term debt), and mercantilism (undervaluation of the exchange rate). The relative importance of these determinants has clearly shifted over time. While the R-squared between imports and reserves declines only slightly over the three time periods (pre-Asian crisis; post-Asian crisis; emergence of global imbalances), the R-squared for the capital account shocks rises from 0-10 percent in 1980-97 to 11-26 percent in 1998-2004, and 14-38 percent in 2005-10. Likewise, the R-squared between reserves and our measure of currency undervaluation (a higher value indicates greater undervaluation) is close to zero in the pre-Asian crisis period, but rises to around 4 percent afterwards. Mercantilist motives and insurance against capital account shocks clearly grew in importance over time.

In a similar vein, different motives might apply at different points along the sample distribution of reserve holdings; countries that hold low levels of reserves may do so because they are not very financially integrated and are mostly concerned about current account rather than capital account shocks. But once one recognizes that different motives may be at play, there is no reason to believe that the effect of various explanatory variables will be the same across the distribution

[8] Heller (1966) appears to be the first to have formalized a model of optimal precautionary management; see Hamada and Ueda (1977), Frenkel and Jovanovic (1981), and Frenkel (1983) for extensions to his work.

of reserve holdings. There are two aspects to this: first, a variable may help explain why a country holds a high or a low level of reserves; second, it may help differentiate within the group of high- (or low) reserve holders (capturing both types of correlations requires quantile regression techniques that we adopt below). Of course, if different motives are not at play, and if the "homogeneity" assumption that underlies most studies is satisfied, then it should not make any difference—the same variable would explain both whether a country holds a high or low level of reserves, and its relative position within the relevant group, with an identical marginal impact regardless of the level of reserves.

Is this homogeneity assumption satisfied? Figure 3 plots the bivariate relationships between reserves and the same explanatory variables, but now segmented into quartiles of the reserves distribution rather than time periods. Again, some of the relationships look quite different at different levels of reserves. In particular, those related to capital account shocks (broad money and short-term debt), as well as currency undervaluation, are stronger for higher levels of reserves than for lower levels. In part, this is the same as the chronological story (i.e., in the early part of the sample, when countries worried mainly about current account shocks, they held lower reserves), but it is not the full story: about 40 percent of the below-median reserves-to-GDP observations occur in the post-Asian crisis sample; conversely, 44 percent of the above-median observations occur in the pre-Asian crisis sample. As such, it is important to go beyond OLS regressions that ignore these important features of the data.

III. Data and Specification

Our sample consists of a panel of 43 emerging market economies over the period 1980-2010. The dependent variable is the logarithm of gross international reserves, end-period stock, expressed in percent of GDP. Following the discussion above, we include three sets of variables intended to capture: (i) precautionary demand for reserves against current account shocks; (ii) precautionary demand against capital account shocks; and (iii) reserve holdings as a by-product of export-led growth strategies.

A. Precautionary Motives

Current Account Shocks

We include three variables to proxy precautionary demand against current account shocks: imports of goods and services, Imports/GDP; the volatility of exports of goods and services, measured as the three-year moving standard deviation of the export-to-GDP ratio, σ(exports/GDP); and the volatility of trading partners' real GDP growth, also measured by the three-year standard deviation, σ(Δypartner). Each of these is expected to be associated with higher precautionary demand because more reserves will be required to finance imports if the country's normal imports are large, while the likelihood that a liquidity buffer will be required is increasing in the volatility of partner countries' demand or of actual exports.

In addition, we include two variables related to the country's exchange rate regime: a dummy for hard or soft pegs, Peg; and the nominal effective exchange rate volatility σ(ΔNEER). Since a country that has a truly floating exchange rate (and that is willing to let its exchange rate move to any level in the face of shocks) should never need foreign exchange reserves, the peg dummy

variable is expected to be associated with greater demand for precautionary reserves while de facto willingness to tolerate greater exchange rate volatility should be associated with lower demand for reserves.

Capital Account Shocks

Turning to capital account shocks, crises in Mexico (1994), Argentina (1995), Indonesia (1997), Turkey (2001), Argentina (2002), and Uruguay (2003) showed how banking crises can spill on to the balance of payments as investors withdraw deposits and flee the currency, while the Mexican (1994), Korean (1997), and Thai (1997) crises also underscored the risks of short-term debt. Accordingly, we include three variables to capture precautionary demand against capital account shocks: a measure of the de jure openness of the capital account—the Chinn-Ito index, which is based on the IMF Annual Report on Exchange Arrangements and Restrictions, KA; short-term debt on a residual maturity basis, ShortDebt/GDP; and banking system liabilities/broad money, Money/GDP. Each is expected to be associated with higher precautionary demand for reserves.

B. Mercantilist Motives and Other Variables

Obtaining proxies that capture possible mercantilist motives for reserve accumulation (as a by-product of maintaining an undervalued real exchange rate) poses significant challenges. To get improved proxies, we rely on the three methodologies that underlie the IMF's exchange rate assessments (see Lee et al., 2008). Under the macro balance approach, the exchange rate is undervalued if a real appreciation is required to close the gap between the actual current account and its "norm" (the value predicted from a cross-country regression of medium-run determinants of the current account). The equilibrium real exchange rate approach compares the real exchange rate to its equilibrium value implied by "fundamentals" (productivity differentials, terms of trade, government consumption, and the net foreign asset position). Under the external stability approach, the real exchange rate is compared to the level that would generate a current account balance that stabilizes the net foreign asset position at some benchmark value.

Once the implied misalignments under the three approaches are obtained, we average them and map the average into an indicator of more than 10 percent undervaluation (Undervaluation); see Appendix A. In our robustness tests, we use an alternative proxy of mercantilism, namely whether the country exports more than would be expected on the basis of a trade gravity model (Qureshi and Tsangarides, 2010): excess exports. While these proxies are an improvement over existing measures, they cannot distinguish between undervalued exchange rates resulting from crises and those that correspond to deliberate mercantilism. Another issue is that undervaluation of the exchange rate is associated with the accumulation of reserves, not with the holding of a stock per se (by contrast, precautionary motives give rise to the demand for a stock of reserves). Of course, if a country accumulates reserves as a by-product of deliberate mercantilism, then over time this will be reflected in a rising stock of reserves as well, which is what we capture in our baseline regression. As a robustness check, however, below we consider the effect of the accumulation of periods of undervalued exchange rate on the stock of reserves as well.

Regardless of the motive for holding reserves, the benefits need to be weighed against the costs. To this end, we add the interest rate differential between the Treasury bill rate in the country and the US short-term T-bill rate (the typical return on reserve assets). In addition, since the

dependent variable is expressed in percent of GDP, we include per capita income and population to allow for non-homogenous scale effects in the demand for reserve holdings as income rises. In the baseline regression, we exclude time and country fixed effects as we are interested in whether we can explain the rise in average reserve holdings and the dispersion across countries with plausible economic determinants. In the robustness tests, however, we add both.

Our full model is therefore:

$$\begin{aligned}&\log(Res/GDP)_{it} = \beta_0 + \beta_1 \log(y^{pc})_{it} + \beta_2 \log(Pop)_{it} \\ &+\beta_3 Peg_{it} + \beta_4 \sigma(\Delta NEER_{it}) + \beta_5 \ln(Imports/GDP)_{it} + \beta_6 \sigma(Exports/GDP)_{it} + \beta_7 \sigma(\Delta y^{partner})_{it} \\ &+\beta_8 KA_{it} + \beta_9 (ShortDebt/GDP)_{it} + \beta_{10} \log(Money/GDP)_{it} \\ &+\beta_{11} UnderVal_{it} + \beta_{12} IntRateDiffer_{it} + \varepsilon_{it}\end{aligned} \quad (1)$$

IV. Empirical Analysis

Our empirical analysis proceeds in four steps. We begin by estimating (1) using OLS over the full sample, 1980-2010. Then we consider various sub-samples: 1980-97 (pre-Asian crisis); 1998-2004 (post-Asian crisis); 2005-2010 (global imbalances). Next we turn to quantile regressions to allow the effect of regressors to vary according to the amount of reserves held. We conclude by reporting the results of various robustness tests.

A. Full Sample

We build up to our full model (1) in steps, starting with just the "scale variables" of per capita income and population to provide a benchmark (Table 1 [1]). Reserve holdings are not homogenous in (the US dollar value of) GDP, as the coefficient on per capita income is positive and statistically significant; the regression explains about 15 percent of the variation of the (logarithm) of the reserves-to-GDP ratio. Next, we add the exchange rate regime variables on grounds that countries that wish to limit exchange rate flexibility require more reserves to defend their de jure or de facto pegs. This turns out to be the case, with nominal exchange rate volatility being statistically significant, though the pegged exchange rate regime dummy is not (Table 1 [2]).[9] Perhaps surprisingly, the interest rate differential against US assets, which is our proxy for the cost of holding reserves, is statistically insignificant. Adding these variables raises the regression R-squared only marginally to about 17 percent.

What does make a material difference to the explanatory power of the regression is the addition of current account precautionary variables, which more than doubles with the R-squared to 47 percent (Table 1[3]). Reserve holdings are strongly related to imports, with one percentage point of GDP higher imports eliciting an almost proportionate increase in the ratio of reserves to GDP. The volatility of trading partner growth is also statistically significant, though the volatility of the country's own exports is not (controlling for other variables, its estimated coefficient becomes

[9] Excluding nominal exchange rate volatility or differentiating between hard and soft pegs makes no difference to the statistical insignificance of the pegged exchange rate regime dummy.

significant). A one-standard deviation increase in each of these current account variables would (individually) raise the implied level of reserves by about 2 percent of GDP (against a sample average of about 13 percent of GDP).

Turning to precautionary demand against capital account shocks, both de jure financial openness and banking system liabilities are positive and statistically significant determinants of reserve holdings (Table 1 [4]). The coefficient on short-term debt, albeit positive, is not statistically significant. This is surprising inasmuch as policy advice at least over the past decade has emphasized the need for EMEs to hold reserves equivalent to the country's short-term debt exposure. This result is, however, consistent with that of other studies who generally find that short-term debt performs poorly as a determinant of reserve holdings (see Obstfeld et al., 2010; IMF, 2001). Overall, with the addition of the capital account precautionary variables, the regression's explanatory power rises to about 55 percent, with one-standard deviation increases in the capital account variables individually raising the level of reserves by 1.5 percent of GDP.

As discussed above, mercantilism forms a quite distinct explanation for accumulating international reserves. Table 1 [5] adds our measure of currency undervaluation to the model with just the exchange rate regime variables (i.e., excluding the current and capital account precautionary variables). Our proxy for mercantilism is strongly related to reserve holdings; a country whose currency is undervalued by (at least) 10 percent would, other factors equal, hold some 3 percent of GDP more foreign exchange reserves than a country without an undervalued currency. Although the coefficient is highly significant, the contribution to the model's explanatory power is modest (an incremental R-squared of about 2 percent), possibly because of the limited variation of the undervaluation dummy variable.

The full model, including exchange rate regime, current and capital account precautionary variables, and mercantilist motives is given in Table 1[6]. The model explains about 56 percent of the variation in reserve holdings percent without the inclusion of annual or country fixed effects. Moreover, most coefficient estimates are of the expected sign and are statistically significant, with the notable exceptions of the exchange rate regime variables, short-term debt, and the implied carry cost of reserves, all of which are statistically insignificant.

B. Sub-periods: Pre- and Post-Asian Crisis

How have the motives for holding reserves evolved over time? In Table 1 [7]-[9], we re-estimate the full model over various sub-periods: the years preceding the East Asian crisis (1980-97), and the years following it, which we further subdivide into 1998-2004 and 2005-10—the latter period being when global imbalances came to the fore amidst charges that (some) EMEs were pursuing mercantilist policies. While the model's explanatory power remains roughly the same over the three periods, a time pattern emerges on the importance of the various motives.

During the early period of the sample (1980-97; Table 1[7]), there is a clear dominance of exchange rate regime and current account precautionary motives. The pegged exchange rate regime dummy is positive and significant (nominal exchange rate volatility is not significant, possibly because most EMEs during this period had de jure or de facto pegs). Imports are a highly significant determinant of reserve holdings during this period, with the coefficient appreciably larger (0.68) than in subsequent periods (0.47). Likewise, the other current account

precautionary variables (volatility of exports and volatility of partner country growth) are statistically significant in this period but not in the subsequent periods (1998-04; 2005-10). Conversely, the capital account precautionary variables are either insignificant (short-term debt) or have smaller coefficients (broad money) than in subsequent periods. Lastly, the coefficient on undervaluation is both economically and statistically insignificant in the pre-Asian crisis period. To put this in perspective, a one-standard deviation increase in the current account variables in this period would (individually) raise reserve holdings by 1.2 percent of GDP; the corresponding effect of an increase in the capital account variables is 0.5 percent of GDP, while the estimated effect of an undervalued currency is similar, at around 0.5 percent of GDP.

The Asian crisis appears to have been a wake-up call in terms of the need for reserves as a buffer against capital account shocks (Table 1[8]). During this period (1998-04), precautionary reserve holdings against current account shocks become less important (the coefficient on imports falls relative to the earlier period, while the volatility of exports, and of partner country growth turn insignificant). By contrast, the coefficients on capital account variables (financial openness, broad money, short-term debt) become statistically significant or larger in magnitude. Moreover, currency undervaluation now becomes positive and statistically significant.

These trends continue in the final sub period (2005-10; Table 1[9]) where none of the exchange rate regime or current account precautionary variables (except imports, whose coefficient diminishes further) is statistically significant. On capital account variables, the coefficient on broad money increases while that on short-term debt is slightly smaller; both are statistically significant. Financial openness becomes insignificant, possibly because by this period most (though not all) emerging market countries have largely open capital accounts.[10] The magnitude of the interest rate differential coefficient becomes larger in absolute value though it remains statistically insignificant. Finally, the coefficient on undervaluation is positive, larger than in the previous periods, and highly statistically significant. One-standard deviation increases in the current account variables would individually raise the implied level of reserves by 1.6 percent of GDP, while corresponding increases in the capital account variables would raise it by 2.0 percent of GDP; undervaluation of the currency would raise it by 7 percent of GDP. (These may be contrasted with the results given above for the 1980-97 period, where current account variables have a larger impact than either capital account variables or undervaluation.)

Confirming our hypothesis, regressions over the sub periods thus suggest shifting motives for holding reserves.[11] In the 1980s and 1990s, EMEs held reserves to defend their exchange rate pegs or as a buffer against current account shocks. Following the Asian and other EME capital account crises, insurance against capital account shocks (including banking crises that could spill on to the balance of payments) gained importance. At the same time, mercantilism in the form of an undervalued real exchange rate appears to have contributed to higher reserve holdings. While

[10] The Chinn-Ito capital account openness index, which ranges from -1 (fully closed) to +1 (fully open), averages -0.7 during the 1980s; -0.1 in the 1990s; and +0.7 in the 2000s for our sample of EMEs.

[11] Decomposing the regression R-squared into the contribution of the different variables shows that, post-1998, current account variables explain about 30 percent of the "adjusted-overall" R-squared (compared to 39 percent pre-1998), while capital account variables about 55 percent compared to 40 percent in the pre-1998 period.

this pattern accords well with intuition, it need not be limited to motives shifting over time: different levels of reserves across countries at a given point in time may likewise correspond to different reasons for holding them.

C. Quantile Regressions

Do countries that hold a lot of reserves (in relation to GDP) do so for different reasons than those that hold few reserves? To examine this possibility, we adopt quantile regression techniques developed by Koenker and Bassett (1978). Briefly, quantile regressions allow the coefficients on the regressors to vary according to the position of the dependent variable. The key advantage of quantile regressions is that they avoid the (potentially serious) sample selection bias that OLS on subsamples (stratified by the level of reserve holdings) would imply.[12] Intuitively, if a variable helps determine whether a country holds high or low reserves but does not help determine reserve holdings within the group of high (or low) reserve holders, then OLS on subsamples would not identify it as such, but quantile regressions would. Both by allowing the marginal impact of explanatory variables to vary by the value of the dependent variable, and by identifying factors that might be missed in OLS, quantile regressions potentially offer a richer picture of what has been driving reserve accumulation across time and countries.[13]

Quantile regressions can be estimated at any percentile; here we report the results of estimating our full model for each quartile, so the regression becomes:[14]

$$\begin{aligned}
&\log(Res/GDP)_{it} = \beta_0^q + \beta_1^q \log(y^{pc})_{it} + \beta_2^q \log(Pop)_{it} \\
&+\beta_3^q Peg_{it} + \beta_4^q \sigma(\Delta NEER_{it}) + \beta_5^q \ln(Imports/GDP)_{it} + \beta_6^q \sigma(exports/GDP)_{it} + \beta_7^q \sigma(\Delta y^{partner})_{it} \\
&+\beta_8^q KA_{it} + \beta_9^q (ShortDebt/GDP)_{it} + \beta_{10}^q \log(Money/GDP)_{it} \\
&+\beta_{11}^q UnderVal_{it} + \beta_{12}^q IntRateDifffer_{it} + \varepsilon_{it} \quad q = 25,\ 50,\ 75,\ 95
\end{aligned} \tag{2}$$

Estimating (2) suggests some commonalities, but also important differences in the determinants of reserve holdings at various points in the distribution (Table 2; Figure 4). Figure 4 traces the change in the coefficient estimates as the quantiles increase, holding all other variables constant. The solid line in each figure plots the point estimate from quantile regressions ranging from 0.05 to 0.95 percentile of the distribution and the associated confidence interval. The straight dotted lines represent the estimates for the average reserve holder (i.e., the OLS results in Table 1 [6]) along with their confidence intervals. The majority of the graphs show little "overlap" between the quantiles line and average OLS estimates suggesting that there are indeed differences in both the magnitude and significance of the regressors at different points along the reserves

[12] See Koenker and Halloc (2001) for a discussion on why quantile regressions are preferable to OLS on subsamples because they avoid the Heckman-type sample selection bias.

[13] While classical linear regression methods are based on minimizing sums of squared residuals and estimate models for conditional mean functions, quantile regression methods are based on minimizing asymmetrically weighted absolute residuals and can estimate conditional functions at any point on the reserves' distribution.

[14] Since the estimation procedure needs to put some weight both below and above the chosen percentile, it is not possible to go all the way up to the 100th percentile.

distribution. Indeed, several variables (nominal exchange rate volatility, short-term debt, and the carry cost/interest rate differential) that were insignificant in the OLS regressions for the average reserve holder (reproduced in Table 2 [1]), turn out to be highly significant at various points on the reserve holding distribution.

Comparing across quantiles, the exchange rate regime and precautionary demand against current account shocks is more important for low reserve holders than for high reserve holders. Thus the coefficient on imports declines from 0.85 for observations in the lowest quartile (Table 2 [2]) to 0.37 for observations above the 75th percentile (Table 2 [5]), with the differences in coefficients across the distribution statistically significant. Likewise, volatility of exports is a significant determinant for below-median reserve holders (Table 2 [2]-[3]) but not for above-median reserve holders (Table 2 [4]-[5]), while the coefficient on volatility of partner-country growth decreases with rising reserve holdings, albeit statistically insignificant throughout the distribution.

The picture is more mixed for capital account shocks. At the lower end of the distribution (Table 2 [2]-[3]), the coefficients on financial openness and short-term debt are large and statistically significant, whereas they are smaller and/or insignificant for above-median reserve holders (Table 2 [4]-[5]).[15] The coefficient on broad money, by contrast, increases along the distribution: for high-reserve holders, banking system liabilities are a more important determinant of reserves accumulation than for low-reserve holders. This is intuitive in that, for high-reserve holders, banking system liabilities (which average 70 percent of GDP for this group) are a much larger source of potential capital account shocks than is short-term debt (17 percent of GDP).[16]

The cost of holding reserves (proxied by the interest rate differential), which was always insignificant in the OLS regressions, becomes negative and statistically significant for above-median reserve holders (Table 2 [4]-[5]). This makes sense since the absolute cost of holding reserves will be proportional to reserve holdings (in percent of GDP). Therefore, the carry cost will be largely irrelevant when reserves are low (and perhaps at the prudent minimum required for precautionary purposes), but will figure more prominently in the country's cost-benefit analysis as reserve holdings (and therefore their absolute carry cost) increases.

More surprising, undervaluation of the exchange rate is important across the distribution, with the coefficient always positive and highly significant (Table 2 [1]-[4]).[17] Although charges of mercantilism and currency manipulation tend to be leveled against countries with larger stocks of reserves, the analysis here suggests that currency undervaluation as a driver of reserves

[15] This is consistent with the findings of Obstfeld et al. (2010) that many EMEs now hold reserves equivalent to more than 100 percent of short-term debt. In our sample, average reserves for the third and fourth quartiles of the reserves distribution is 14 and 26 percent of GDP, respectively, whereas short-term debt for these two groups is 14 and 17 percent of GDP. Thus, above-median reserve holders have more than 100 percent coverage of short-term debt, and short-term debt is not a significant determinant of their reserve holdings.

[16] High-reserves holders have both larger banking system liabilities (BSL) and short-term debt (STD) than low-reserves holders, but the ratio of BSL to STD is around 4 for them compared to 3 for low-reserves holders.

[17] The coefficient declines along the reserves distribution, which suggests that the results are not being driven by endogeneity bias. If endogeneity of undervaluation were responsible for the results, then we would expect a larger estimate for high-reserve holders, who have both a higher level, and faster accumulation of reserves.

accumulation may be a more common phenomenon. What we suspect, however, is that the correlation between undervalued exchange rates and reserves for low-reserve holders largely reflects collapsed real exchange rates in the aftermath of the 1980s debt crisis (and other EME financial crises) rather than deliberate undervaluation through sterilized intervention. It is noteworthy in this regard that undervaluation for low-reserve holders is typically in the context of declining reserves (on average, reserves declined by about 2 percent for low-reserve holders with undervalued exchange rates) whereas undervaluation for high-reserve holders is associated with increasing reserves of about 15 percent.

D. Robustness

To test the sensitivity of our estimates to alternative specifications and proxies, we conduct several robustness tests on both the OLS and quantile regressions, reported in Tables 3-5. First, in the OLS regressions, we replace our exchange rate undervaluation variable with a PPP-based measure (Table 3 [2]) or "excess" exports (i.e., whether the country exports more than would be predicted by a gravity model of international trade; Table 3 [3]). Using either variable yields a positive and statistically significant coefficient, suggesting that our findings above on mercantilist motives are not driven by any idiosyncrasy of our proxy. Next, we consider whether changes in EME reserve accumulation behavior during the global financial crisis that started in 2008 might be driving our results. We alternatively stop the sample in 2007 or 2008 (Table 3 [4]-[5]) instead of 2010; this makes virtually no difference to the results.

Our baseline specification excludes time and country fixed effects as we are interested in seeing whether we can account for the rise—and dispersion across EMEs—in reserve holdings without resorting to time trends or country fixed effects (to say that China holds a high level of reserves because it is China is not very informative). Nonetheless, to check the robustness of our results, we report the coefficient estimates when annual and country fixed effects are added to the regression. Annual fixed effects make little difference (Table 3 [6]); the scale variables (per capita income and population) lose their significance but the others are barely affected. Moreover, despite the evident time trend in reserve holdings, the regression R-squared only increases by 6 percent, suggesting that the independent variables already included can account for much of the average increase in reserves over the sample period. Adding country fixed effects (Table 3 [7]) raises the regression R-squared from 56 percent to 80 percent, but individual coefficients are little affected: only the partner country growth loses its significance. Volatility of the nominal exchange rate, imports, volatility of exports, broad money, and exchange rate undervaluation all remain statistically significant.[18]

An issue that has been largely ignored in this literature concerns possible simultaneity bias, with several regressors (e.g., short-term debt, exchange rate undervaluation, volatility of the nominal exchange rate) being potentially endogenous to reserve holdings. Table 3 [8] therefore reports coefficient estimates when all variables have been instrumented using their second and third lagged values. While this does not necessarily eliminate all endogeneity bias (given possible

[18] We have also experimented with introducing interaction terms of undervaluation with the peg dummy, capital account openness and imports in our specifications. No statistically significant effect was found in the OLS and period regressions.

serial correlation), it is noteworthy that the coefficients are very similar to the baseline model, and only the volatility of the nominal exchange rate flips sign and the volatility of partner country growth loses its significance. We fail to reject the exogeneity tests of the instruments; as such, the results do not appear to be driven by reverse causality.

Turning to the quantile regressions, Table 4 reports robustness tests of the specifications in Table 2, repeated in Table 4 [1]-[4] for convenience. Replacing our undervaluation measure with the PPP based measure (Table 4 [5]-[8]) yields quite different and counterintuitive results: for high-reserve holders, the coefficient on undervaluation turns strongly negative and is statistically significant. This highlights the fragility of results using PPP-based measures (as noted, e.g., by Aizenman and Lee, 2007) and the advantage of using our undervaluation proxies. Coefficient estimates when time (Table 4 [9]-[12]) and country (Table 4 [13]-[16]) fixed effects are introduced suggest that neither set of fixed effects appreciably alters the story.[19] For below-median reserve holders, the exchange rate regime and current account precautionary variables (imports and volatility of exports) are statistically significant and generally of larger magnitude than for above-median reserve holders.[20] Turning to capital account precautionary variables, broad money is a statistically significant determinant across the board, however financial openness (which does not vary much over time for a given country) loses its significance, and the coefficients on short-term debt become wrongly signed. Neither annual nor country fixed effects materially alter the coefficients on currency undervaluation, which are positive and statistically significant across the distribution of reserve holdings.

Similarly, instrumenting the regressors with their lagged values does not change the story. For below-median reserve holders (Table 4 [17]-[18]), coefficients on current account precautionary variables (imports, export volatility, partner country growth volatility) are statistically significant and larger than for above-median reserve holders (Table 4 [19]-[20]). Again, therefore, the results are robust to correcting for possible endogeneity bias.

Finally, we turn to the question about stock versus change in reserves. So far, our specification assumes that the explanatory variables influence the stock of reserves a country wishes to hold. This is a natural assumption for the precautionary motives for holding reserves, but less so if countries are accumulating reserves as a by-product of undervalued exchange rates as part of an esport-led growth strategy. Of course, a country that is pursuing a mercantilist strategy will need to maintain an undervalued exchange rate and over time this accumulation should show up in the stock of reserves held. Nevertheless, this also implies that the stock of reserves should be related to the duration of the undervaluation.[21]

To examine this issue, we re-estimate our baseline, period, and quantile regressions of Tables 1

[19] Fixed effects are incorporated by removing annual and country means from the dependent and independent variables.

[20] The only exception being the volatility of partner country growth (when both time and country fixed effects are added), which is positive and statistically significant only for the 75th to 90th percentile.

[21] About 35 percent of our observations are undervalued (45, aligned). About half of our counties are undervalued for at least 5 years, and about 15 percent for at least 10 years.

and 2 replacing undervaluation with two measures of undervaluation duration.[22] The first is the cumulative number of years a country is undervalued; the second is the same except that it is reset to zero in any year it is not undervalued. Results in Table 5 suggest that—just like undervaluation—the *duration* of undervaluation matters for the average stock of reserves, post-Asian crisis in the period analysis, and across all quantiles. Results in Tables 1 and 2 are broadly preserved, and, in addition, partner growth volatility now becomes statistically significant across all quantiles, with greater effect on low reserve holders; the volatility of exchange rate is not important for reserve holders beyond the 25th percentile.

V. ACCOUNTING FOR EME RESERVE HOLDINGS

How well does the model account for EME reserves? Figure 5 graphs the cumulative change in reserves (in percent of GDP, averaged across countries) as well as the fitted values for the quantile regression.[23] The residuals are large and negative following the onset of the 1982 onset of the debt crisis (recall that we exclude time and country fixed effects) until the start of the 1990s—suggesting that EMEs involuntarily held fewer reserves than they would consider sufficient for precautionary purposes. During this period, undervaluation contributes positively to the predicted increase in reserves—though, as noted above, this likely reflects devalued real exchange rates in the aftermath of the debt crisis rather than deliberate mercantilism. Precautionary demand against current account shocks contributes negatively because these shocks are becoming less important during this period.[24] Insurance against capital account shocks contributes positively, albeit minutely, to accumulation in the early part of the sample.

From the early 1990s onwards, reserve holdings by EMEs are increasing, eventually at a faster pace than the model would predict. Insurance against capital account shocks is the most important determinant of the rise in predicted reserves, especially in the years following the Asian financial crisis. Undervaluation of the exchange rate becomes progressively important in the latter half of the 2000s, and since this is in the context of increasing reserves, it probably represents intentional undervaluation. Insurance against potential current account shocks is a positive, but marginal, contributor to reserves accumulation. Finally, the average residual is positive starting around 2000, except in 2008 when EMEs ran down reserves as their currencies came under pressure from both the current account shock (the fall in export demand) and the capital account shock (the sudden stop of capital inflows).

Turning to the cross sectional variation, Figure 6 shows the improvement in fit that we obtain using quantile regressions. The average error (here given by the mean absolute deviation) is consistently smaller using quantile regressions, with the largest improvement apparent for

[22] This is preferable to the alternative of estimating the model with the dependent variable being the change in reserves, because the precautionary motives apply to the stock of reserves.

[23] For graphical convenience, the effects of the scale variables (population and per capita income) and of the exchange rate regime are suppressed from both the fitted and the "actual" change in reserves.

[24] In part, this may be because countries experiencing debt servicing difficulties compressed imports. But all three components—imports level, export volatility, and trading partner growth volatility—decrease (cumulatively) during the 1980s, generating a commensurate decline in reserve holdings against these shocks.

observations in the bottom and/or lowest quartile (implying that low-reserve holders behave more differently than the average reserve holder). The bottom panel of Figure 6 compares the mean absolute deviation under the quantile and OLS regressions by country; most observations are to the right of the 45º line, implying a larger average error under OLS.

Figure 7a compares fitted and actual reserves using quantile regressions by country for the period just prior to the onset of the global financial crisis (i.e., 2007). Using estimated coefficients from the 25^{th} to the 90^{th} percentiles the figures we trace the improvement in the fit across, say, the high and low reserve holders: for the bottom 25^{th} reserve holders, the better fit should lie in the top left graph, while for the top 75th holders, the better fit should be bottom right graph. This is indeed the case: for the bottom three reserve holders Mexico, Ecuador, Dominican Republic (painted in blue) their fitted values are closest to the actual (and the 45^0 line) in the first figure using the 25^{th} percentile betas, and worse in the 90^{th}; similarly, the top reserve holders China, Russia, Malaysia, Lebanon (painted in red) have their best fit in the last figure using the 90^{th} percentile estimates (and worst in the first). Comparing to the OLS fitted-actual graph (Figure 7b), China is estimated to have significantly more reserves (in percent of GDP) than predicted by the OLS regression, but to be almost exactly on the regression line when compared to other countries with more similar levels, and corresponding motives, for holding reserves.

VI. CONCLUSIONS

Over the past three decades, emerging market economies have been stockpiling international reserves. In this paper we argue that accounting for this growth in reserves requires several explanations: precautionary demand against both current and capital account shocks as well as intentional or unintentional undervaluation of the exchange rate. No single explanation can account for the behavior of all countries at all times.

We find that insurance against current account shocks was relatively more important in the early part of the sample, and for countries that hold low reserves more generally. Undervaluation of the exchange rate is also important for low reserve holders, but to the extent that it represents collapsed real exchange rates in the aftermath of debt or currency crises, it need not be indicative of deliberate mercantilism.

Following the emerging market capital account crises of the 1990s, especially after the Asian crises of 1997-98, insurance against capital account shocks became increasingly important. Moreover, the export booms that followed the real exchange rate collapses in these crises likely demonstrated the benefits of undervalued currencies for export-led growth. Starting in the early 2000s, currency undervaluation again becomes an important determinant of reserve accumulation—though this time in the context of rising reserves, and hence more probably due to deliberate undervaluation through sterilized intervention. Even including all three motives for holding reserves, and allowing different motives to apply at different points in the reserves distribution, there remains a positive residual for the more recent years (except when EMEs ran down reserves in the global financial crisis). Either EMEs are becoming more risk averse—or they have learned that the potential shocks are even larger than past experience had led them to believe previously. Moreover, while we have examined plausible motives for EME's to hold reserves, in this paper we have not attempted to assess the adequacy of EME reserve holdings for these various purposes. This is left to future research.

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TABLES AND FIGURES

Figure 1. International Reserves held by EME's, 1980-2010
(in percent of GDP)

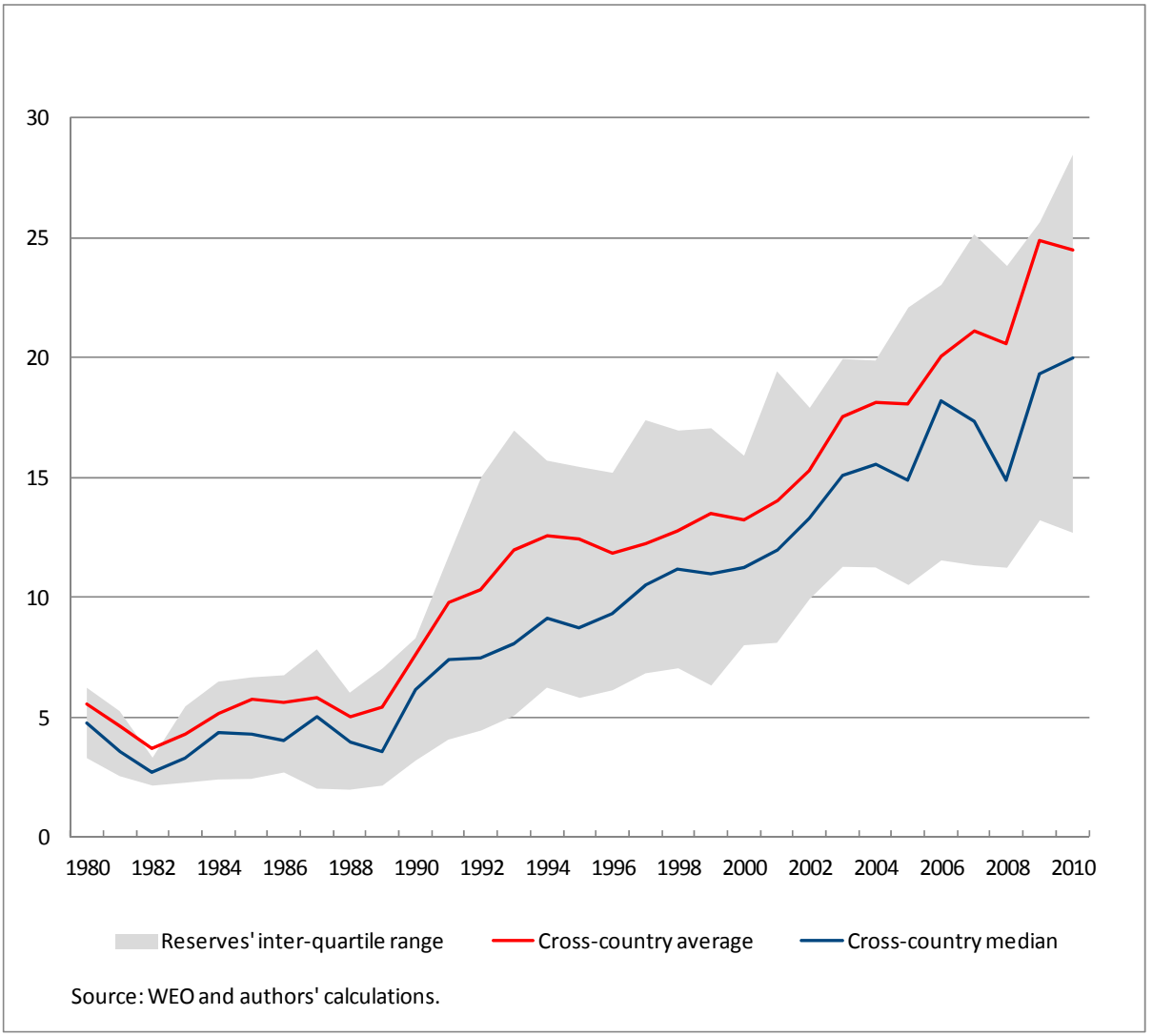


Figure 2. Bivariate Relationships by Period

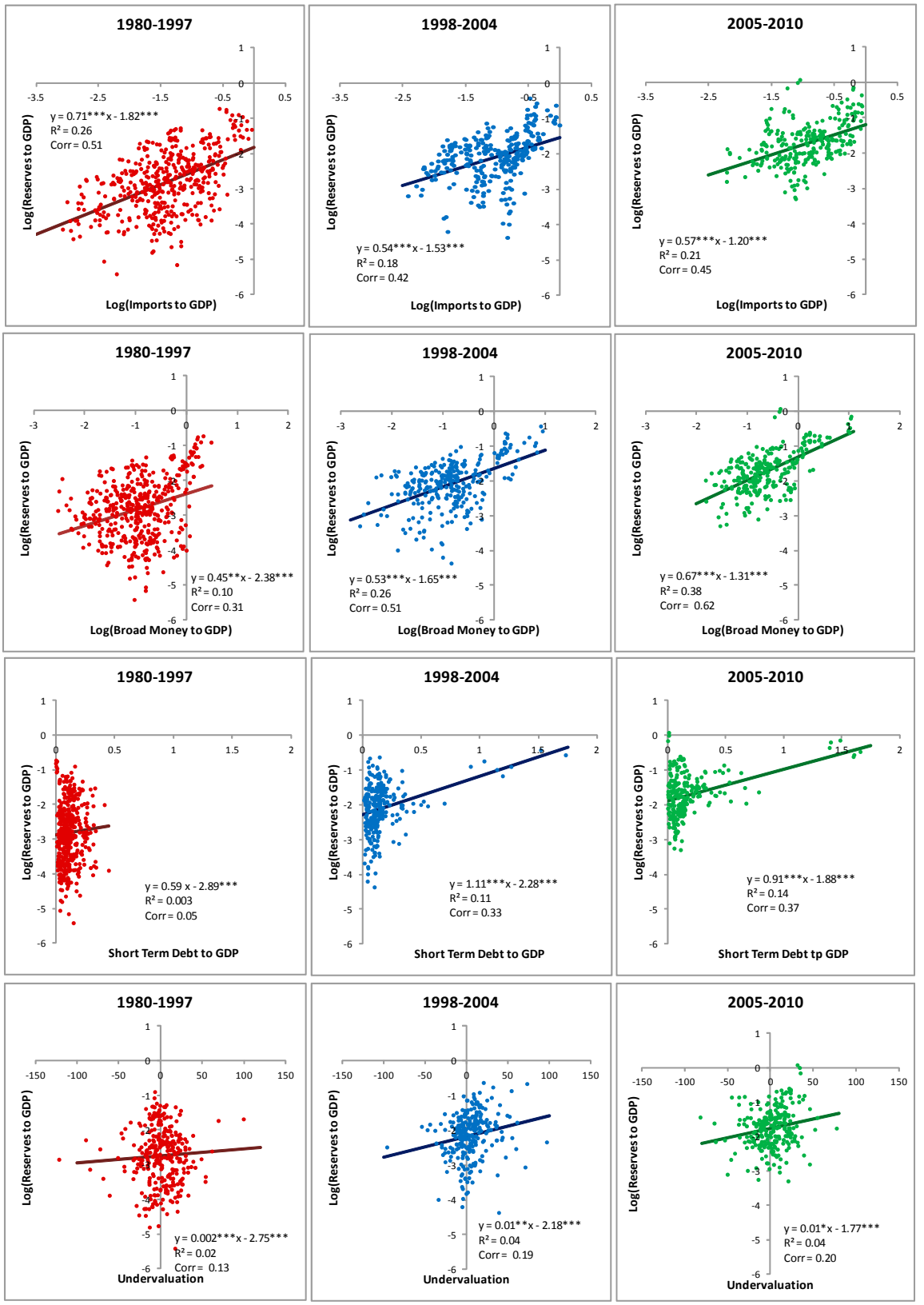


Figure 3. Bivariate Relationships by Quantile

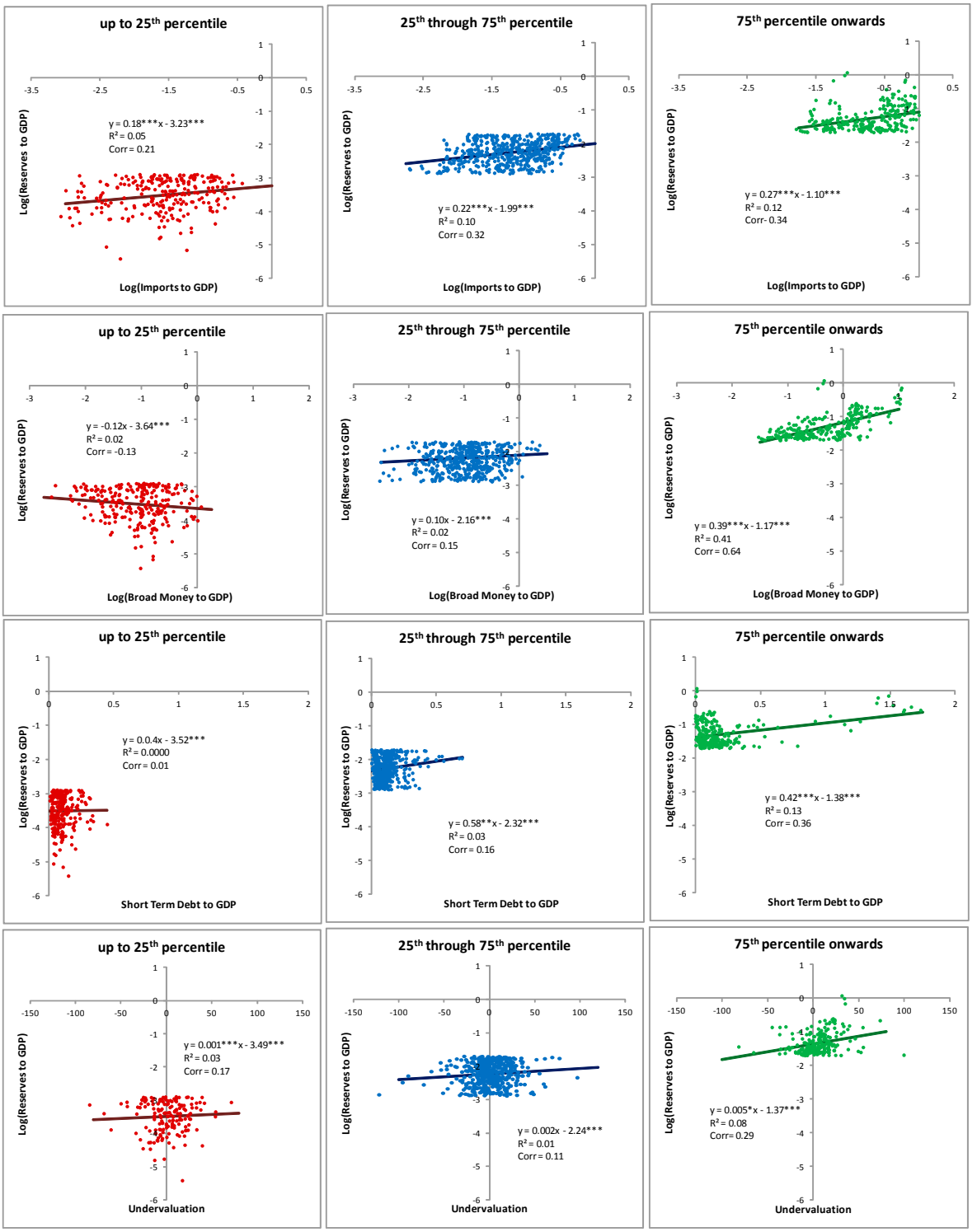
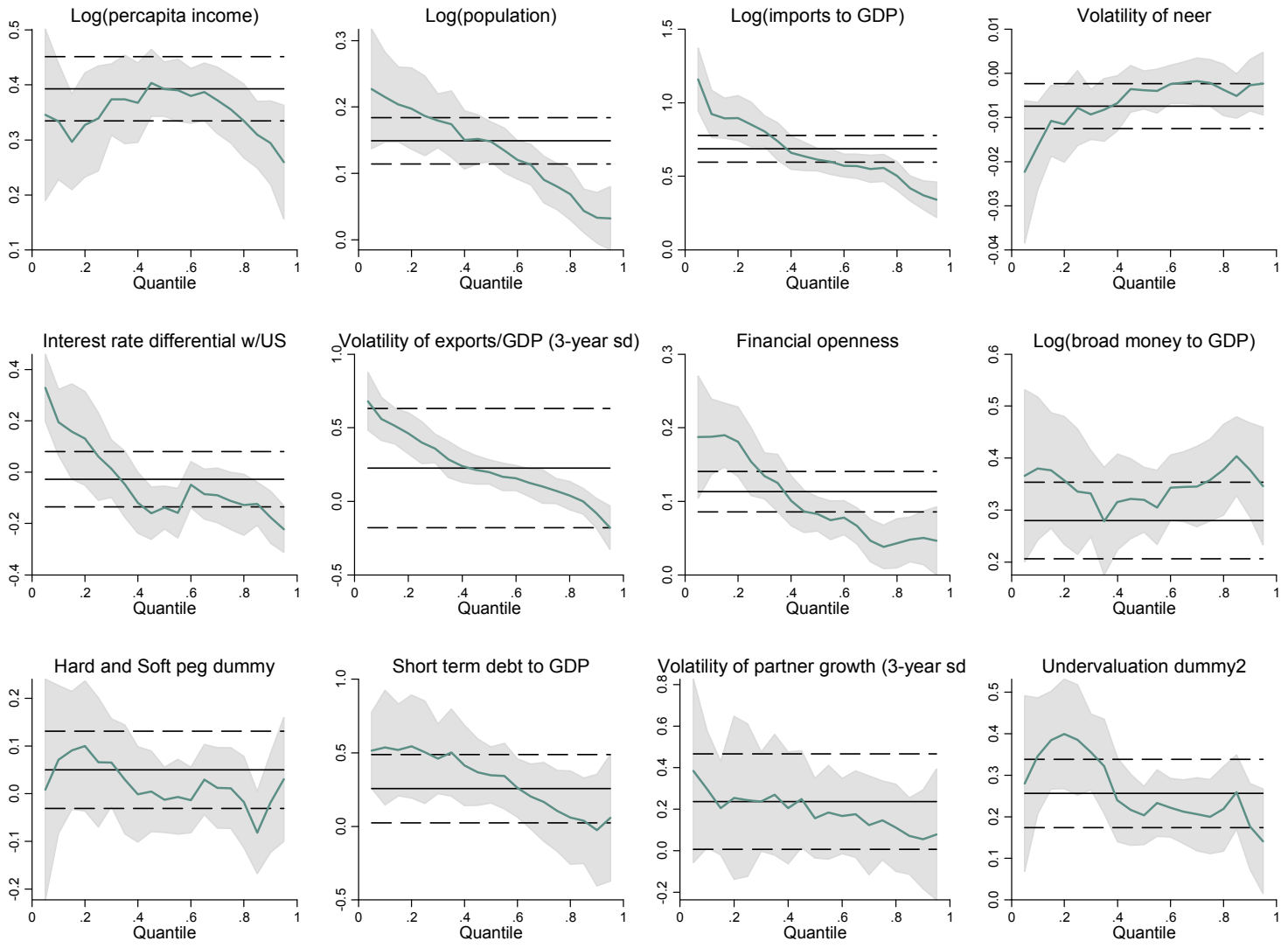
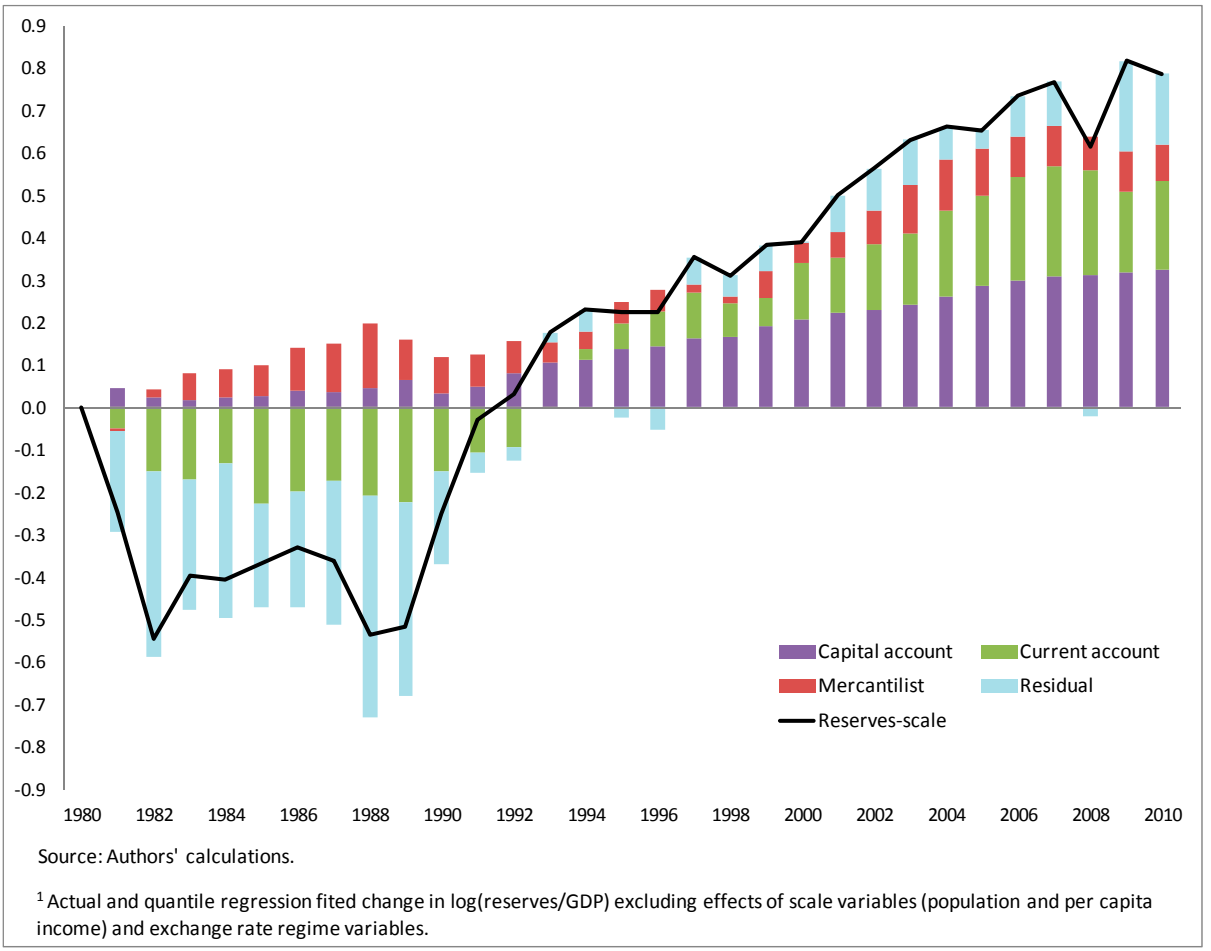


Figure 4. Comparison of Quantile Regression and OLS Coefficient Estimates



Source: Authors' calculations.

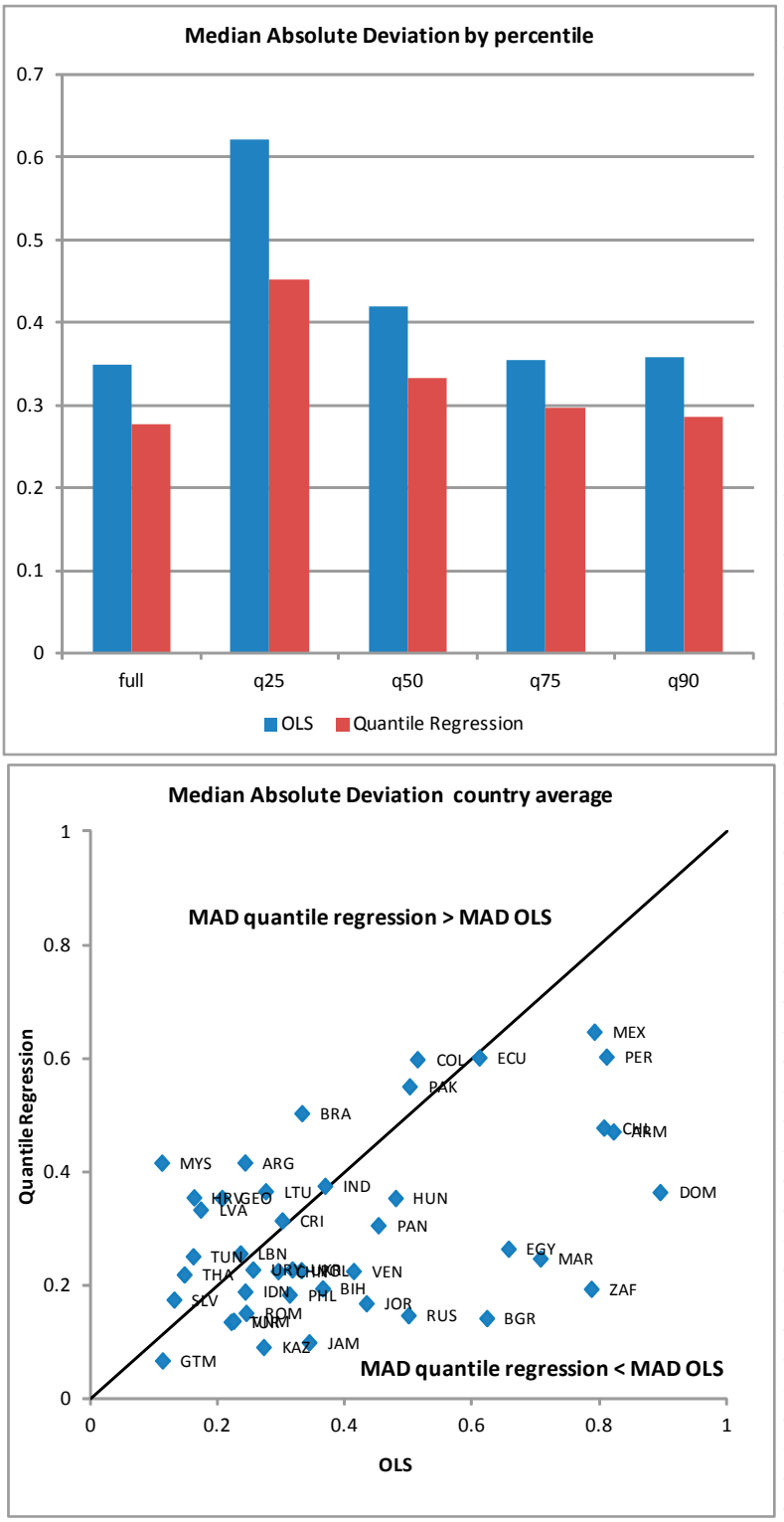
Figure 5. Actual and Fitted Cumulative Change in Reserves[1]



Source: Authors' calculations.

[1] Actual and quantile regression fited change in log(reserves/GDP) excluding effects of scale variables (population and per capita income) and exchange rate regime variables.

Figure 6. Mean Absolute Deviations, Quantile Regressions and OLS



Source: Authors' calculations.

Figure 7a. Actual vs. Fitted Values, Quantile Regressions

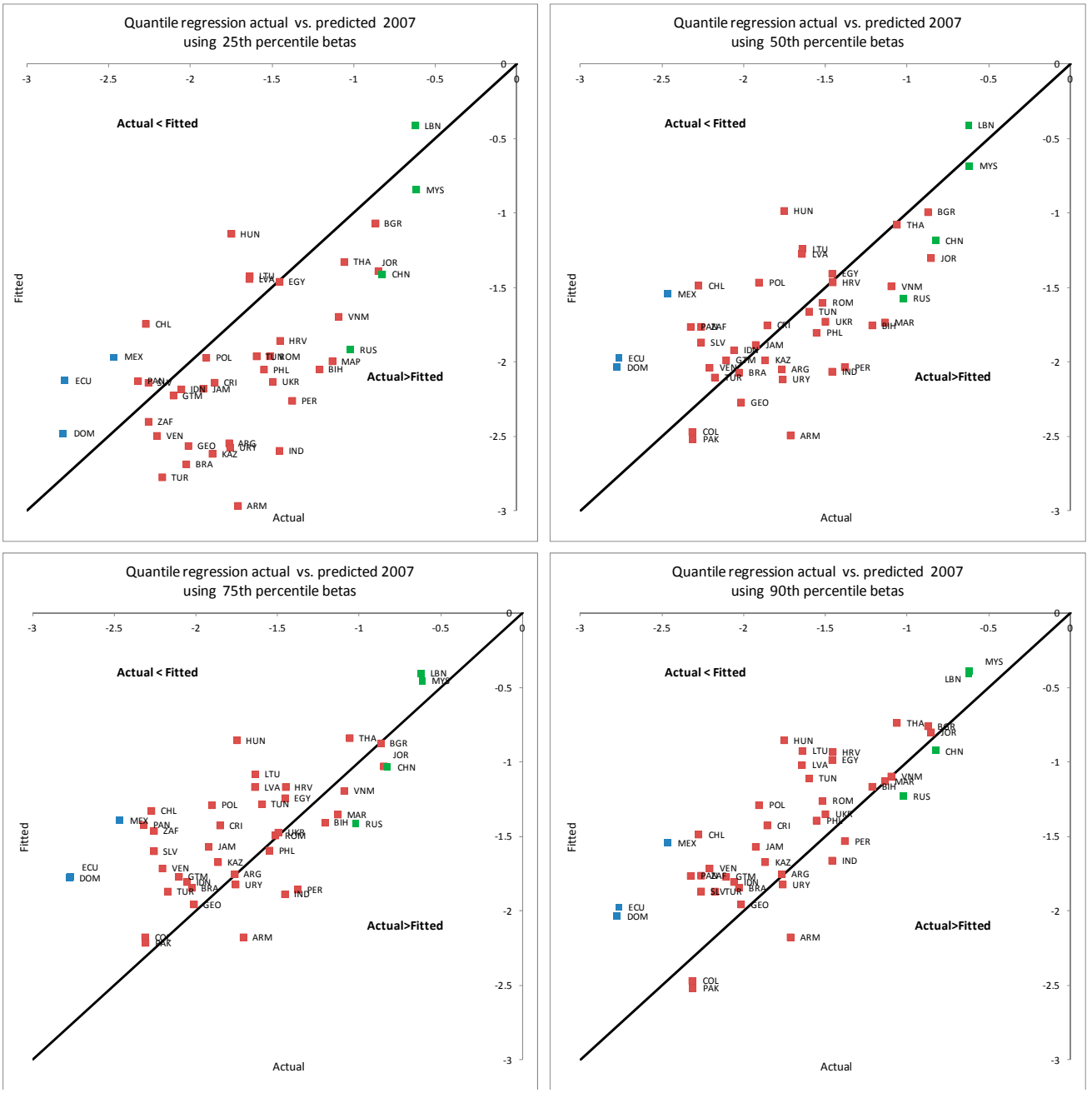


Figure 7b. Actual vs. Fitted Values OLS

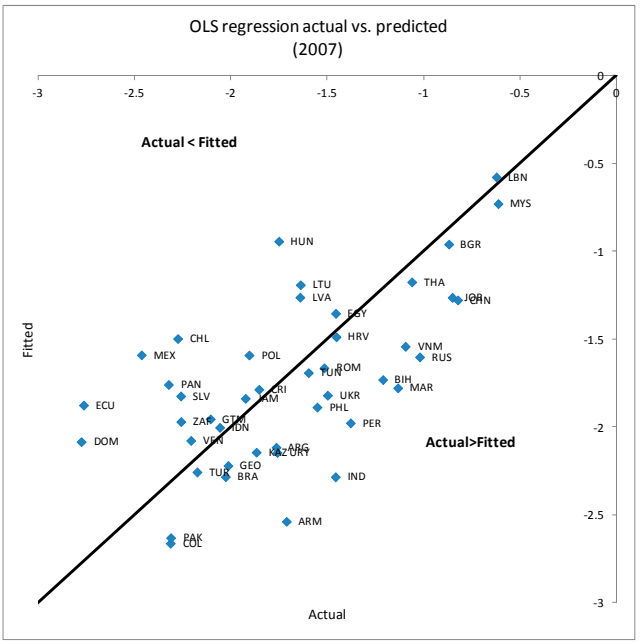


Table 1. Current Account, Capital Account and Mercantilist Determinants of Reserve Demand

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		scale regime	scale regime opp. cost		scale regime opp. cost				
Sample	scale	opp. cost	+CA	+KA	+mercantilist	full	80-97	98-04	05-10
Scale									
Log(per capita income)	0.523***	0.546***	0.501***	0.414***	0.529***	0.393***	0.390**	0.125	0.0985
	(0.106)	(0.112)	(0.0932)	(0.0913)	(0.107)	(0.0850)	(0.154)	(0.104)	(0.100)
Log(population)	0.00113	0.0211	0.180***	0.152***	0.0106	0.149***	0.110	0.0974	0.0235
	(0.0721)	(0.0665)	(0.0551)	(0.0560)	(0.0632)	(0.0528)	(0.0725)	(0.0735)	(0.0680)
Regime									
Hard and Soft peg dummy		-0.00499	0.0807	0.0280	0.0103	0.0502	0.308*	0.0467	-0.103
		(0.155)	(0.135)	(0.123)	(0.154)	(0.120)	(0.181)	(0.125)	(0.0935)
Volatility of neer		-0.0174***	-0.0102*	-0.00605	-0.0191***	-0.00743	-0.000622	-0.0187***	-0.00322
		(0.00504)	(0.00524)	(0.00476)	(0.00488)	(0.00460)	(0.00650)	(0.00561)	(0.00621)
Opportunity cost									
Interest rate differential w/ US		-0.482***	-0.0461	-0.0365	-0.484***	-0.0269	0.0207	-0.0676	-0.362
		(0.0706)	(0.0714)	(0.0828)	(0.0788)	(0.0797)	(0.103)	(0.836)	(0.952)
Current account									
Log(imports to GDP)			0.876***	0.674***		0.687***	0.684***	0.473***	0.454***
			(0.126)	(0.126)		(0.124)	(0.145)	(0.135)	(0.142)
Volatility of exports/GDP (3-year sd)			0.192**	0.257**		0.226***	0.195**	1.459	0.162
			(0.0844)	(0.0962)		(0.0584)	(0.0735)	(1.115)	(2.054)
Volatility of partner growth (3-year sd)			0.308**	0.325**		0.237*	0.332*	0.244	0.405
			(0.141)	(0.130)		(0.118)	(0.171)	(0.257)	(0.595)
Capital account									
Financial openness				0.103**		0.113**	0.111*	0.123**	-0.0245
				(0.0461)		(0.0467)	(0.0593)	(0.0587)	(0.0475)
Log(broad money to GDP)				0.304***		0.280***	0.200*	0.284**	0.445***
				(0.102)		(0.0960)	(0.107)	(0.123)	(0.158)
Short term debt to GDP				0.209		0.256	-0.399	0.481*	0.341*
				(0.203)		(0.199)	(0.633)	(0.251)	(0.188)
Mercantilist									
Exchange rate undervaluation					0.242**	0.256***	0.0805	0.331***	0.335***
					(0.0938)	(0.0654)	(0.107)	(0.0828)	(0.0922)
Constant	-6.785***	-7.024***	-8.552***	-7.405***	-6.766***	-7.250***	-6.923***	-4.174**	-2.392
	(1.915)	(1.927)	(1.554)	(1.560)	(1.832)	(1.452)	(2.279)	(1.811)	(1.754)
Observations	996	996	996	996	996	996	449	289	258
R-squared	0.189	0.281	0.484	0.546	0.296	0.562	0.428	0.519	0.532

Notes:
1. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

Table 2. Reserves Demand Across Quantiles

	(1)	(2)	(3)	(4)
Percentile	qreg25	qreg50	qreg75	qreg90
Scale				
Log(per capita income)	0.339***	0.392***	0.356***	0.295***
	(0.0486)	(0.0252)	(0.0313)	(0.0386)
Log(population)	0.187***	0.148***	0.0801***	0.0330*
	(0.0305)	(0.0150)	(0.0177)	(0.0194)
Regime				
Hard and Soft peg dummy	0.0657	-0.0129	0.0115	-0.0190
	(0.0689)	(0.0349)	(0.0431)	(0.0529)
Volatility of neer	-0.00787*	-0.00380*	-0.00216	-0.00272
	(0.00430)	(0.00218)	(0.00268)	(0.00296)
Opportunity cost				
Interest rate differential w/ US	0.0608	-0.138***	-0.112**	-0.176***
	(0.0867)	(0.0424)	(0.0565)	(0.0513)
Current account				
Log(imports to GDP)	0.853***	0.614***	0.557***	0.371***
	(0.0765)	(0.0390)	(0.0461)	(0.0493)
Volatility of exports/GDP (3-year sd)	0.400***	0.200***	0.0700	-0.0819
	(0.0725)	(0.0416)	(0.0434)	(0.0513)
Volatility of partner growth (3-year sd)	0.244	0.157	0.147	0.0558
	(0.187)	(0.0976)	(0.0964)	(0.121)
Capital account				
Financial openness	0.154***	0.0828***	0.0381**	0.0502***
	(0.0235)	(0.0118)	(0.0149)	(0.0185)
Log(broad money to GDP)	0.335***	0.320***	0.358***	0.377***
	(0.0615)	(0.0317)	(0.0401)	(0.0461)
Short term debt to GDP	0.504***	0.348***	0.105	-0.0261
	(0.177)	(0.0968)	(0.140)	(0.193)
Mercantilist				
Exchange rate undervaluation	0.385***	0.203***	0.200***	0.177***
	(0.0676)	(0.0355)	(0.0456)	(0.0526)
Constant	-7.647***	-7.167***	-5.431***	-3.951***
	(0.775)	(0.383)	(0.470)	(0.566)
Observations	996	996	996	996
Pseudo R2	0.364	0.370	0.367	0.382

Notes:

1. Quantile regression estimates 1980-2010.
2. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

Table 3. Robustness of OLS Estimates

Sample	(1) full	(2) excess exports	(3) ppp	(4) upto 2007	(5) upto 2008	(6) country FE	(7) country & year FE	(8) instrum. variables
Scale								
Log(per capita income)	0.393***	0.395***	0.401***	0.372***	0.370***	0.162	-0.0475	0.399***
	(0.0850)	(0.0901)	(0.0908)	(0.0982)	(0.0925)	(0.119)	(0.234)	(0.0799)
Log(population)	0.149***	0.138**	0.145**	0.149***	0.148***	0.0682	-1.210**	0.137**
	(0.0528)	(0.0545)	(0.0556)	(0.0542)	(0.0532)	(0.0555)	(0.547)	(0.0566)
Regime								
Hard and Soft peg dummy	0.0502	0.000651	0.0395	0.0823	0.0709	0.155	0.0804	0.128
	(0.120)	(0.103)	(0.123)	(0.128)	(0.124)	(0.111)	(0.0861)	(0.186)
Volatility of neer	-0.00743	-0.00562	-0.00728	-0.00829	-0.00804	-0.00474	-0.00970**	0.000342
	(0.00460)	(0.00482)	(0.00476)	(0.00523)	(0.00490)	(0.00455)	(0.00400)	(0.0186)
Opportunity cost								
Interest rate differential w/ US	-0.0269	-0.0509	-0.0440	-0.00293	-0.00965	0.0186	-0.0148	0.0299
	(0.0797)	(0.0750)	(0.0792)	(0.0871)	(0.0853)	(0.0873)	(0.0589)	(0.145)
Current account								
Log(imports to GDP)	0.687***	0.590***	0.664***	0.695***	0.690***	0.509***	0.538***	0.620***
	(0.124)	(0.116)	(0.125)	(0.125)	(0.126)	(0.120)	(0.148)	(0.217)
Volatility of exports/GDP (3-year sd)	0.226***	0.227**	0.245***	0.195***	0.200***	0.218**	0.247***	0.231*
	(0.0584)	(0.0896)	(0.0804)	(0.0507)	(0.0498)	(0.0831)	(0.0655)	(0.122)
Volatility of partner growth (3-year sd)	0.237*	0.313***	0.257**	0.239*	0.229*	0.311*	0.0838	0.0333
	(0.118)	(0.111)	(0.123)	(0.122)	(0.120)	(0.157)	(0.128)	(0.307)
Capital account								
Financial openness	0.113**	0.0804*	0.114**	0.124**	0.119**	0.0661	-0.00890	0.129**
	(0.0467)	(0.0441)	(0.0469)	(0.0484)	(0.0476)	(0.0453)	(0.0448)	(0.0500)
Log(broad money to GDP)	0.280***	0.379***	0.285***	0.242**	0.255**	0.299***	0.378**	0.327**
	(0.0960)	(0.0985)	(0.102)	(0.0956)	(0.0956)	(0.0897)	(0.156)	(0.131)
Short term debt to GDP	0.256	0.210	0.253	0.291	0.277	0.344*	-0.355*	0.263
	(0.199)	(0.177)	(0.210)	(0.207)	(0.204)	(0.172)	(0.199)	(0.207)
Mercantilist								
Exchange rate undervaluation	0.256***			0.247***	0.254***	0.266***	0.132***	0.363***
	(0.0654)			(0.0731)	(0.0706)	(0.0639)	(0.0455)	(0.108)
Excess Exports		0.472**						
		(0.188)						
Exchange rate undervaluation (ppp)			0.177**					
			(0.0798)					
Constant	-7.250***	-7.132***	-7.235***	-7.130***	-7.082***	-4.225**	20.35**	-7.280***
	(1.452)	(1.557)	(1.536)	(1.552)	(1.495)	(1.721)	(9.526)	(1.486)
Observations	996	950	996	867	910	996	996	873
R-squared	0.562	0.565	0.553	0.542	0.547	0.623	0.800	0.567
Hansen test (p-value)								0.133
Endogeneity test (p-value)								0.531

Notes:
1. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

Table 4. Robustness of Quantile Regressions

	Table 2 results				With ppp-based misalignments				With year fixed effects added				With year and country fixed effects added				With instrumental variables			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Sample	qreg25	qreg50	qreg75	qreg90	qreg25	qreg50	qreg75	qreg90	qreg25	qreg50	qreg75	qreg90	qreg25	qreg50	qreg75	qreg90	qreg25	qreg50	qreg75	qreg90
Scale																				
Log(per capita income)	0.339***	0.392***	0.356***	0.295***	0.288***	0.410***	0.350***	0.317***	0.0869	0.158***	0.165***	0.218***	-0.199*	-0.157	0.0920	0.106	0.330***	0.369***	0.318***	0.250***
	(0.0486)	(0.0252)	(0.0313)	(0.0386)	(0.0439)	(0.0251)	(0.0236)	(0.0369)	(0.0535)	(0.0316)	(0.0344)	(0.0368)	(0.106)	(0.106)	(0.113)	(0.146)	(0.0467)	(0.0367)	(0.0428)	(0.0358)
Log(population)	0.187***	0.148***	0.0801***	0.0330*	0.169***	0.145***	0.0833***	0.0430**	0.0824***	0.0888***	0.0419**	-0.0129	-0.683**	-0.519*	-0.723***	-1.632***	0.176***	0.135***	0.0609**	0.0244
	(0.0305)	(0.0150)	(0.0177)	(0.0194)	(0.0280)	(0.0150)	(0.0139)	(0.0194)	(0.0288)	(0.0163)	(0.0174)	(0.0162)	(0.284)	(0.279)	(0.273)	(0.312)	(0.0287)	(0.0215)	(0.0250)	(0.0179)
Regime																				
Hard and Soft peg dummy	0.0657	-0.0129	0.0115	-0.0190	0.0319	-0.00802	-0.0289	-0.0707	0.140**	0.0934***	0.137***	0.144***	0.0715*	0.0812**	0.0978***	0.0610	0.0750	-0.0461	0.0232	-0.0496
	(0.0689)	(0.0349)	(0.0431)	(0.0529)	(0.0625)	(0.0347)	(0.0327)	(0.0517)	(0.0633)	(0.0357)	(0.0374)	(0.0367)	(0.0424)	(0.0375)	(0.0350)	(0.0475)	(0.0825)	(0.0621)	(0.0756)	(0.0605)
Volatility of neer	-0.00787*	-0.00380*	-0.00216	-0.00272	-0.0117***	-0.00356	-0.000494	-0.00244	-0.00807**	-0.00148	-0.000113	0.00360	-0.0141***	-0.00421**	-0.00430**	-0.00606**	-0.00299	-0.00932	0.00358	-0.00226
	(0.00430)	(0.00218)	(0.00268)	(0.00296)	(0.00391)	(0.00219)	(0.00204)	(0.00308)	(0.00387)	(0.00222)	(0.00245)	(0.00240)	(0.00238)	(0.00210)	(0.00219)	(0.00300)	(0.00824)	(0.00637)	(0.00785)	(0.00620)
Opportunity cost																				
Interest rate differential w/ US	0.0608	-0.138***	-0.112**	-0.176***	0.0387	-0.135***	-0.149***	-0.232***	0.110	-0.0136	-0.111**	-0.224***	0.0197	-0.0383	-0.0621	-0.0366	0.131	-0.0506	-0.124	-0.255***
	(0.0867)	(0.0424)	(0.0565)	(0.0513)	(0.0779)	(0.0423)	(0.0439)	(0.0513)	(0.0911)	(0.0446)	(0.0498)	(0.0546)	(0.0475)	(0.0413)	(0.0429)	(0.0525)	(0.0839)	(0.0690)	(0.0884)	(0.0664)
Current account																				
Log(imports to GDP)	0.853***	0.614***	0.557***	0.371***	0.773***	0.599***	0.487***	0.374***	0.610***	0.519***	0.440***	0.239***	0.730***	0.622***	0.459***	0.428***	0.948***	0.621***	0.569***	0.380***
	(0.0765)	(0.0390)	(0.0461)	(0.0493)	(0.0687)	(0.0390)	(0.0355)	(0.0454)	(0.0706)	(0.0415)	(0.0424)	(0.0389)	(0.0867)	(0.0769)	(0.0809)	(0.102)	(0.0721)	(0.0569)	(0.0658)	(0.0475)
Volatility of exports/GDP (3-year sd)	0.400***	0.200***	0.0700	-0.0819	0.347***	0.183***	0.0654	0.355***	0.337***	0.195***	0.0638	-0.104	0.324***	0.241***	0.0981*	0.0403	0.349***	0.123*	-0.0687	-0.215***
	(0.0725)	(0.0416)	(0.0434)	(0.0513)	(0.0641)	(0.0416)	(0.100)	(0.0999)	(0.0941)	(0.0575)	(0.0634)	(0.0814)	(0.0615)	(0.0553)	(0.0592)	(0.0867)	(0.0754)	(0.0682)	(0.0846)	(0.0726)
Volatility of partner growth (3-year sd)	0.244	0.157	0.147	0.0558	0.298*	0.276***	0.144*	0.127	0.296*	0.241***	0.162*	0.319***	-0.000149	0.0591	0.346***	0.188	0.260	0.315**	0.0884	0.0990
	(0.187)	(0.0976)	(0.0964)	(0.121)	(0.171)	(0.0979)	(0.0740)	(0.117)	(0.166)	(0.0900)	(0.0865)	(0.103)	(0.0976)	(0.0920)	(0.0906)	(0.123)	(0.167)	(0.157)	(0.223)	(0.153)
Capital account																				
Financial openness	0.154***	0.0828***	0.0381**	0.0502***	0.164***	0.0743***	0.0524***	0.0391**	0.0827***	0.0557***	0.0614***	0.0469***	0.0194	0.00914	0.000528	-0.0549***	0.153***	0.0756***	0.0301	0.0449**
	(0.0235)	(0.0118)	(0.0149)	(0.0185)	(0.0222)	(0.0119)	(0.0114)	(0.0169)	(0.0201)	(0.0122)	(0.0143)	(0.0146)	(0.0192)	(0.0166)	(0.0156)	(0.0180)	(0.0227)	(0.0169)	(0.0208)	(0.0177)
Log(broad money to GDP)	0.335***	0.320***	0.358***	0.377***	0.308***	0.330***	0.384***	0.418***	0.329***	0.337***	0.334***	0.349***	0.409***	0.434***	0.455***	0.321***	0.322***	0.346***	0.374***	0.366***
	(0.0615)	(0.0317)	(0.0401)	(0.0461)	(0.0555)	(0.0317)	(0.0306)	(0.0459)	(0.0553)	(0.0313)	(0.0346)	(0.0349)	(0.0702)	(0.0683)	(0.0743)	(0.0934)	(0.0598)	(0.0461)	(0.0566)	(0.0424)
Short term debt to GDP	0.504***	0.348***	0.105	-0.0261	0.586***	0.330***	0.0880	-0.144	0.525***	0.321***	0.0969	-0.129	-0.251**	-0.170	-0.310**	-0.340***	0.452***	0.350***	0.133	0.0198
	(0.177)	(0.0968)	(0.140)	(0.193)	(0.158)	(0.0966)	(0.0990)	(0.188)	(0.158)	(0.0974)	(0.109)	(0.101)	(0.107)	(0.129)	(0.138)	(0.130)	(0.174)	(0.133)	(0.197)	(0.171)
Mercantilist																				
Exchange rate undervaluation	0.385***	0.203***	0.200***	0.177***					0.371***	0.197***	0.195***	0.0411	0.177***	0.0773**	0.0782**	0.123**	0.588***	0.296***	0.280***	0.274***
	(0.0676)	(0.0355)	(0.0456)	(0.0526)					(0.0611)	(0.0362)	(0.0403)	(0.0395)	(0.0371)	(0.0354)	(0.0373)	(0.0498)	(0.0963)	(0.0757)	(0.0944)	(0.0711)
Exchange rate undervaluation (ppp)					0.339***	0.114***	0.0293	-0.102**												
					(0.0659)	(0.0377)	(0.0361)	(0.0507)												
Constant	-7.647***	-7.167***	-5.431***	-3.951***	-6.968***	-7.285***	-5.429***	-4.124***	-0.334***	0.0608***	0.352***	0.644***	-0.191***	0.0294**	0.242***	0.445***	-7.425***	-6.689***	-4.816***	-3.396***
	(0.775)	(0.383)	(0.470)	(0.566)	(0.700)	(0.381)	(0.361)	(0.580)	(0.0257)	(0.0152)	(0.0166)	(0.0166)	(0.0138)	(0.0132)	(0.0133)	(0.0177)	(0.754)	(0.563)	(0.669)	(0.549)
Observations	996	996	996	996	996	996	996	996	996	996	996	996	996	996	996	996	891	891	891	891
Pseudo R2	0.364	0.370	0.367	0.382	0.357	0.362	0.355	0.372	0.194	0.234	0.292	0.320	0.105	0.0971	0.101	0.114	0.355	0.347	0.347	0.374

Notes:
1. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

Table 5. Robustness of Undervaluation Measure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Sample	Full	Full	80-97	80-97	98-04	98-04	05-10	05-10	qreg25	qreg25	qreg50	qreg50	qreg75	qreg75	qreg90	qreg90
Scale																
Log(per capita income)	0.373***	0.295***	0.393**	0.308*	0.110	0.105	0.0775	0.0568	0.322***	0.260***	0.374***	0.347***	0.324***	0.301***	0.276***	0.269***
	(0.0888)	(0.105)	(0.156)	(0.170)	(0.112)	(0.122)	(0.100)	(0.117)	(0.0420)	(0.0471)	(0.0272)	(0.0364)	(0.0261)	(0.0325)	(0.0433)	(0.0435)
Log(population)	0.127**	0.131**	0.113	0.111	0.0746	0.114	-0.0127	-0.00177	0.157***	0.195***	0.135***	0.152***	0.0519***	0.0724***	0.00400	0.00507
	(0.0537)	(0.0501)	(0.0721)	(0.0694)	(0.0849)	(0.0732)	(0.0705)	(0.0711)	(0.0269)	(0.0266)	(0.0163)	(0.0193)	(0.0147)	(0.0160)	(0.0218)	(0.0185)
Regime																
Hard and Soft peg dummy	0.0297	0.0596	0.309*	0.334*	-0.0160	-0.00868	-0.127	-0.126	0.0820	0.0903	-0.00808	0.00969	-0.0601*	0.0116	-0.0678	-0.0397
	(0.118)	(0.115)	(0.180)	(0.166)	(0.131)	(0.132)	(0.0903)	(0.0910)	(0.0584)	(0.0609)	(0.0372)	(0.0442)	(0.0358)	(0.0387)	(0.0607)	(0.0524)
Volatility of neer	-0.00607	-0.00615	-8.79e-05	0.00113	-0.0170***	-0.0170**	-0.00343	-0.00684	-0.00752**	-0.00815**	-0.00333	-0.00300	-0.00165	-0.000504	-0.00343	-0.00471
	(0.00463)	(0.00488)	(0.00639)	(0.00617)	(0.00604)	(0.00640)	(0.00609)	(0.00680)	(0.00368)	(0.00377)	(0.00233)	(0.00275)	(0.00230)	(0.00251)	(0.00394)	(0.00353)
Opportunity cost																
Interest rate differential w/ US	-0.0359	-0.0317	0.0136	0.00365	-0.0795	-0.238	-0.381	-0.901	0.0531	0.00854	-0.142***	-0.112**	-0.115***	-0.119**	-0.205**	-0.245***
	(0.0795)	(0.0780)	(0.101)	(0.101)	(0.875)	(0.849)	(0.954)	(0.992)	(0.0743)	(0.0699)	(0.0454)	(0.0538)	(0.0441)	(0.0472)	(0.0862)	(0.0733)
Current account																
Log(imports to GDP)	0.675***	0.694***	0.691***	0.693***	0.441***	0.462***	0.428***	0.447***	0.839***	0.838***	0.626***	0.675***	0.506***	0.561***	0.352***	0.354***
	(0.123)	(0.119)	(0.147)	(0.139)	(0.138)	(0.142)	(0.145)	(0.128)	(0.0648)	(0.0646)	(0.0417)	(0.0496)	(0.0392)	(0.0410)	(0.0622)	(0.0527)
Volatility of exports/GDP (3-year sd)	0.215***	0.268***	0.200**	0.226***	2.285*	2.201*	0.376	2.206	0.355***	0.389***	0.170***	0.213***	0.0377	0.0522	-0.118*	-0.110*
	(0.0676)	(0.0891)	(0.0779)	(0.0771)	(1.286)	(1.300)	(2.057)	(2.093)	(0.0623)	(0.0769)	(0.0448)	(0.0495)	(0.0450)	(0.0493)	(0.0701)	(0.0625)
Volatility of partner growth (3-year sd)	0.316**	0.355**	0.354**	0.359*	0.320	0.404	0.196	-0.193	0.324*	0.431**	0.254**	0.306***	0.173**	0.297***	0.105	0.280**
	(0.122)	(0.136)	(0.170)	(0.182)	(0.265)	(0.271)	(0.557)	(0.562)	(0.165)	(0.200)	(0.104)	(0.111)	(0.0795)	(0.0896)	(0.141)	(0.120)
Capital account																
Financial openness	0.108**	0.0849*	0.110*	0.109*	0.112*	0.118*	-0.0257	-0.0551	0.138***	0.127***	0.0722***	0.0647***	0.0419***	0.0360***	0.0450**	0.0251
	(0.0464)	(0.0426)	(0.0572)	(0.0560)	(0.0618)	(0.0647)	(0.0484)	(0.0540)	(0.0200)	(0.0206)	(0.0125)	(0.0150)	(0.0124)	(0.0134)	(0.0215)	(0.0185)
Log(broad money to GDP)	0.272***	0.289***	0.197*	0.216**	0.304**	0.331**	0.431***	0.422***	0.311***	0.332***	0.301***	0.316***	0.356***	0.343***	0.359***	0.362***
	(0.0957)	(0.0899)	(0.106)	(0.101)	(0.127)	(0.131)	(0.155)	(0.147)	(0.0531)	(0.0531)	(0.0339)	(0.0400)	(0.0335)	(0.0357)	(0.0548)	(0.0455)
Short term debt to GDP	0.276	0.321*	-0.397	-0.345	0.461*	0.452*	0.328*	0.390**	0.485***	0.520***	0.363***	0.342***	0.118	0.124	-0.00462	0.000934
	(0.196)	(0.165)	(0.631)	(0.631)	(0.258)	(0.257)	(0.194)	(0.170)	(0.151)	(0.160)	(0.104)	(0.124)	(0.109)	(0.117)	(0.229)	(0.197)
Mercantilist																
Exchange rate undervaluation duration 1	0.0545***		0.0285		0.0540*		0.0496***		0.0642***		0.0348***		0.0335***		0.0369***	
	(0.0155)		(0.0218)		(0.0286)		(0.0167)		(0.0115)		(0.00697)		(0.00673)		(0.0109)	
Exchange rate undervaluation duration 2		0.0395***		0.0402*		0.00581		0.0387**		0.0484***		0.0285***		0.0269***		0.0289***
		(0.0136)		(0.0201)		(0.0172)		(0.0186)		(0.00744)		(0.00592)		(0.00533)		(0.00644)
Constant	-6.730***	-6.234***	-6.996***	-6.384***	-3.634*	-4.192**	-1.582	-1.705	-7.031***	-7.250***	-6.801***	-6.916***	-4.676***	-4.940***	-3.277***	-3.351***
	(1.501)	(1.522)	(2.282)	(2.286)	(2.065)	(1.931)	(1.769)	(2.001)	(0.685)	(0.711)	(0.415)	(0.515)	(0.387)	(0.443)	(0.627)	(0.564)
Observations	996	996	449	449	289	289	258	258	996	996	996	996	996	996	996	996
R-squared	0.567	0.569	0.430	0.443	0.495	0.479	0.544	0.527								
Pseudo R2									0.369	0.366	0.369	0.372	0.367	0.366	0.380	0.387

Notes:
1. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

APPENDIX A
Construction of the Mercantilist Variables

A. Exchange Rate Misalignments

We construct several estimates for misalignments based on application of three equilibrium exchange rate methodologies, namely, the macroeconomic balance (MB), the equilibrium real effective rate (ERER), and external sustainability (ES), as well as the PPP methodology. Our assessments are based on the methodologies described in the IMF Occasional Paper 261, "Exchange Rate Assessments: CGER Methodologies". The ERER approach focuses directly on prices (exchange rates), while the other two approaches focus on quantities (current accounts and net foreign assets), and then derive the implications for the exchange rate.

Based on each estimation we first construct misalignment estimates. Then, we combine estimates to construct the average misalignments. Finally, given the inherent uncertainties in estimating misalignments, we map this average misalignment into a dummy variable for greater than 10 percent overvalued.

Macroeconomic Balance (MB)

The MB approach calculates the difference between the "underlying" current account balance projected over the medium term at prevailing exchange rates and the estimated equilibrium current account balance or "current account norm". The former is estimated as the current account over the medium term based on WEO forecasts, while the latter is derived from estimating an equilibrium relationship between the current account balance and a set of macroeconomic fundamentals. The exchange rate adjustment that would eliminate this difference over the medium term is obtained using the country-specific elasticity of the current account with respect to the real exchange rate.[25]

The estimated equation for the MB approach is

$$ca_{it} = \beta_0 + \beta_1 oldage_{it} + \beta_2 pop_{it} + \beta_3 income_{it} + \beta_4 output_{it} + \beta_5 oil_{it} + \beta_6 fiscal_{it} + \beta_7 NFA_{it} + \varepsilon_{it}$$

where

[25] The semi-elasticity of the current account changes to changes in the exchange rate is constructed based on the medium run elasticity of the volume of exports or imports with respect to the real effective exchange rate, and the ratios of exports or imports to output.

ca:	Ratio of the current account balance to output for economy
$oldage$:	Old age dependency ratio relative to trading partners
pop:	Population growth relative to trading partners
$income$:	GDP per capita relative to trading partners
$output$:	Real output growth relative to trading partners
oil:	Ratio of oil trade balance to nominal GDP
$fiscal$:	Fiscal balance to nominal GDP ratio, relative to trading partners
NFA:	Ratio of initial net foreign assets to nominal GDP

Reduced-form Equilibrium Real Exchange Rate (ERER)

The ERER approach estimates an equilibrium real exchange rate as a function of medium-term fundamentals. The exchange rate adjustment needed to restore equilibrium over the medium term is then calculated as the difference between the estimated equilibrium real exchange rate and its current value.

For each country in the sample, the medium run equilibrium value is estimated in two steps: (i) A panel regression model is used to estimate an equilibrium relationship between real exchange rates and a set of fundamentals; and (ii) equilibrium real exchange rates are computed as a function of the actual (medium term) projections of the fundamentals.

The estimated equation for the ERER approach is

$$\ln Q_{it} = \beta_{0i} + \beta_1 tot_{it} + \beta_2 prod_{it} + \beta_3 govconsum_{it} + \beta_4 NFA_{it} + \varepsilon_{it}$$

where

Q:	Real effective exchange rate for economy
β_0:	Economy specific fixed effect
tot:	Terms of trade
$prod$:	Relative productivity
NFA:	Initial net foreign assets to nominal GDP ratio

External Sustainability (ES)

The ES approach calculates the difference between the actual current account balance and the balance that would stabilize the countries' NFA position at some benchmark level. Using the elasticities derived in the MB approach we translate the difference into the real exchange rate adjustment that would bring the current account balance in line with its NFA-stabilizing level (ca^s), that stabilizes the NFA/GDP ratio at nfa^s :

$$ca^s \approx \frac{g+\pi}{1+g+\pi} nfa^s$$

where g is the growth rate of real GDP and π is the inflation rate. The NFA/GDP level at the end of the prior year is used as nfa^s.

Purchasing Power Parity (PPP)

The PPP theory predicts that prices are equalized when measured in the same currency. This suggests that an equilibrium real exchange rate should be constant over time and equal to one if the absolute PPP holds. We estimate the real effective exchange rate (RER) as $RER_{it} = \frac{ExchangeRate_{it}}{PPP_{it}}$ where a value of *RER* greater (smaller) than one suggests that the value of the currency is lower (higher) than is indicated by purchasing-power parity theory. To account for the "Balassa-Samuelson hypothesis" (which explains deviations between *RER* and its *PPP* on the basis of higher productivity growth in the tradable sector in rich countries compared to that in poor countries) "adjusted" PPP estimates are based on a regression of *RER* on a constant term, per capita GDP and country and time fixed effects

$$\ln(RER_{it}) = \alpha + \beta \ln(PerCapitaGDP_{it}) + f_t + u_t + \varepsilon_{it}$$

The degree of exchange rate misalignment is inferred as the proportional change in the underlying real effective exchange rate and the predicted real effective exchange rate. Empirical evidence shows that absolute *PPP* does not hold. Relative PPP does not hold in the short-run, but does hold in the long-run after a significant period of adjustment. Therefore, we calculate estimates based on the PPP for comparison purposes only.

B. Construction of Excess Exports

Our measure of excess exports is based on bilateral exports predicted from a gravity model estimation. Predicted exports capture the multidimensional nature of exports by taking into account transportation costs, trade barriers, and the rest of the usual determinants, and give a sense of the "potential" exports a country would have given those characteristics. Deviations of the "potential" exports from the actual could then be used as another measure of a mercantilist motive.

With these in mind, we use a gravity model to estimate bilateral trade and aggregate the predicted trade by country. We extend the gravity dataset in Qureshi and Tsangarides (2010) and regress bilateral trade on a vector consisting of various gravity variables: distance, land border, membership of regional trade agreement, and dummy variables indicating bilateral free trade agreements, historical ties, sharing of a common currency. Specifically, we estimate:

$$\log(X_{ijt}) = a_0 + \sum b_k' W_{ijt} + u_{ijt}$$

where X_{ijt} stands for the value of bilateral exports between countries *i* and *j* at time *t*, W_{ijt} is a vector of *k* gravity variables and u_{ijt} is an error term.

Following the literature, we consider several estimators (pooled OLS, pooled OLS with country effects *à la* Anderson and van Wincoop, panel country-pair fixed effects, and Hausman-Taylor), to examine the robustness of the results. Estimated coefficients are in line with results in the literature, and confirm the importance of the "gravity variables" (including GDP, distance, currency union, other pegged regime, exchange rate volatility, and free-trade area participation) on bilateral trade. Both OLS and country-fixed effects are likely to be biased, so we focus our attention on the country-pair fixed effects and the Hausman-Taylor estimates. While the Hausman-Taylor estimates are able to identify the effect of time-invariant determinants (which drop out with the country-pair fixed effects) and can control for the endogeneity of certain determinants, the estimated coefficients are sometimes sensitive to the choice of instruments.

Using the obtained fitted values for exports we construct estimates of excess exports based on the deviation of the observed level of exports from the predicted level. In particular, we calculate an in-sample export potential index as $PotX_{it} = \frac{ActualX_{it}}{FittedX_{it}}$ where $ActualX_{it}$ are export flows from exporter country to all partner countries, and $FittedX_{it}$ are the fitted export flows generated by the gravity equation. Further, standardized indices (so that the index would take values between [-1,1]) are constructed as $PotX_{it} = \frac{ActualX_{it} - 1}{FittedX_{it} + 1}$ $PotX_{it} = \frac{ActualX_{it} - 1}{FittedX_{it} + 1}$, with a positive index value (0,1] suggesting a higher bilateral effective exports than what the model predicts (and negative values [-1,0) suggest the opposite). We also construct dummy variables for "excess exports" (foe each estimate) where the value of 1 indicates a positive index value and 0 otherwise.

Appendix B
Data and Summary Statistics

Table B1. Countries in the Sample and Variable Definitions and Sources

Countries in the sample

Argentina, Armenia, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, Egypt, El Salvador, Georgia, Guatemala, Hungary, India Indonesia, Jamaica, Jordan, Kazakhstan, Latvia, Lebanon, Lithuania, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Tunisia, Turkey, Ukraine, Uruguay, Venezuela, Vietnam.

Variable definitions and sources

Variable	Description	Source
Log(reserves to GDP)	Natural log of ratio of foreign exchange reserves to USD GDP	IMF, *World Economic Outlook*
Log(per capita income)	Natural log of per capita income (at PPP)	IMF, *World Economic Outlook*
Log(population)	Natural log of population	IMF, *World Economic Outlook*
Log(imports to GDP)	Natural log of ratio of imports to GDP	IMF, *World Economic Outlook*
Volatility of neer	Twelve month standard deviation of end of period nominal effective exchange rate	IMF, *International Financial Statistics* and authors' calculations
Interest rate differential w/ US	$\ln[(1 + i)/(1 + i^{US})]$, where i^{US} is the US interest rate corresponding to the definition used for the national interest rate (deposit, money market, t-bill rate, lending)	IMF, *International Financial Statistics* and authors' calculations
Volatility of exports/GDP (3-year sd)	3 year standard deviation of export to GDP (goods)	IMF, *World Economic Outlook* and authors' calculations
Financial openness	Chinn-Ito index index measuring a country's degree of capital account openness	Chinn and Ito (2009)
Log(broad money to GDP)	Natural log of ratio of M2 to GDP	IMF, *World Economic Outlook*
Peg dummy	Dummy variable equal to 1 if the currency pegged and zero otherwise	Ghosh, Qureshi, and Tsangarides (2011)
Short term debt to GDP	Ratio of total short-term debt outstanding to GDP	IMF, *World Economic Outlook*
Volatility of partner growth (3-year sd)	3 year standard deviation of growth of trading partners' real GDP	IMF, *World Economic Outlook* and authors' calculations
Undervaluation dummy	Dummy variable equal to 1 if the currency is undervalued and zero otherwise	Authors' calculations

Table B2. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Log(reserves to GDP)	-2.33	0.87	-5.42	0.07
Log(per capita income)	8.47	0.74	6.03	9.88
Log(population)	17.01	1.60	14.56	21.01
Log(imports to GDP)	-1.20	0.60	-3.07	0.01
Volatility of neer	13.04	8.15	0.81	45.45
Interest rate differential w/ US	0.13	0.40	-0.12	5.08
Volatility of exports/GDP (3-year sd)	0.02	0.08	0.00	2.54
Financial openness	0.16	1.53	-1.84	2.48
Log(broad money to GDP)	-0.84	0.62	-2.71	1.05
Peg dummy	0.61	0.49	0	1
Short term debt to GDP	0.14	0.17	0.00	1.73
Volatility of partner growth (3-year sd)	1.19	0.93	0.02	6.91
Undervaluation dummy	0.32	0.47	0	1
Excess exports	0.27	0.24	-0.58	0.94