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Kathryn M. E. Dominguez

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Kathryn M. E. Dominguez*
University of Michigan and NBER,
Weill Hall, Ann Arbor, MI 48109, USA

Abstract

International reserve accumulation by developing countries is just one example of the puzzling behavior of international capital flows. Capital should flow to where its return is highest, which ought to be where capital is scarce. Yet recent data suggest the opposite – net capital flows from developing countries to industrialized countries. This paper examines the role of financial market development in the accumulation of international reserves. In countries with underdeveloped capital markets the government's accumulation of reserves may substitute for what would otherwise be private sector capital outflows. Effectively, these governments are acting as financial intermediaries, channeling domestic savings away from local uses and into international capital markets, thereby offsetting the effects of domestic financial constraints that lead to excessive private sector exposure to potential capital shortfalls.

* Author Address: Gerald R. Ford School of Public Policy, University of Michigan, Weill Hall, 735 South State Street, Ann Arbor, MI 48109;
Tel: +1 734 764-9498;
Fax: +1 734 763-9181;
Email address: kathrynd@umich.edu;
URL: <http://www-personal.umich.edu/~kathrynd/index.html>

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Introduction

China's official foreign exchange reserves have passed the two trillion dollar mark, equivalent to approximately \$2000 for every Chinese citizen.¹ Although China is currently the country with the largest foreign reserve accumulation, reserves have risen dramatically for many developing countries in recent years. Economic models suggest a number of motivations for reserve accumulation, including precautionary and mercantilist motives, which may be especially compelling for developing countries. However, the recent upsurge in reserve accumulation among developing countries cannot be explained solely on the basis of these rationales. This paper examines a potential new role for reserve accumulation in helping to mitigate distortions created by the undeveloped financial markets of developing countries.

The growth and liberalization of financial markets in industrial countries over the past three decades provides developing countries unprecedented access to international capital markets, and exposes them to sometimes dramatic and sudden swings in capital flows. The 1990s witnessed a number of economic crises in developing countries that were accompanied by (if not precipitated by) outflows of international capital. This recent experience with capital flow reversals can, at least in part, explain the desire by developing countries to decrease their dependence on international capital by accumulating foreign reserves.

While global financial markets have recently been tumultuous, the trend has been for financial markets in industrial countries to deepen and broaden at the same time that markets in many developing countries remain incomplete. This paper focuses on the

¹ In June 2009 Chinese foreign exchange reserves reached \$2,132 billion.

implications for developing countries of underdeveloped capital markets. In a series of papers, Ricardo Caballero and coauthors have developed models showing that underdeveloped capital markets cause under-valuation of international resources by the private sector, which encourages excessive external borrowing, dollarization of international liabilities, and other actions that increase their exposure to potential capital shortfalls.² One way to mitigate the costs of this exposure is for developing country governments to accumulate international reserves.³

The analysis in the paper considers the role of financial market underdevelopment in motivating reserve accumulation by developing countries, while also allowing for the more traditional mercantilist and precautionary motives. In theory there can be a strict distinction between the precautionary motive, which seeks to smooth consumption fluctuations, and the underdeveloped financial markets motive, which seeks to offset a tightening of a financial constraint. However, in practice, these two motivations for reserve accumulation may be difficult to disentangle. In particular, the desire to smooth intertemporal consumption is likely to be influenced by financial market constraints. Whereas Aiyagari (1994) in a closed economy framework suggests that for the U.S. private sector precautionary savings is likely to be sufficient to relax financial constraints, this is less likely to be the case in developing countries where distortions may bias the private sector against saving, thereby providing incentives for the public sector to step in.

Official foreign exchange reserve holdings by developing countries greatly exceed those of industrial countries (in the case of China, in absolute terms, and in most

² See for example Caballero and Krishnamurthy (2001, 2004, 2005).

³ Caballero and Panageas (2004) suggest that while international reserve accumulation is not the best insurance against sudden stops, in practice many countries seem to rely on reserves for this purpose. See also Summers (2006) and Devereux (2009) for discussions of the reasons for and implications of reserve accumulation by developing countries.

other cases relative to the sizes of their economies). This is yet another example of the capital flows paradox described by Lucas (1990). Capital should flow to where its return is highest, which ought to be where capital is scarce. If instead capital flows from the capital-poor developing world to the capital-rich industrialized world, the explanation is likely to be found in distortions not entertained in standard models.

I. Motives for the Accumulation of International Reserves

International reserves held by government authorities are part of national wealth, and were originally important for countries with fixed exchange rates that wanted to avoid costly adjustments to disturbances in the external sector of the economy. For example, if a country ran a current account deficit, reserves could be used by the government to forestall an exchange rate depreciation that might otherwise occur.

However, in this view of reserves, as a country's level of wealth increases over time, or if a country moves away from a fixed exchange rate regime, it is less clear how much of a share of the national wealth should be devoted to international reserve assets.

Heller (1966) provides one of the first attempts at calculating an optimal country specific level of international reserves based on what he termed the precautionary motive. The three parameters he thought important to this calculation include: (1) the cost of adjusting to an external imbalance (measured as the propensity to import); (2) the cost of holding liquid international reserves (measured as the difference between the return on the reserves relative to a benchmark return on domestic bonds); and (3) the probability that there will actually be a need for reserves of a given magnitude (based on the history of past external imbalances).

In the period following the 1971 break down of the Bretton Woods system, while many industrial countries moved away from fixed exchange rate systems toward more flexible regimes, countries continued to hold reserves despite the disappearance of their original purpose which was to help finance current account imbalances. In practice there seem to have evolved a number of “rules of thumb” to determine optimal reserve levels loosely based on Heller’s precautionary motive. These rules included maintaining reserves equivalent to: (1) three months of imports (to offset current account shocks); (2) 5-20 percent of M2 (to be able to shore up confidence in the value of the domestic currency in the event of a currency crisis); and (3) the value of all debt obligations falling due within the following year (in the event of a sudden disappearance of short-term capital inflows)⁴.

All of these rules of thumb imply a desire on the part of governments to acquire reserves to serve as a cushion against adverse economic shocks of one form or another, and as such can be categorized as satisfying Heller’s precautionary motive. Frenkel and Jovanovic (1981) provide a more formal approach to modeling the precautionary motive for holding reserves using a stochastic inventory-theoretic framework. Their model indicates that optimal reserve holdings increase with the volatility of reserves (which are presumably influenced by current account shocks, the value of the domestic currency, and capital inflows) subject to a fixed cost of reserve accumulation and the opportunity cost of holding reserves. Ben-Bassat and Gottlieb (1992) follow in this buffer stock modeling tradition while also linking international reserves with sovereign risk.⁵

⁴ This is often referred to as the “Greenspan-Guidotti rule”.

⁵ Durdu, Mendoza and Terrones (2009) show that emerging markets that face large external shocks have an incentive to hold reserves even when households and firms can smooth domestic income fluctuations. Alfaro and Kanczuk (2009) consider the joint decision to accumulate reserves and issue sovereign debt. In

An alternative view of reserve accumulation is that it is the byproduct of a government strategy to keep the international value of the domestic currency low in order to boost export growth. In this view purchases of foreign reserves are not motivated by a desire to smooth consumption in the face of external shocks, but rather they are the unintended consequence of sterilized interventions in the foreign exchange market.⁶ This rationale for reserve accumulation, typically labeled the mercantilist motive, has been advanced by Dooley, Folkerts-Landau and Garber (2003) as a description of the development strategy followed by many East Asian countries, particularly China.

There have been a number of recent empirical studies attempting to measure whether the precautionary or mercantilist motive better explains foreign reserve accumulations by both industrialized and developing countries. These studies generally find evidence in support of both motivations (see, for example, Aizenman and Lee (2007)), while at the same time finding that neither motivation fully explains the recent upsurge in reserve accumulations by developing countries (Jeanne (2007) and Jeanne and Ranciere (2007)). As Figure 1 indicates, any theory of official reserve accumulation that hopes to explain the recent data will need to match the timing of the dramatic increase in reserve accumulations by developing countries over the 1990s and early 2000s. Even if we allow for an increase in precautionary holdings in the aftermath of the developing

the context of a stochastic dynamic equilibrium model they find that optimal policy is not to hold reserves at all (since reserves can be used to pay down the debt). Of course, in practice countries generally both issue debt and hold reserves.

⁶ There is a large literature exploring the efficacy of sterilized intervention policy (see for example, Dominguez and Frankel (1993b) and Fatum and Hutchison (2003)). In the traditional portfolio balance model sterilized intervention can only be effective if domestic and foreign assets are imperfect substitutes and Ricardian equivalence does not hold. Dominguez and Frankel (1993a) and Dominguez (2003) provide empirical evidence suggesting that sterilized interventions by industrial countries have, at times, effectively influenced currency values. The efficacy of sterilized intervention policies in developing countries has been less widely studied, in large part because governments have been reluctant to provide detailed data on their operations. Reinhart and Reinhart (2009) document the extent to which the accumulation of foreign exchange reserves has been sterilized by developing countries since 1990.

country crises of the 1990s, studies suggest that current reserve accumulations far exceed warranted levels (Jeanne (2007)).⁷

Table 1 presents data from the financial accounts of industrialized and developing countries over the period 1990 through 2004. For developing countries over 40 percent of foreign asset accumulation consists of official reserves, while for industrialized countries official reserves make up only 2 percent of gross foreign assets. Figure 2 provides a time series view of the decomposition of foreign assets for developing countries over time. The figure highlights the increasing relative importance of official reserve accumulation for developing countries especially since 2000. On the liability side, developing countries rely much more heavily on foreign direct investment (FDI) than do the industrialized countries.⁸ Figure 3 depicts official reserves as a fraction of net FDI liabilities, in which the recent dramatic upsurge in reserves evident in Figure 1 for developing countries (where reserves are measured as a fraction of GDP), is no longer apparent. Hence if one views reserves in the context of private sector (FDI) liabilities, the trend patterns of reserve accumulation across industrial and developing countries are no longer so starkly divergent.

Underlying most standard models of economic growth is the assumption that investment leads to capital accumulation, which in turn, leads to higher levels of production. It is therefore instructive to consider how measures of capital flows (as shown in the cross-country financial accounts reported in Table 1) are related to aggregate investment rates. Chen (2007) shows that higher investment rates are

⁷ A notable exception is a recent study by Obstfeld, Shambaugh and Taylor (2008) which suggests that if reserve adequacy is gauged against the size of the banking sector the recent reserves accumulation in emerging markets is less puzzling.

⁸ Developing countries seem to be increasingly making direct investments into industrial countries, providing yet another example of the capital flow paradox, see Chari, Chen and Dominguez (2009).

associated with *lower* net capital inflows for developing countries. Further, the component of capital flows that is driving this counter intuitive result is official foreign reserves. Figure 4 presents a cross-country scatter plot of investment rates and reserve holdings showing a significant positive relationship for developing countries. A similar scatter plot for industrialized countries shows no relationship between investment and reserves.

The negative relationship between rates of investment and capital inflows for developing countries most likely reflects credit constraints. The pace of financial market development, like reserve accumulation, has diverged markedly between industrialized countries, where markets have generally deepened and broadened, and developing countries, where this deepening has yet to take place. It seems reasonable to hypothesize that in countries with underdeveloped capital markets the private sector faces constraints on its ability to borrow. In this situation the government's accumulation of reserves may act as a substitute for what would otherwise be private sector capital outflows. The next section presents a simple model to help clarify the role of reserve accumulation in loosening financial constraints for countries with less developed financial markets.

II. A Simple Model of Private Sector External Underinsurance

It is useful to start with a simple example to highlight the problem of underinsurance by the private sector in developing countries. Consider an economy over three periods with a single consumption good. In period zero firms make initial investments, in period one some firms need to re-invest as part of the normal restructuring of an economy, and in period two the output is produced.

In period one the firms that need to make additional investments will be able to produce less than otherwise, though with full re-investment all firms produce the same output. Those firms that need to re-invest finance this by borrowing, and must provide their creditors with collateral. If we make the realistic assumption that domestic lenders allow some fraction of domestic plant and equipment to serve as collateral, whereas foreign lenders do not, collateral is limited in an asymmetric way; firms will have less access to foreign lenders than they do to domestic lenders. In this simple setup the supply of loans can be assumed to be elastic where the domestic and foreign interest rate are equalized, up to the point that firms borrow the maximum available from foreigners and beyond this point the supply of loans is completely inelastic.⁹ The domestic interest rate in period one lies above the foreign interest rate, as a consequence of the more binding collateral constraint on foreign borrowing, and below the marginal product of full re-investment.

If firms know that they may be financially constrained in period one, they should optimally borrow less in period zero in order to save resources. Yet the model suggests that firms will not insure themselves against this potential financing constraint. Why not? The problem is that the return to savings in period zero does not reflect the true marginal product of financing in period one because of the distortions caused by collateral constraints. In equilibrium external financing is under-valued, and as a consequence firms will be underinsured against potential capital shortfalls.

There are a number of possible solutions to the underinsurance problem, at least in theory. The key is to find a way to bring the ex post price of international resources in

⁹ Loans are always worth it from the standpoint of the borrower because of the high return to reinvestment (the investment function is assumed to be strictly increasing, positive and convex).

line with the marginal product of re-investment. One such solution is reserve accumulation by the government. In this case, governments purchase international bonds and sterilize the effects of this purchase on the home money supply by issuing domestic bonds. If the interest rate offered on these domestic bonds in period zero is higher than the period one domestic interest rate, the government is essentially subsidizing savings in period zero, which is exactly what is needed to mitigate the underinsurance problem.

III. Empirical Evidence Connecting Reserve Accumulation, Private Sector Underinsurance and Financial Market Underdevelopment

This simple model provides two important predictions for reserve accumulating countries. The first implication is that these countries will exhibit private sector underinsurance against future capital shortfalls. The second implication is that there will be a wedge between the collateral value of domestic projects in the home country and international valuations of the same projects. In practice, while cross-country data on private and public sector external debt is available, data measuring the “collateral wedge” are not. There is, however, a large literature focused on the measurement of financial market development which is likely to be directly related to collateral constraints (see, for example, Beck, Demirgüç-Kunt and Levine, 2000). This literature provides a number of suggested measures of financial market (under)development including: financial openness (Chinn and Ito, 2006), money and quasi-money supply as a percentage of GDP (Lane and Burke, 2001 and Obstfeld et. al., 2008), and the sum of private credit creation and stock market capitalization (Ito and Chinn, 2008). Another measure of financial market development is the extent of external liabilities, based on the assumption that countries with less developed domestic financial markets also have fewer external

liabilities. Figure 5 shows one such measure of financial development (*fin_dev1*) that sums foreign portfolio equity and debt liabilities divided by GDP for industrialized and developing countries over the period 1977 through 2004.¹⁰ The figure shows that while this measure of financial markets has increased steadily in the industrialized countries, the growth rate of financial markets has been substantially slower for developing countries. It is also the case that the divergence in growth rates between the two groups of countries widens at around the same time as reserve accumulation by developing countries starts to accelerate.

An alternative measure of financial market development (*fin_dev2*) focuses on the size of domestic financial markets. Figure 6, which measures financial development as the sum of a country's domestic private credit creation and stock market capitalization as a ratio of GDP, shows again the widening divergence between industrialized and developing countries in the late 1990s. Interestingly, this measure of domestic financial market size rises for industrialized countries (and to some extent developing countries) earlier than is apparent in figure 5, which is based on external rather than domestic liabilities.

Yet another measure of financial markets, focused more narrowly on the banking sector, is the ratio of money and quasi-money to GDP. Obstfeld, Shambaugh and Taylor (2008) make the case that the primary reason for reserve accumulation is to protect the domestic banking sector during periods of capital flight. In their view financial development *increases* the need for reserves because it allows domestic residents to convert domestic bank deposits into foreign exchange, leading to both a run on the

¹⁰ This measure of financial market development is *not* the “international financial integration” measure used in Lane and Milesi-Ferretti (2007), which is the sum of foreign assets (which includes reserve assets) and liabilities over GDP.

banking system and a depreciation of the domestic currency. Figure 7 depicts the ratio of M2 to GDP for industrialized and developing countries, which shows a steady upward trend for developing countries over this time period.

Financial market development need not only be measured in terms of the size of markets or deposits, presumably the quality of institutions within a country will also influence the depth and breath of markets. Cheung and Ito (2009) focus on the relationship between a number of country specific institutional variables (corruption, bureaucratic quality, law and order, form of government, government fractionalization) and reserve accumulation and find weak evidence for their importance. One potential explanation is that many of these indicators do not change, or change only infrequently in some countries. In the empirical work to follow country fixed effects are included to capture these time invariant institutional differences.

In the empirical literature that attempts to estimate reserve holdings for panels of countries based on mercantilist and precautionary motives¹¹ the standard regression specification includes: scale factors (GDP), an indicator of exchange rate flexibility, indicators of openness and vulnerability to external shocks, the share of imports in GDP, and the ratio of M2 to GDP.¹² The first column of Table 2 presents the results of a panel

¹¹ See, for example, Aizenman and Marion (2003). Machlup (1966) argued that the behavior of governments toward reserve accumulation was very much like that of his wife with regard to her wardrobe: no matter how many dresses she possessed, she added to her stock of them each year. “Mrs. Machlup’s Wardrobe theory” involves including lagged values of reserves in the specification. Lagged reserves are generally not found to be statistically significant in any of the specifications estimated in this paper.

¹² Previous studies have also included a number of different measures of the cost of holding reserves (generally an interest rate on foreign assets relative to a domestic benchmark). Rodrik (2006) estimates that the cost of holding reserves is close to 1% of GDP for all developing countries, however, this variable is never found to be statistically or economically important in explaining reserve accumulations.

regression that includes 56 (industrialized and developing¹³) countries over the 1977 to 2004 time period using this standard specification:

$$R_{it} = \alpha_0 + \alpha_1 GDP_{it} + \alpha_2 ExRate_{it} + \alpha_3 CC_{it} + \alpha_4 Crisis_{it} + \alpha_5 CurOver_{it} + \alpha_6 ShImp_{it} + \alpha_7 ShM2_{it} + \varepsilon_{it}$$

where R is holdings of foreign reserves valued in logged millions of US dollars (from Lane and Milesi-Ferretti, 2007), $ExRate$ is an exchange rate classification based on the Reinhart and Rogoff (2004) defacto regimes, CC measures financial account openness (capital controls) based on Chinn and Ito's (2006) classifications, $Crisis$ indicates the dates of currency crisis as defined by Frankel and Rose (1996), $CurOver$ indicates currency-overvaluation relative to PPP, $ShImp$ is the share of imports of goods and services in GDP, and $ShM2$ is the ratio of M2 to GDP. The panel estimation includes country fixed effects (so that coefficients are estimated from the time-series variation within countries).

The results from this standard regression specification suggest that the various explanatory variables enter with the expected signs. Wealthier countries hold more reserves than do poorer countries. Countries that have more open capital markets (potentially making them more vulnerable to sudden stops) hold more reserves. The indicator of currency crises suggests, as expected, that those countries experiencing crises held fewer reserves during their crises. Those countries whose exchange rate is “undervalued” relative to PPP, who have higher shares of imports relative to GDP, and who have higher ratios of M2 to GDP, hold more reserves.

¹³ Data constraints limit the sample of countries included in the empirical work. In particular, none of the poorest countries are in the sample. One plausible implication from the simple model in section 2 is that very poor countries that are completely closed to international flows have no incentive to hold foreign reserves. This implication is unfortunately not testable with the available data.

The next two columns in Table 2 include additional variables suggested by the potential role of underdeveloped financial markets in explaining reserve accumulation by developing countries. One issue that arises in this context is how to distinguish proxies for the precautionary motive (the *CC*, *Crisis* and *ShM2* variables) from those that reflect financial market underdevelopment. The precautionary motive for holding reserves stems from the desire to smooth consumption distortions intertemporally in the face of sudden reversals of international capital inflows. Of course, it may well be that those countries most likely to face sudden stops (or capital flight) are also countries that have underdeveloped financial markets¹⁴, potentially making it difficult to separate these two motives for reserve accumulation. The objective here is not to attempt to allocate weights across the different motives for reserve accumulations, but rather to expand the set of explanatory variables in the empirical specification to incorporate the insights provided by the under-insurance view, and in so doing test whether one can more readily explain the most recent upsurge in reserve accumulation.

An important feature of the simple model presented earlier is its emphasis on the role of public sector reserve accumulation as a solution to the private sector external underinsurance problem. One way to capture this interaction between the private and public sectors is to test whether reserves are influenced differently by private and public liabilities. The regression reported in column two of Table 2 includes measures of public and private liabilities as explanatory variables. As the model predicts, countries with

¹⁴ Martin and Rey (2006) intriguingly show that financial globalization in emerging markets may inherently lead to self-fulfilling financial crashes and further market incompleteness.

higher levels of private sector liabilities hold greater reserves, while countries with higher levels of public sector liabilities¹⁵ hold fewer reserves.

Column three and four of Table 2 include the two alternative measures of financial market development, the first based on the size of external liabilities and the second based on the size of domestic liabilities. Recall that the model predicts that countries with less developed financial markets are likely to hold greater reserves. This prediction is confirmed in both sets of regression results, in that the sign of the financial market development indicator is negative and highly statistically significant. Three points are worth noting from these results: (1) the size and significance of the standard precautionary and mercantilist variables are little changed by the inclusion of the financial development measure, (2) both measures of financial market development (based on external and domestic liabilities) yield similar results (the measure based on the size of domestic markets is not available for China and for a number of other countries over certain years so that the sample size is substantially smaller in this specification)¹⁶, (3) the prediction from the Obstfeld, Stambaugh and Taylor (2008) model that financial development *increases* the need for reserves is not borne out in these regressions. While I find, as they do, that the share of M2 to GDP is economically and statistically significant in explaining reserve accumulation, increased financial development in these

¹⁵ The predicted sign on public liabilities is less clear cut than is the case for private liabilities. If governments fully sterilize reserve accumulations, this will result in higher public debt and a positive correlation with reserves. Excluding public liabilities in all relevant regression specifications has no qualitative effects on the other included variables, these results are not reported but are available upon request.

¹⁶ In some developing countries governments, rather than the private sector, play a large role in financial intermediation, for example by providing credit through state-owned institutions. In order to take this into account, one can use estimates from La Porta et al (2002) of the ratios of government ownership of banks to adjust the private credit creation component of *fin_dev2*. Estimates using this adjusted financial development measure (*fin_dev3*) did not significantly differ from those reported using the unadjusted measure. These results are available upon request.

regressions *decreases* reserve accumulation.¹⁷ These results provide suggestive empirical support for the hypothesis that official reserve accumulation may, at least in part, be working to loosen the financial constraints faced by developing countries with underdeveloped financial markets.

While some of the empirical specifications presented in Table 2 are fairly standard in the literature, two issues are worth noting. First, a number of the explanatory variables included in the various regression specifications are likely to be correlated. For example, wealthier countries are more likely to have open capital markets, high levels of liabilities, and highly developed financial markets. Table 3 presents cross-correlations across a number of the key variables used in the regressions which were found to have relatively high correlations (variables with low cross-correlations are not included in the table). The highest (positive) correlation is found between public and private external liabilities, followed by the correlations of public and private liabilities and GDP (indicating, unsurprisingly, that it is the wealthier countries that are doing most of the borrowing). The domestic financial development measure (*fin_dev2*) is also highly (positively) correlated with the share of M2 in GDP. The finding that many of the “controls” in the regression, variables capturing the precautionary and mercantilist motives, are correlated with the measures of financial development, biases against the finding of an additional financial markets motive. In order to take account of possible multicollinearity (and interaction effects) among the explanatory variables, the various specifications in table 2 were re-run dropping individual variables one at a time. The results presented in table 2 were found to be robust to these exclusions.

¹⁷ One possible explanation for this is that the Obstfeld, Stambaugh and Taylor paper is more focused on explaining cross-country (between) differences in reserve accumulation, while the inclusion of country fixed effects in this paper puts the focus on time-series (within country) variation.

A second issue that arises in these sorts of tests is endogeneity bias. Our tests examine whether various motivations (precautionary, mercantilist and financial underdevelopment) lead countries to accumulate foreign reserves. Causality may, however, go the other way. It may be that countries with high levels of foreign reserves, are more likely to, for example, maintain a fixed exchange rate, be the subject of a currency crisis, or be less concerned about developing domestic financial markets. Or, it may be that whatever drives countries to accumulate reserves also leads them to certain exchange rate, capital control and financial market regimes. One possible candidate for this underlying motivation is national legal origin. La Porta et. al. (1998) show that legal origin (English, French, German or Scandinavian) helps to explain cross-country differences in financial development, providing a plausible instrumental variable for our analysis. The estimation results using dummies for the national legal origin as instruments yielded qualitatively similar results to those presented in table 2, suggesting that endogeneity, at least between reserves and the financial development variables, is not a concern.¹⁸

Tables 4 and 5 provide two additional sets of robustness tests. Table 4 presents results for the final specifications in table 2, including year fixed effects (and omitting country fixed effects). The year effects are statistically significant, but again the coefficient estimates on the financial development measures do not change much from those reported in table 2. Interestingly, in these “between” regressions the capital controls variable is positive and highly significant (suggesting that countries with more

¹⁸ Another approach, taken by Cheung and Ito (2009) and Ito and Chinn (2008), is to use period averages rather than annual data to avoid time dependent endogeneity. Ito and Chinn (2008) also instrument for financial development with the legal origin dummies in their panel regressions explaining current account balances, national saving and investment.

controls accumulate higher reserves). Unsurprisingly the year-fixed effects sweep out the crisis dummy. Finally, Table 5 pools the various countries into seven regionally based groups. These robustness checks confirm the basic results presented in table 2, reserve accumulating countries have higher private liabilities and less developed financial markets.

IV. Conclusions

Economists have long studied the question of optimal reserve holdings by governments. In the days when most countries were part of a fixed exchange rate system, reserves allowed countries to avoid costly adjustments to disturbances to external sectors of their economies. More recently, even as many countries allow their exchange rates more flexibility, reserves continue to be held for both precautionary and (possibly) mercantilist motives. This paper provides another rationale for reserve accumulation based on the distortions that arise in countries with underdeveloped financial markets.

Data from the financial accounts of industrial and developing countries indicate that reserve accumulations by developing countries have increased markedly in the past decade. Further, developing countries with high levels of investment receive lower, rather than higher, net capital inflows. The component of the financial account that is driving this counter intuitive relationship is official foreign reserves. This is puzzling, in that standard economic models suggest that capital should flow from rich to poor countries.

The negative relationship between rates of investment and capital inflows among developing countries is likely to reflect credit constraints. While financial markets in industrial countries have deepened and broadened, financial markets in many developing

countries have not kept pace. In this context, incentives for firms in countries with less developed financial markets may be distorted leading to under-insurance against future credit constraints. Sterilized reserve accumulation by governments results in a subsidy to the private sector, inducing it to save (through purchases of government bonds) as a way of insuring against future financing constraints.

The simple model presented in the paper provides two important empirical predictions for reserve accumulating countries. They are first, that the private sectors of these countries will underinsure against capital shortfalls, and second, that their financial markets will be relatively underdeveloped. Proxies for both these characteristics explain reserve holdings for 56 industrialized and developing countries over the period 1977-2004. Hence, it appears that the accumulation of foreign reserves by governments of developing countries may represent sensible responses to prevailing economic conditions.

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Data Appendix

I. Developing countries included in the panel estimates

COUNTRY	IFS_code
Argentina	213
Brazil	223
Chile	228
China	924
Colombia	233
Czech Republic	935
Egypt	469
Estonia	939
Hong Kong	532
Hungary	944
India	534
Indonesia	536
Israel	436
Latvia	941
Lithuania	946
Malaysia	548
Mexico	273
Pakistan	564
Peru	293
Philippines	566
Poland	964
Russia	922
Saudi Arabia	456
Singapore	576
Slovak Republic	936
Slovenia	961
South Africa	199
South Korea	542
Taiwan	528
Thailand	578
Turkey	186
Venezuela	299

II. Industrial Countries included in the panel estimates

COUNTRY	IFS_code
Australia	193
Austria	122
Belgium	124
Canada	156
Denmark	128
Euro Area	163
Finland	172
France	132
Germany	134
Greece	174
Iceland	176
Ireland	178
Italy	136
Japan	158
Luxembourg	137
Netherlands	138
New Zealand	196
Norway	142
Portugal	182
Spain	184
Sweden	144
Switzerland	146
United Kingdom	112
United States	111

III. Panel Estimation Variable Definitions (unless otherwise noted data are available for all 56 countries from 1977-2004).

Capital Controls (*CC*): the Chinn and Ito (2006) capital controls index (*kaopen*), inverted so higher number indicates more binding controls. Mean zero, min=-2.6025, max=1.767.

Excludes: Luxembourg; Netherlands, 1977-1980; Switzerland, 1977-1995; Taiwan; Russia, 1977-1997; China, 1979-1983; Czech Republic, 1977-1997; Slovak Republic, 1977-1997; Estonia, 1977-1997; Latvia, 1977-1997; Hungary, 1977-1997; Lithuania, 1977-1997; Slovenia, 1977-1997; Poland, 1977-1997 and 1992-1997

Crisis Dummy (*Crisis*): based on the Frankel and Rose (1996) definition of a “crisis”: a nominal depreciation of the currency of at least 25 percent relative to the previous year that is also at least a 10 percent acceleration, year over year, in the rate of depreciation.

Currency Overvaluation (*CurOver*): measure of currency overvaluation based on the PPP spot exchange rate.

Excludes: Taiwan; Korea; Russia, 1977-1992; Czech Republic, 1977-1992; Slovak Republic, 1977-1992; Estonia, 1977-1992; Latvia, 1977-1991; Lithuania, 1977-1991; Slovenia, 1977-1990; Poland, 1977-1989

Exchange Rate Regime (*ExRate*): based on the Reinhart and Rogoff (2004) de-facto exchange rate regime classifications until 2001, updated by the author.

Excludes: Russia, 1977-1991; Czech Republic, 1977-1989; Slovak Republic, 1977-1992; Estonia, 1977-1990; Latvia, 1977-1990; Lithuania, 1977-1990; Slovenia, 1977-1990; Poland, 1977-1987

Financial Market Development Index (*Fin_dev1*): external portfolio equity liabilities + total debt liabilities over GDP from Lane and Milesi-Ferretti (2007).

Excludes: Luxembourg, 1977-1999; Greece, 1977-1985; Peru, 1977-1989; Hong Kong, 1977-1978; Russia, 1977-1992; China, 1977-1980; Czech Republic, 1977-1992; Slovak Republic, 1977-1992; Estonia, 1977-1992; Latvia, 1977-1991; Hungary, 1977-1983; Lithuania, 1977-1992; Slovenia, 1977-1991

(Alternative) Financial Market Development Index (*Fin_dev2*): private credit creation + stock market capitalization over GDP, as defined in Ito and Chinn (2008); data from the World Bank’s database on financial development and structure (original source: Beck, Demirgüç-Kunt and Levine, 2000)

Excludes: United States, 1977-1988; United Kingdom, 197-1988; Austria, 1977-1988, 1998-1999; Belgium, 1977-1988, 1998-1999; Denmark, 1977-1988; France, 1977-1988, 1998-1999; Germany, 1977-1988, 1990-1991; Italy, 1977-1988; Luxembourg, 1977-1988, 1993-1994, 1998-1999; Netherlands, 1977-1988; Norway, 1977-1988; Sweden, 1977-1988; Switzerland, 1977-1988; Iceland, 1977-1994; Ireland, 1977-1995; Portugal, 1977; Spain, 1977-1988; Turkey, 1977-1980, 1985-1986; Australia, 1977-1988; New Zealand, 1977-1988; South Africa, 1977-1988; Argentina, 1977-1987; Brazil, 1977-1991; Chile, 1977-1978;

Colombia, 1986-1987, 1989-1990; Mexico, 1977; Peru, 1977-1989; Venezuela, 1977, 1984-1985; Israel, 1977-1988; Saudi Arabia, 1977-1991; Egypt, 1977-1988; Taiwan; Hong Kong, 1977-1990; India, 1978-1979; Indonesia, 1977-1980; Malaysia, 1977; Singapore, 1977-1980; Russia, 1977-1993; China; Czech Republic, 1977-1994; Slovak Republic, 1977-1994; Estonia, 1977-1997; Latvia, 1977-1995; Hungary, 1977-1991; Lithuania, 1977-1995; Slovenia, 1977-1994; Poland, 1977-1991

(Adjusted Alternative) Financial Market Development Index (*Fin_dev3*): private credit creation adjusted by a proxy for the involvement of the government in the creation of private credit + stock market capitalization over GDP, as defined in Ito and Chinn (2008); data from the World Bank's database on financial development and structure (original source: Beck, Demirgüç-Kunt and Levine, 2000)

Excludes: same observations as listed for *Fin_dev2*

GDP: nominal *GDP* in millions of USD from Lane and Milesi-Ferretti (2007)

Excludes: Czech Republic, 1977-1991; Estonia, 1977-1992; Latvia, 1977-1991

Imports (*ShImp*): share of imports in GDP, World Development Indicators

Excludes: Taiwan; Korea; Singapore, 2000-2004; Russia, 1977-1988; Czech Republic, 1977-1989; Slovak Republic, 1977-1986; Estonia, 1977-1991; Latvia, 1977-1989; Lithuania, 1977-1989; Slovenia, 1977-1989; Poland, 1977-1989

M2/gdp: ratio of M2 money supply to GDP; main source: WDI; missing data filled in using the IFS database

Excludes: United Kingdom; Austria, 1977-1979, 1998-2004; Belgium, 1977-1979, 1998-2004; France, 1977-1979, 1998-2004; Germany, 1977-1979, 1999-2004; Italy, 1977-1979, 1999-2004; Luxembourg; Netherlands, 1977-1979, 1998-2004; Greece, 1977-1979, 2001-2004; Ireland, 1977-1981, 1999-2004; Portugal, 1977-1979, 1999-2004; Spain; Colombia, 1986-1987, 1989-1990; Taiwan; Hong Kong, 1977-1991; Russia, 1977-1993; China, 1977; Czech Republic, 1977-1993; Slovak Republic, 1977-1993; Estonia, 1977-1991; Latvia, 1977-1993; Hungary, 1977-1982; Lithuania, 1977-1993; Slovenia, 1977-1991; Poland, 1977-1984

Private Liabilities: total foreign liabilities of private (bank and non-bank) borrowers from BIS Consolidated Banking Statistics

Excludes: United States, 1977-1998; United Kingdom, 1977-1998; Austria, 1977-1998; Belgium, 1977-1998; Denmark, 1977-1998; France, 1977-1998; Germany, 1977-1998; Italy, 1977-1998; Luxembourg, 1977-1998; Netherlands, 1977-1998; Norway, 1977-1998; Sweden, 1977-1998; Switzerland, 1977-1998; Canada, 1977-1998; Japan, 1977-1998; Finland, 1977-1998; Greece, 1977-1982; Iceland, 1977-1998; Ireland, 1977-1998; Portugal, 1977-1982; Spain, 1977-1998; Turkey, 1977-1982; Australia, 1977-1982; New Zealand, 1977-1982; South Africa, 1977-1982; Argentina, 1977-1982; Brazil, 1977-1982; Chile, 1977-1982; Colombia, 1977-1982; Mexico, 1977-1982; Peru, 1977-1982; Venezuela, 1977-1982; Israel, 1977-1982; Saudi Arabia, 1977-1982; Egypt, 1977-1982; Taiwan, 1977-1982;

Hong Kong, 1977-1982; India, 1977-1982; Indonesia, 1977-1982; Korea, 1977-1982; Malaysia, 1977-1982; Pakistan, 1977-1984; Philippines, 1977-1982; Singapore, 1977-1982; Thailand, 1977-1982; Russia, 1977-1992; China, 1977-1982; Czech Republic, 1977-1992; Slovak Republic, 1977-1992; Estonia, 1977-1995; Latvia, 1977-1994; Hungary, 1977-1982; Lithuania, 1977-1992 and 1994-1995; Slovenia, 1977-1992; Poland, 1977-1982

Public Liabilities: total foreign liabilities of public borrowers from BIS Consolidated Banking Statistics

Excludes: United States, 1977-1998; United Kingdom, 1977-1998; Austria, 1977-1998; Belgium, 1977-1998; Denmark, 1977-1998; France, 1977-1998; Germany, 1977-1998; Italy, 1977-1998; Luxembourg, 1977-1998; Netherlands, 1977-1998; Norway, 1977-1998; Sweden, 1977-1998; Switzerland, 1977-1998; Canada, 1977-1998; Japan, 1977-1998; Finland, 1977-1998; Greece, 1977-1982; Iceland, 1977-1998; Ireland, 1977-1998; Portugal, 1977-1982; Spain, 1977-1998; Turkey, 1977-1982; Australia, 1977-1982; New Zealand, 1977-1982; South Africa, 1977-1982; Argentina, 1977-1982; Brazil, 1977-1982; Chile, 1977-1982; Colombia, 1977-1982; Mexico, 1977-1982; Peru, 1977-1982; Venezuela, 1977-1982; Israel, 1977-1982; Saudi Arabia, 1977-1982; Egypt, 1977-1982; Taiwan, 1977-1982; Hong Kong, 1977-1982; India, 1977-1982; Indonesia, 1977-1982; Korea, 1977-1982; Malaysia, 1977-1982; Pakistan, 1977-1984; Philippines, 1977-1982; Singapore, 1977-1982; Thailand, 1977-1982; Russia, 1977-1992; China, 1977-1982; Czech Republic, 1977-1992; Slovak Republic, 1977-1992; Estonia, 1977-1995; Latvia, 1977-1994; Hungary, 1977-1982; Lithuania, 1977-1992 and 1994-1995; Slovenia, 1977-1992; Poland, 1977-1982

Private/Public Liabilities_loc: private and public (public sector and non-bank private sector) liabilities from the BIS Locational bank statistics data

Excludes: Luxembourg, 1977-1982; Taiwan; Russia, 1977-1992; Czech Republic, 1977-1992; Slovak Republic, 1977-1992; Estonia, 1977-1992; Latvia, 1977-1992; Lithuania, 1977-1992; Slovenia, 1977-1992

Reserves: total foreign reserves from Lane and Milesi-Ferretti (2007)

Excludes: Luxembourg, 1977-1983, 1998; Russia, 1977-1992; Czech Republic, 1977-1992; Slovak Republic, 1977-1992; Estonia, 1977-1991; Latvia, 1977-1991; Hungary, 1977-1981; Lithuania, 1977-1991; Slovenia, 1977-1990

IV. Country Groups used in Pooled regressions

1. East Asia and Pacific
2. Europe and Central Asia
3. Latin America and Caribbean
4. Middle East and North Africa
5. South Asia
6. Sub-Saharan Africa
7. North America

1. East Asia and Pacific

- China
- Indonesia
- Korea
- Malaysia
- Philippines
- Thailand
- Japan
- Australia
- New Zealand
- Taiwan
- Hong Kong
- Singapore

2. Europe and Central Asia

- Latvia
- Lithuania
- Poland
- Russia
- United Kingdom
- Austria
- Belgium
- Denmark
- France
- Germany
- Italy
- Luxembourg
- Netherlands
- Norway
- Sweden
- Switzerland
- Finland
- Greece
- Iceland

- Portugal
- Spain
- Czech Republic
- Slovak
- Estonia
- Hungary
- Slovenia

3. Latin America and Caribbean

- Argentina
- Brazil
- Chile
- Columbia
- Mexico
- Peru
- Venezuela

4. Middle East and North Africa

- Egypt
- Turkey
- Israel
- Saudi Arabia

5. South Asia

- India
- Pakistan

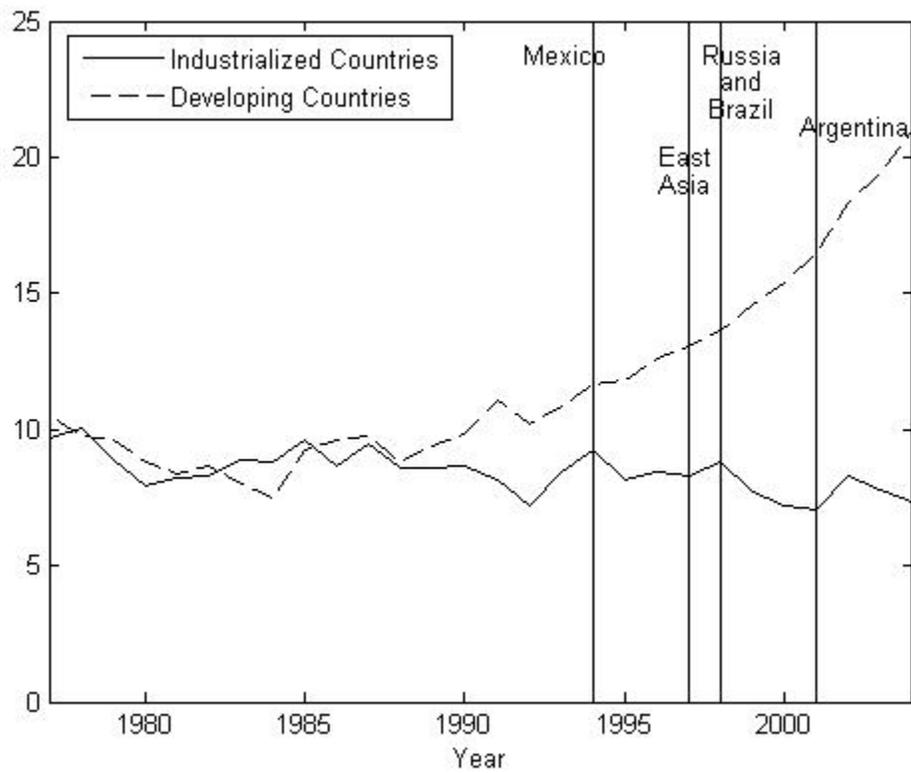
6. Sub-Saharan Africa

- South Africa

7. North America

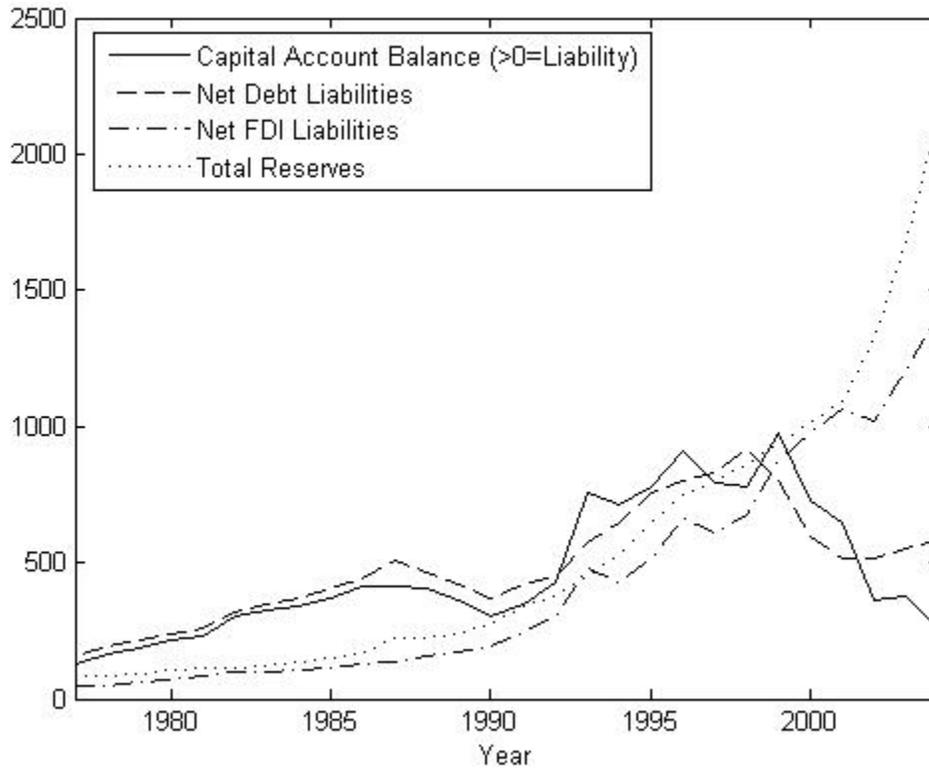
- Canada
- United States

Figure 1
Foreign Reserves as a Percent of GDP, 1977-2004



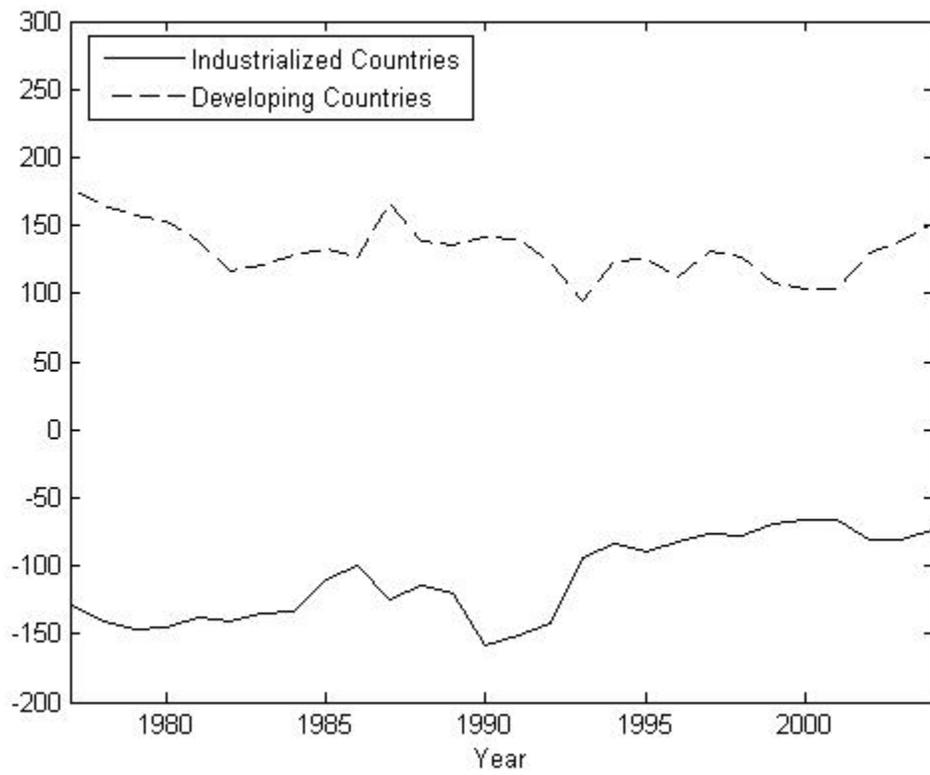
Source: Lane and Milesi-Ferretti (2007) external wealth of nations database.

Figure 2
Foreign Reserves and Net Liabilities for Developing Countries, 1977-2004
(Billions of US dollars)



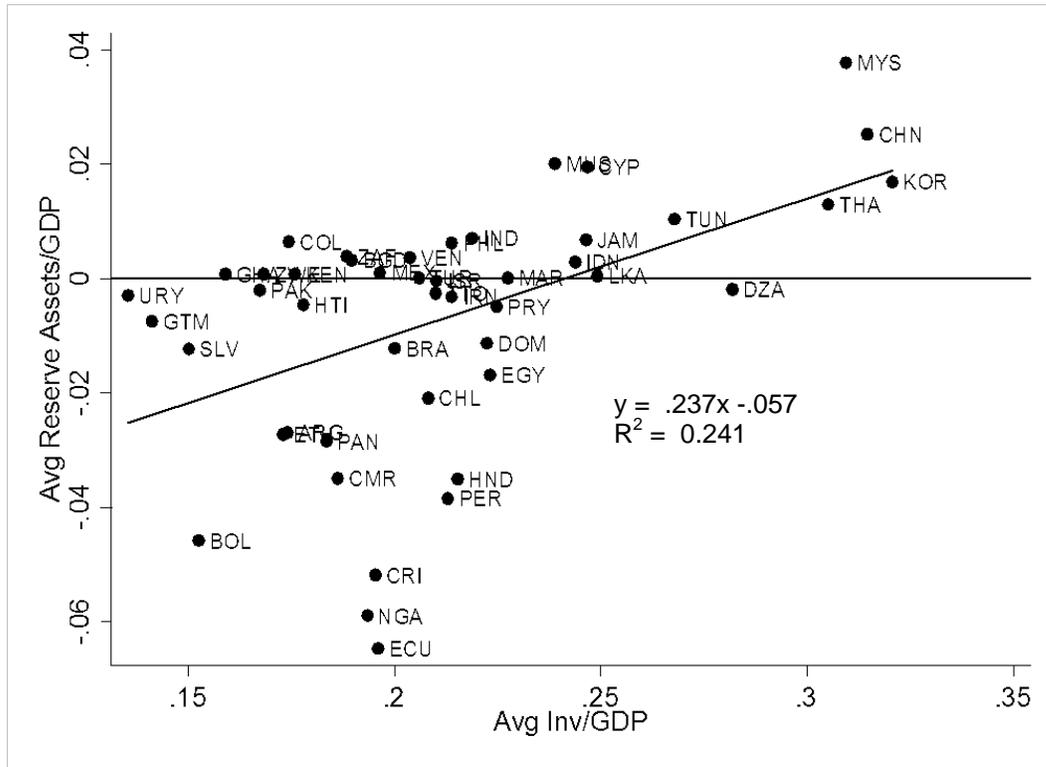
Source: Lane and Milesi-Ferretti (2007) external wealth of nations database.

Figure 3
Foreign Reserves as a Share of Net FDI Liabilities, 1977-2004



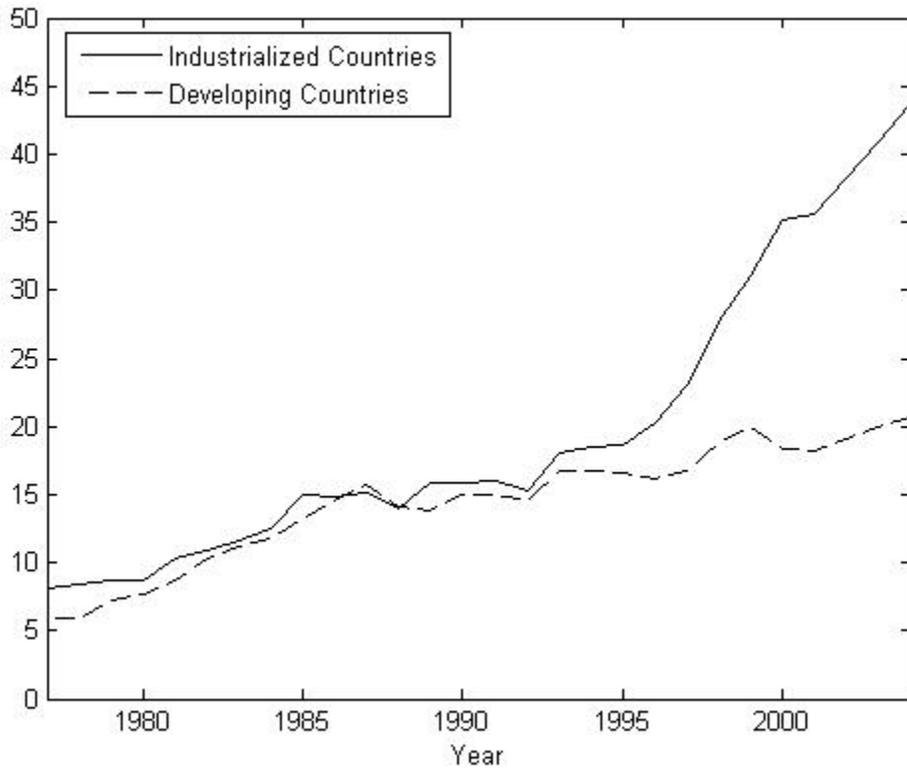
Source: Lane and Milesi-Ferretti (2007) external wealth of nations database.

Figure 4
Investment and Foreign Reserves for Developing Countries



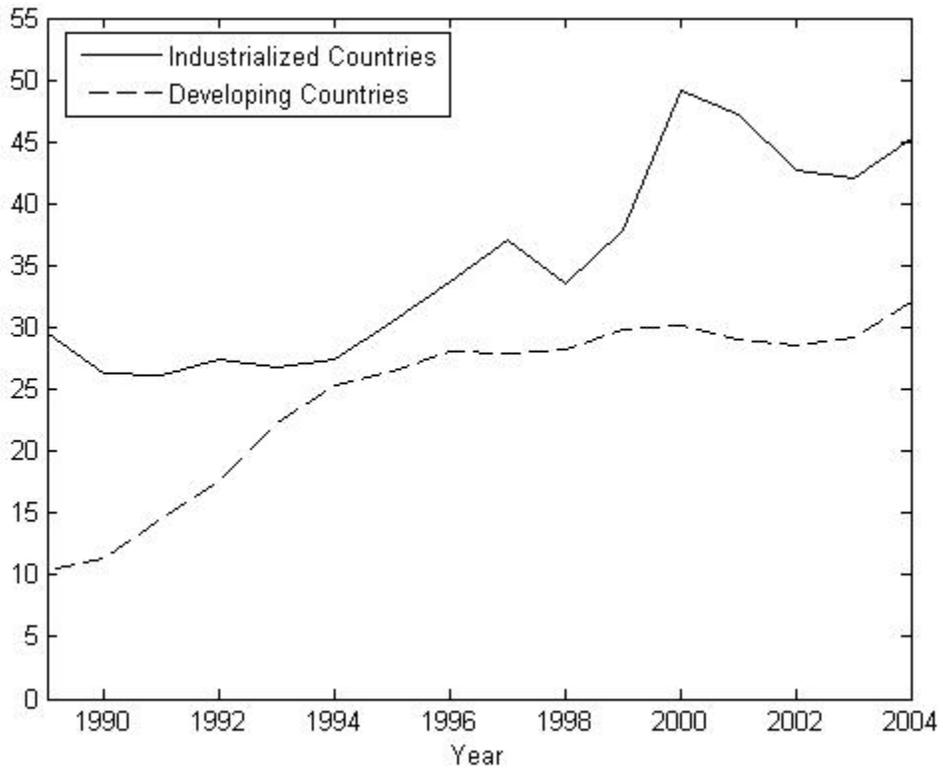
Source: IFS and WDI; Investment/GDP and Reserves/GDP are averages over 1980-2001, from Chen (2007).

Figure 5
Financial Market Development, *Fin_dev1*, 1977-2004
(based on the size of foreign equity and debt liabilities)



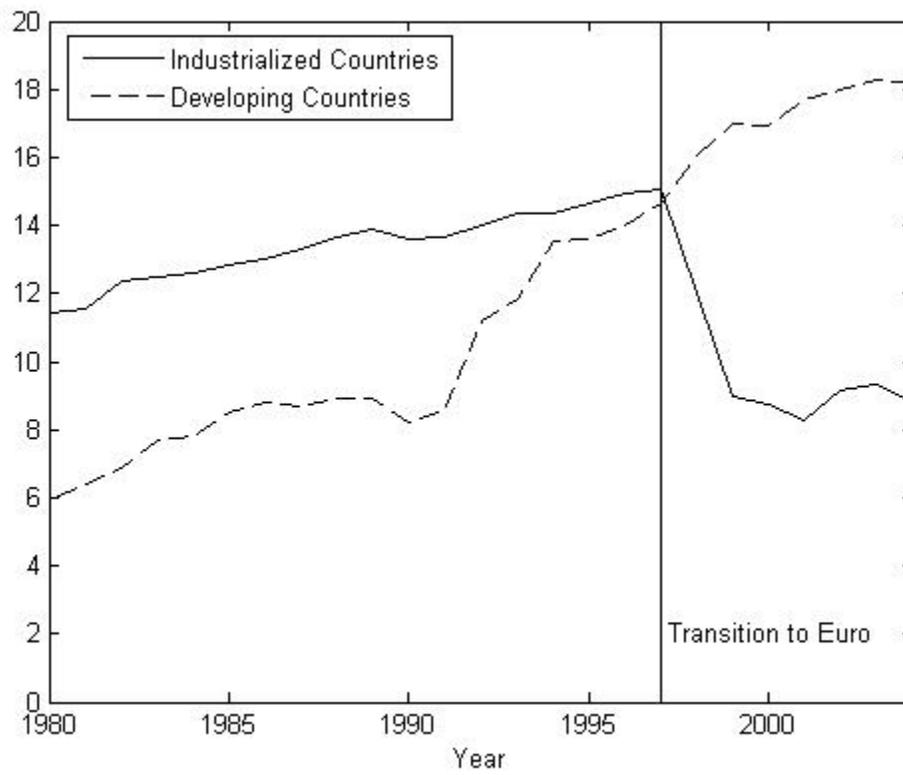
Source: Lane and Milesi-Feretti (2007) external wealth of nations database; measured as the sum of foreign equity and debt liabilities over GDP; excludes Luxembourg.

Figure 6
Financial Market Development, *Fin_dev2*, 1988-2004
(based on domestic market size)



Source: World Bank database on financial development and structure, measured as the sum of a country's private credit creation and stock market capitalization as a ratio of GDP.

Figure 7
Ratio of M2 money supply to GDP, 1980-2004



Source: World Development Indicators; excludes Euro-zone countries after 1999.

Table 1
Reserve Accumulation and the Financial Account 1990-2004

Financial Account Category	Industrial Countries	Developing Countries
<i>Composition of the increase in gross foreign assets</i>		
FDI	22.90	14.87
Portfolio	19.19	9.99
Other	55.64	33.38
Reserves	2.27	41.76
<i>Composition of the increase in gross foreign liabilities</i>		
FDI	19.35	41.57
Portfolio	19.25	20.06
Other	61.41	38.37
<i>BIS decomposition of foreign liabilities</i>		
Public	22.08	30.49
Private	77.92	69.51

Sources: IMF, Balance of Payments Statistics and Bank for International Settlements

Table 2

Panel Regressions Explaining Reserve Holdings based on Precautionary, Mercantilist and Financial Market Underdevelopment Motivations (Country-Fixed Effects)

	Standard Specification: Precautionary and Mercantilist Motives	Add: Private and Public Liabilities	Add: Measure of External Liabilities ¹ (<i>Fin_dev1</i>)	Add: Measure of Domestic Liabilities ² (<i>Fin_dev2</i>)
Constant	-7.20*** (0.46)	-5.51*** (0.52)	-4.84*** (0.52)	-6.84*** (0.64)
GDP	1.30*** (0.04)	0.84*** (0.06)	0.73*** (0.06)	0.84*** (0.07)
Exchange Rate Regime	-0.06 (0.49)	0.03 (0.04)	-0.002 (0.04)	-0.04 (0.05)
Capital Controls (kaopen)	-0.07*** (0.02)	0.003 (0.02)	-0.008 (0.01)	0.004 (0.02)
Crisis Dummy	-0.37*** (0.08)	-0.27*** (0.07)	-0.26*** (0.07)	-0.28*** (0.07)
Currency Overvaluation	-0.007*** (.001)	-0.007*** (0.001)	-0.007*** (0.001)	-0.005*** (0.001)
Share of Imports	1.81*** (0.25)	1.31*** (0.23)	1.54*** (0.23)	1.02*** (0.29)
Share of M2	0.49*** (0.13)	0.43*** (0.12)	0.37*** (0.11)	0.73*** (0.15)
Public Liabilities		-0.05* (0.03)	-0.02* (0.01)	-0.07** (0.03)
Private Liabilities		0.46*** (0.03)	0.50*** (0.03)	0.53*** (0.04)
Financial Market Development			-0.38*** (0.06)	-0.21*** (0.05)
Country fixed effects	yes	yes	yes	yes
R ² within	.72	.77	.78	.77
R ² between	.78	.81	.82	.83
Time observations	1017	1017	1017	712
# of Countries	50	50	50	49

Robust standard errors clustered by country in parenthesis. ***, ** and * indicate significance at 99%, 95% and 90% confidence levels, respectively. See data appendix III for explanations of the variables and data sources.

¹This measure of financial market development is based on each country's foreign equity and bond liabilities (graphed in figure 5).

²This measure of financial market development is based on each country's domestic equity and bond liabilities (graphed in figure 6); this measure is not available for China and is also unavailable for a number of countries prior to 1988 (see Appendix III for details).

Table 3
Correlations

	reserves	fin_dev (1)	fin_dev (2)	gdp	kaopen	M2/gdp	public_liab	private_liab
reserves	1							
fin_dev (1)	0.2028	1						
fin_dev (2)	0.4076	0.5904	1					
gdp	0.6823	-0.0721	0.2811	1				
kaopen	-0.3637	-0.4171	-0.3684	-0.3724	1			
M2/gdp	0.5823	0.4529	0.7495	0.3406	-0.4141	1		
public_liab	0.5851	0.3084	0.4083	0.7648	-0.4105	0.3224	1	
private_liab	0.7518	0.4355	0.5641	0.7791	-0.5929	0.5993	0.8176	1

See Data Appendix III for explanations of the variables and data sources

¹ *Fin_dev1* is a measure of financial market development based on each country's foreign equity and bond liabilities (graphed in figure 5).

² *Fin_dev2* is a measure of financial market development based on each country's domestic equity and bond liabilities (graphed in figure 6); this measure is not available for China and is also unavailable for a number of countries prior to 1988 (see Appendix III for details).

Table 4

Panel Regressions Explaining Reserve Holdings based on Precautionary, Mercantilist and Financial Market Underdevelopment Motivations (Year-Fixed Effects)

	Includes: <i>Fin_dev1</i> ¹	Includes: <i>Fin_dev2</i> ²
Constant	1.28*** (0.27)	0.81*** (0.31)
GDP	0.32*** (0.03)	0.45*** (0.04)
Exchange Rate Regime	-0.024 (0.04)	-0.14** (0.05)
Capital Controls (kaopen)	0.04*** (0.01)	0.05*** (0.01)
Crisis Dummy	0.06 (0.11)	-0.05 (.11)
Currency Overvaluation	-0.003* (0.002)	-0.001 (0.002)
Share of Imports	0.94*** (0.13)	1.01*** (0.13)
Share of M2	0.16** (0.07)	0.54*** (0.09)
Public Liabilities	-0.04** (0.02)	-0.04 (0.03)
Private Liabilities	0.46*** (0.03)	0.33*** (0.04)
Financial Market Development	-0.45*** (0.05)	-0.29*** (0.04)
Year fixed effects	Yes	Yes
Country fixed effects	No	No
R ² within	.75	.74
R ² between	.87	.92
Time observations	1017	712
# of Countries	50	49

Robust standard errors clustered by country in parenthesis. ***, ** and * indicate significance at 99%, 95% and 90% confidence levels, respectively. See data appendix III for explanations of the variables and data sources.

¹This measure of financial market development is based on each country's foreign equity and bond liabilities (graphed in figure 5).

²This measure of financial market development is based on each country's domestic equity and bond liabilities (graphed in figure 6); this measure is not available for China and is also unavailable for a number of countries prior to 1988 (see Appendix III for details).

Table 5

Panel Regressions Explaining Reserve Holdings based on Precautionary, Mercantilist and Financial Market Underdevelopment Motivations (Pooled Regression)

	Includes: <i>Fin_dev1</i> ¹	Includes: <i>Fin_dev2</i> ²
constant	-0.72 (0.70)	-1.24 (.94)
GDP	0.45*** (0.13)	0.69*** (0.16)
Exchange Rate Regime	-0.11 (0.20)	-0.19 (0.14)
Capital Controls (kaopen)	-0.03 (0.05)	-0.01 (0.02)
Crisis Dummy	-0.27*** (0.13)	-.38*** (0.09)
Currency Overvaluation	-0.009*** (0.001)	-0.005*** (0.001)
Share of Imports	1.63*** (0.11)	1.56*** (0.22)
Share of M2	0.21* (0.11)	0.31* (0.16)
Public Liabilities	0.05 (0.07)	-0.16 (0.10)
Private Liabilities	0.36*** (0.11)	0.31* (0.16)
Financial Market Development	-0.46*** (0.13)	-0.08* (0.05)
Time observations	1017	712
# of Country Groups	7	7

GEE population averaged model. Standard errors (adjusted for clustering on group) are in parenthesis. ***, ** and * indicate significance at 99%, 95% and 90% confidence levels, respectively. See data appendix III for explanations of the variables and data sources.

Country groups are described in data appendix IV

¹This measure of financial market development is based on each country's foreign equity and bond liabilities (graphed in figure 5).

²This measure of financial market development is based on each country's domestic equity and bond liabilities (graphed in figure 6); this measure is not available for China and is also unavailable for a number of countries prior to 1988 (see Appendix III for details).