International Reserves and Underdeveloped Capital Markets

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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 scare. 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.

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I. Introduction

China's official foreign exchange reserves are now well over one trillion dollars, and have recently reached $1000 per head for the entire population of China. 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 financial markets in industrial countries have deepened and broadened, financial markets in many developing countries remain incomplete. This paper focuses on the implications for developing countries of underdeveloped capital markets. Caballero and Kirshnamurthy (2004) develop a model 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. One way to mitigate the costs of this exposure is for developing country governments to accumulate international reserves.

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 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 scare. 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.

II. 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)[1].

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.[2]

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

[1] This is often referred to as the "Greenspan-Guidotti rule".
[2] Alfaro and Kanczuk (2007) consider the joint decision to accumulate reserves and issue sovereign debt. In 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.

unintended consequence of sterilized interventions in the foreign exchange market.[3] 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 (*forthcoming*)), while at the same time finding that neither motivation fully explains the recent upsurge in reserve accumulations by developing countries (Jeanne (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 country crises of the 1990s, studies suggest that current reserve accumulations far exceed warranted levels (Jeanne (2007)).[4]

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

[3] 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 holds. 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.

[4] A notable exception is a recent study by Obstfeld, Shambaugh and Taylor (2007) 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.

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.[5] 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 associated with *lower* net capital inflows for developing countries. Further, Chen (2007) finds that 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

[5] 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 (2007).

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.

III. A Model of Private Sector External Underinsurance

It is useful to start with a simple production economy set-up with spot loan markets in order to highlight the problem of underinsurance by the private sector in developing countries. Following Caballero and Krishnamurthy's (2001, 2004) framework consider a simple economy over three periods with a single consumption good. In period zero the private sector makes initial investments, in period one one-half of all firms need to re-invest as part of the normal restructuring of an economy (and to make things simple, the assumption is that the firms that need to re-invest are randomly chosen). Further, assume that all investment involves imports of capital goods from

foreigners, which are paid for by issuing date two foreign debt claims.[6] In period two the output is produced.[7]

In period one half of the firms need to make additional investments (these firms may be called "distressed"), while the other firms (labeled "intact firms") are able to produce date 2 output of Ak without additional funding in period one. The distressed firms will only be able to produce ak (which is strictly less than Ak: define $\Delta=A-a$ and $\Delta>1$) if they do not make the requisite investments in period 1. With full re-investment a distressed firm is able to produce the same output as an intact firm, Ak.

How do the distressed firms finance the needed re-investments in period one? Borrowers must provide their creditors with collateral. Each firm is assumed to be endowed with w units of a good that arrives at date 2 that can be used as collateral for either domestic or foreign lenders. An important (and likely realistic) assumption is that domestic lenders also allow some fraction (λ) of domestic plant and equipment (though not all of the output Ak) to serve as collateral, whereas foreign lenders do not. Put another way, collateral in this economy is limited in an asymmetric way, so that distressed firms will have less access to foreign lenders than they do to domestic lenders. (Underlying this is the realistic assumption that it is more difficult for foreign creditors to identify and seize domestic assets than is the case for domestic creditors.) Distressed firms may borrow an amount d in either date 0 or date 1 from foreigners (f), so that the collateralization constraint for each firm is:

$$d_{o,f} + d_{1,f} \leq w \tag{1}$$

Whereas the collateral constraint for domestic firms borrowing from local creditors (l) is:

[6] We assume that all firms are identical to start with and that there is no domestic debt at time 0.
[7] The model implicitly assumes that the objective of agents in this economy is to maximize date 2 expected consumption.

(2) $$d_{0,I} + d_{1,I} \leq \lambda ak + w - (d_{0,f} + d_{1,f})$$

In this framework an external crisis in period one is defined as a situation where the financing needs of all the firms in the economy, *½k*, exceed the international financing resources available to each of them, $(w - d_{0,f})$.

In period one firms learn whether or not they need to re-invest, and therefore whether they are distressed. A distressed firm will want to borrow from foreigners up to its collateral constraint and then turn to local lenders (intact firms) for any additional financing needs. These loans are always worth it from the standpoint of the borrower because of the high return to reinvestment.[8] Since goods are not produced until period 2, intact firms will need to borrow from foreigners in order to lend to distressed firms in period 1. Equilibrium in this framework (assuming only spot loan markets) is shown in Figure 5 and consists of investment and financing decisions by both distressed and intact firms and the domestic interest rate, L. The supply of loans is assumed to be elastic at L_1=1 (where the domestic and foreign interest rate are equalized) up to the point that intact firms borrow the maximum available from foreigners, beyond this point (where $d_{1,f} = w - d_{0,f}$) the supply of loans is completely inelastic. Demand for loans is given by $\lambda ak/2L_1$. Solving for the domestic interest rate by substituting date one decisions into the market clearing condition (that loans taken by distressed firms equal the loans provided by intact firms):

(3) $$L_1 = \frac{\lambda ak}{w - d_{0,f}}$$

[8] Investing *I(k)* units results in capital of *k* units, where *I(k)* is assumed to be strictly increasing, positive and convex.

it transpires that the domestic interest rate in period one lies above the foreign interest rate (normalized to one) as a consequence of the more binding collateral constraint on foreign borrowing (recall that foreigners here will *not* hold claims against λak) and below the marginal product of full re-investment by distressed firms, Δ. If domestic and foreign lender collateral requirements are symmetric then arbitrage would drive domestic and foreign interest rates together. It is also the case that if the collateral endowment, w, is large enough, so that distressed firms do not need to borrow from intact firms, interest rates would again be equalized.

This simple model highlights the central role of collateral. From equation three it is clear that if the amount of needed investment, k, is fixed, the domestic interest rate is increasing in λ, which is the fraction of distressed firm plant and equipment allowed as collateral for loans from intact firms. The looser the collateral constraint from within the domestic economy (the more intact firms are willing to fully value the resources of distressed firms) the less distorted will be the domestic interest rate.

Although the focus is on period one when distressed firms need to finance additional investment (to get them from ak to Ak), the constraints that firms face in period one will importantly impact the behavior of all firms in period 0 (recall firms do not learn whether they are distressed until period one). 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 for period one. Yet in this set-up firms will not insure themselves (by saving in period 0) against this potential financing constraint. Why not? The problem is that lenders only receive L_1 for loans made to distressed firms, whereas the marginal benefit of these loans to distressed firms is higher, $\Delta > L_1$. The return to savings in period

0 does not reflect the true marginal product of financing in period 1 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, $L_{1,}$ in line with the marginal product of re-investment, Δ. If the shock in period 1 were public information, then insurance contracts could be written in period zero, contingent on firm type, which would result in a loosening of the domestic collateral constraint. Of course, it is unlikely that these shocks would be public information, and if the information is private, intact firms would always have the incentive to masquerade as distressed in order to avoid payment. Mechanism design solutions could truthfully elicit information from the two types of firms, but these programs are generally very difficult to implement in practice and typically entail various types of costs. Another set of possible solutions involve government action.

Reserve accumulation by the government is one solution to the private sector underinsurance problem. 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.

Incorporating reserve accumulation in our simple model involves the government purchasing international reserves and sterilizing these purchases by issuing domestic

bonds. In the context of our three period model the government in period zero purchases international bonds and at the same time issues two period bonds, with face value b and interest rate L_0. These transactions result in firms holding an additional b/L_0 in debt (needed to purchase the bonds) and the government holding the same amount in reserves. At date 1 (when the distressed firms require additional financing) the government can re-purchase the bonds using its international reserves. In period two the government will need to raise taxes (T) in order to balance its budget[9]: $\frac{b}{L_0} L_1 + T = b$.

As long as the governments' future tax liability is rationally anticipated, the domestic bonds issued by the government and held by domestic firms are not considered collateral by foreigner lenders, and the international borrowing constraint is binding, Caballero and Krishnamurthy (2004) show that the return on the government bonds, L_0, must exceed the period one interest rate, L_1. It is in this way that sterilized reserve accumulation by governments results in a subsidy to the private sector, inducing firms to save in period 0 (by purchasing the government bonds) as a way of insuring against the financing constraints they may face (if they are distressed) in period 1.[10]

IV. Empirical Evidence Connecting Reserve Accumulation, Private Sector Under-Insurance 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

[9] Unless $L_0=L_1$ in which case the budget will be balanced without raising taxes.
[10] Caballero and Krishnamurthy (2004) also show that this result is not coalition incentive compatible. If firms have the option not to pay taxes and not to buy the government bonds, and at the same time are allowed to trade with firms that do pay taxes, they would prefer this option. Of course, in most countries taxes are not optional, though tax compliance in many developing countries is less than perfect.

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 sector external debt is readily available from the Bank for International Settlements (BIS), data measuring the "collateral wedge" are generally not available. 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, Wurgler (2000), Morck et. al (2000) and Islam and Mozumdar (2007)). This literature provides a number of suggested measures of underdevelopment including: the extent of state ownership in the economy, the amount of firm-specific information in domestic stock returns[11], and legal protections for minority investors[12]. Wei (2006) creates an index measure of cross-country corruption which he suggests is likely to be negatively correlated with financial market development.[13] The Lane and Milesi-Ferretti (2006) measure of financial development (the sum of portfolio equity liabilities plus total debt liabilities divided by GDP) is essentially a measure of the overall size of a country's financial market. Figure 6 shows that while financial markets have grown 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 start to accelerate.

[11] Morck et. al. (2000)
[12] La Porta et. al. (1997)
[13] The corruption index is based on three independent sources of survey responses, including ratings produced by Business International (now part of the Economist's Economic Intelligence Unit), the WDR index derived from a World Bank survey in 1996, and the Global Competitiveness Report Index produced by the World Economic Forum and Harvard Institute for International Development. See Wei (2006) pages 6-8 for a detailed description of the corruption index.

There is a high degree of correlation among the various measures of financial market development for industrialized countries, which generally have large and efficient capital markets. Among developing countries there is more heterogeneity across the various measures, although (unsurprisingly) countries with fewer legal protections often have limited markets and higher levels of corruption. The regressions that follow use an index of financial development for each country that incorporates four key characteristics: (1) market size, (2) legal protections, (3) stock price synchronism and (4) level of corruption.[14] Some of these characteristics do not change, or change only infrequently in some countries, while for other countries there is considerable time variation. For example, for many of the industrialized countries in the sample, the only component of the financial development index that changes over time is the size of equity and bond markets. In this case the other components of the index are being captured in the regression as part of the country fixed effects.

In the empirical literature that attempts to estimate reserve holdings for panels of countries based on mercantilist and precautionary motives[15] the standard regression specification includes: scale factors (GDP), the share of imports in GDP, an indicator of exchange rate flexibility, and an indicator of openness and vulnerability to external shocks.[16] The first column of Table 2 presents the results of a panel regression that includes 53 countries (24 industrialized countries and 31 developing countries) over the 1983 to 2004 time period using this standard specification:

[14] This version of the paper reports results obtained using the Lane and Milesi-Ferretti (2006) measure of financial market development. Preliminary results suggest that using the more comprehensive financial market development index provides qualitatively similar conclusions.
[15] See Aizenman and Marion (2003).
[16] 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), though this variable is never found to be statistically or economically important.

(4) $$R_{it} = \alpha_0 + \alpha_1 GDP_{it} + \alpha_2 ShImp_{it} + \alpha_3 ExRate_{it} + \alpha_4 CC_{it} + \alpha_5 Crisis\_dum_{it} + \varepsilon_{it}$$

where *R* is holdings of foreign reserves valued in logged millions of US dollars (from Lane and Milesi-Ferretti), *ShImp* is the share of imports of goods and services in GDP, *ExRate* is an exchange rate classification based on the Reinhart and Rogoff (2004) defacto regimes, *CC* measures financial account openness (capital controls) based on Chin and Ito's (2005) classifications, and *Crisis_dum* indicates the dates of currency crisis as defined by Frankel and Rose (1996). The panel estimation includes country fixed effects.

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 sign on the exchange rate regime indicator suggests that countries with more flexible exchange rates hold fewer reserves. The indicator of currency crises suggests, as expected, that those countries experiencing crises held fewer reserves during their crises.

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* and *Crisis_dum* 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 are also countries that have underdeveloped

financial markets, 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 Caballero and Krishnamurthy (2004) model 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 higher levels of private sector liabilities hold greater reserves, while countries with higher levels of public sector liabilities hold fewer reserves.

Column three of Table 2 includes the measure of financial market development. Recall that the model predicts that countries with less developed financial markets are likely to hold greater reserves. This prediction is confirmed in the regression, in that the sign of the financial market development indicator is negative and statistically significant. Also included in this specification is an interaction term that measures whether financial market development potentially matters more for fast growing countries. This prediction is confirmed, suggesting that the constraints of financial market underdevelopment may be particularly severe for countries experiencing lower levels of economic growth. Overall, 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.

V. 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 53 countries over the period 1983-2004. 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 our 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 our 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

Reserves: total foreign reserves from Lane and Milesi-Ferretti (2006)

GDP: nominal GDP in millions of USD from Lane and Milesi-Ferretti (2006)

ShImp: Share of Imports in GDP, World Development Indicators

ExRate: based on the Reinhart-Rogoff de-facto exchange rate regime classifications until 2001, updated by the author.

CC: the Chinn-Ito capital controls index, inverted so higher number indicates more binding controls. Mean zero, min=-2.6025, max=1.767

Crisis_Dum: 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.

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

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

Fin_dev Index: (in this version of the paper) portfolio equity liabilities + total debt liabilities over GDP from Lane and Milesi-Ferretti (2006)

Figure 1

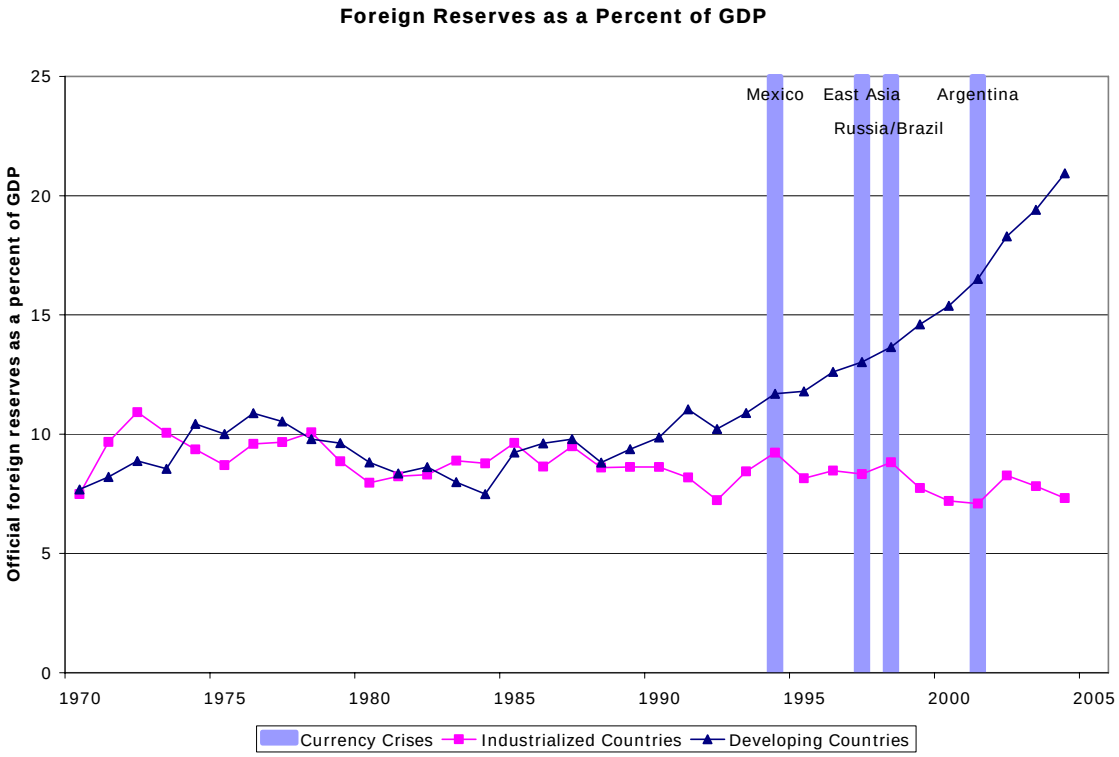

Foreign Reserves as a Percent of GDP
Official foreign reserves as a percent of GDP
25
20
15
10
5
0
1970
1975
1980
1985
1990
1995
2000
2005
Mexico
East Asia
Russia/Brazil
Argentina
Currency Crises
Industrialized Countries
Developing Countries

Figure 2

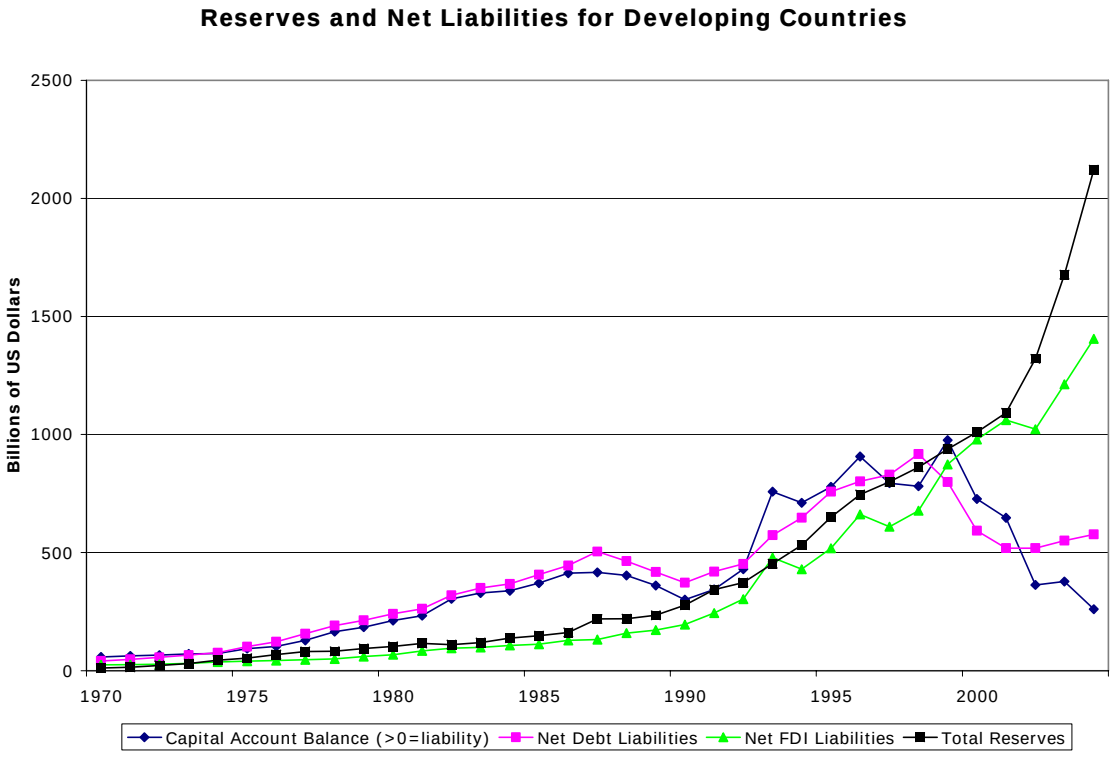

Reserves and Net Liabilities for Developing Countries
Billions of US Dollars
2500
2000
1500
1000
500
0
1970
1975
1980
1985
1990
1995
2000
Capital Account Balance (>0=liability)
Net Debt Liabilities
Net FDI Liabilities
Total Reserves

Figure 3

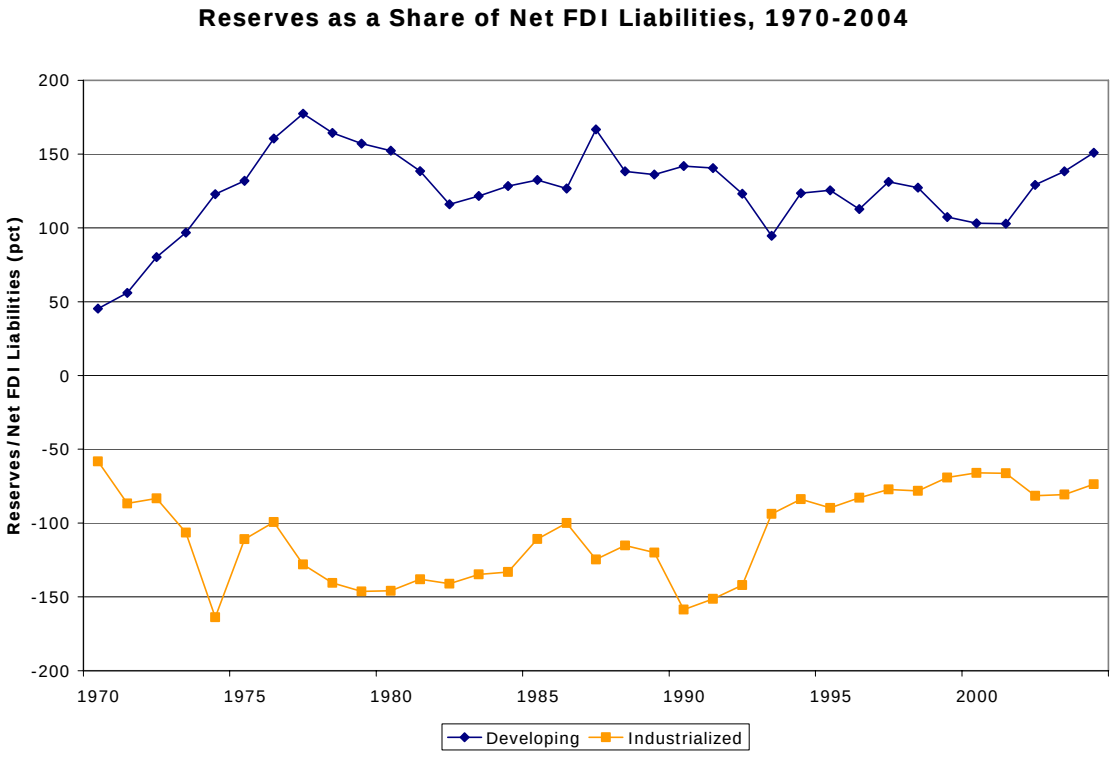
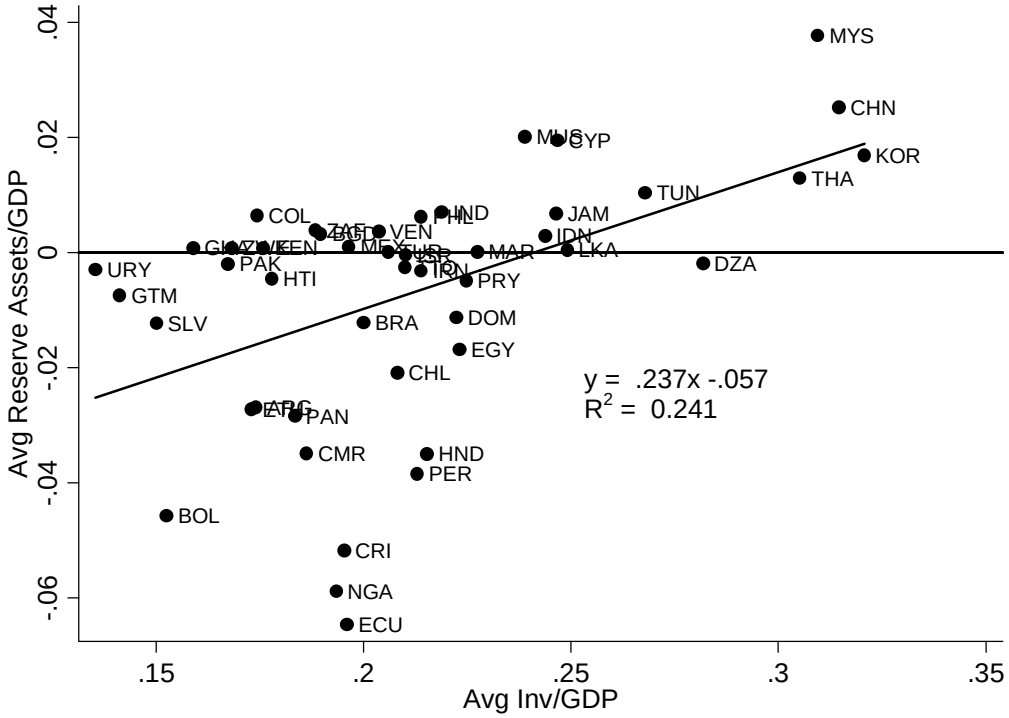

Reserves as a Share of Net FDI Liabilities, 1970-2004
Reserves/Net FDI Liabilities (pct)
200
150
100
50
0
-50
-100
-150
-200
1970
1975
1980
1985
1990
1995
2000
Developing
Industrialized

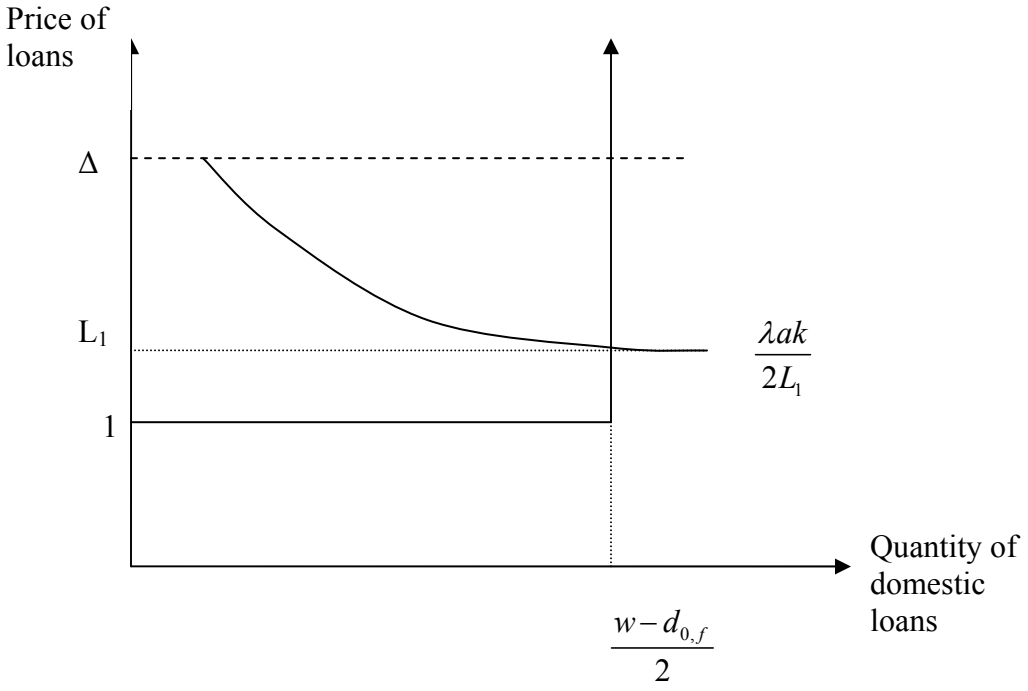
Figure 4
Investment and Reserves



Investment/GDP and Reserves/GDP for 45 developing countries (averages of 1980 – 2001) from Chen (2007).

Source: IFS, WDI

Figure 5
The Supply and Demand for Domestic Loans under Collateral Constraints



This figure is reproduced from Caballero and Krishnamurthy (2004) page 110. It shows equilibrium in the domestic loan market given specific collateral constraints (that only domestic firms are willing to hold claims against λak, where ak is period 2 output of distressed firms that do not re-invest and $\lambda<1$). Recall that in period 1 half the firms are distressed and half are intact. The vertical axis measures the price of loans, Δ is the surplus generated by full re-investment by distressed firms, L_1 is the domestic interest rate which is shown to be above 1 (the normalized foreign interest rate). The horizontal axis measures the quantity of domestic loans, where w-$d_{o,f}$ is the most that intact firms are able to borrow from foreigners.

Figure 6
Lane and Milesi-Feretti measure of financial market development

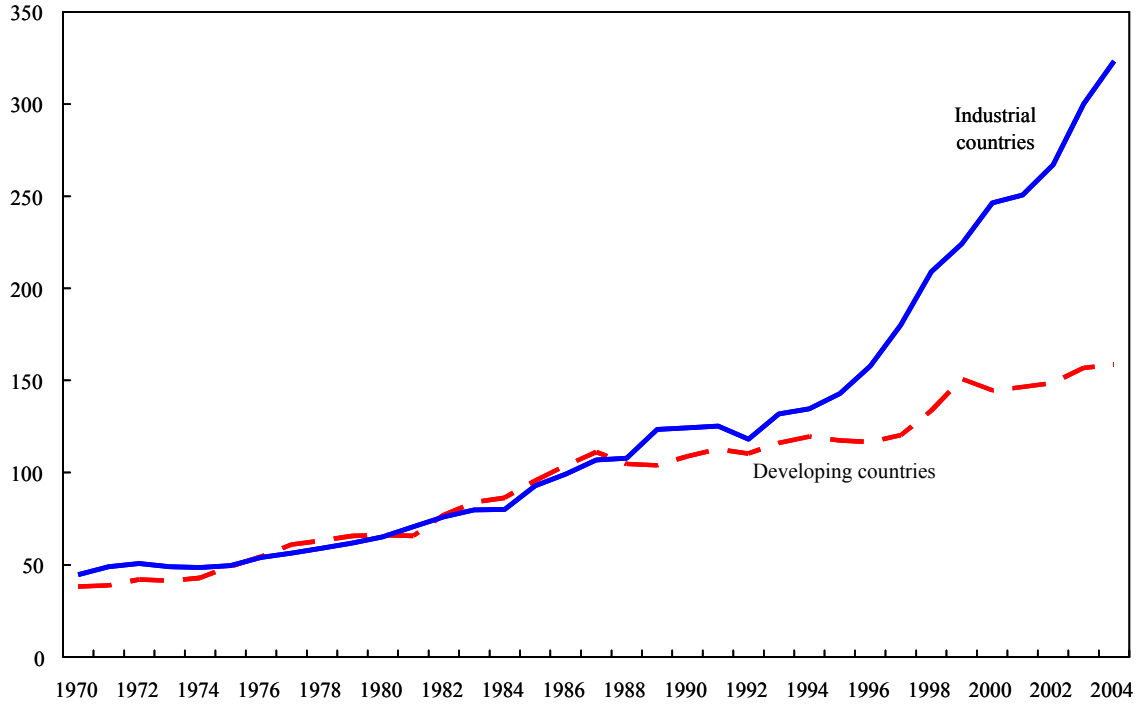


Table 1
Reserve Accumulation and the Financial Account 1990-2004

Financial Account Category	Industrial Countries	Developing Countries
Composition of the increase in gross foreign assets		
FDI	22.90	14.87
Portfolio	19.19	9.99
Other	55.64	33.38
Reserves	2.27	41.76
Composition of the increase in gross foreign liabilities		
FDI	19.35	41.57
Portfolio	19.25	20.06
Other	61.41	38.37
BIS decomposition of foreign liabilities		
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

	Standard Specification: Precautionary and Mercantilist Motives	Add: Private and Public Liabilities	Add: Measure of Financial Market Development
constant	-9.10***	-6.85***	-7.05***
	(0.59)	(0.67)	(0.68)
GDP	1.57***	1.31***	1.33***
	(0.05)	(0.07)	(0.07)
Exchange Rate Regime	-0.11*	-0.11*	-0.14**
	(0.06)	(0.06)	(0.06)
Capital Controls	-0.04	-0.04*	-0.04*
	(0.03)	(0.02)	(0.02)
Crisis Dummy	-0.42***	-0.43***	-0.46***
	(0.09)	(0.09)	(0.09)
Public Liabilities		-0.17***	-0.16***
		(0.03)	(0.03)
Private Liabilities		0.23***	0.22***
		(0.03)	(0.03)
Financial Market Development			-0.16***
			(0.07)
GDP growth & Financial Market Development			-0.49***
			(0.13)
R^2 within	.64	.67	.68
R^2 between	.66	.69	.69
Time observations	747	747	747
# of Countries	53	53	53

Standard errors are in parenthesis. ***, ** and * indicate significance at 99%, 95% and 90% confidence levels, respectively. See data appendix for explanations of the variables and data sources. Panel regressions include country fixed effects.