The Cost of Holding Excess Reserves: Evidence from India

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Abstract

Most of the existing literature has used single reserve adequacy measures to evaluate the volume of excess reserves. In this paper, we present a theoretical model and employ empirical methods to generate a comprehensive reserve adequacy measure, incorporating the various objectives of holding reserves, and compare the actual reserve accumulation experience of various emerging markets with the prediction of our models. Using this comprehensive reserve adequacy measure we calculate the cost of holding excess reserves for India by looking at three different alternative uses of resources. We find that India is foregoing as much as 2% of its GDP by accumulating excess reserves instead of employing resources in alternative uses.

JEL Classification: F37, F47, C33
Keywords: Reserve Holdings, Reserve Management, Opportunity Cost
1. Introduction

With the collapse of the Bretton Woods, the pressure on industrial countries to accumulate reserves eased as they moved to flexible exchange rate regimes and overcame the problem of “original sin” i.e. the inability to borrow from abroad in domestic currencies. On the other hand, emerging market policymakers have been struggling to define adequate reserve levels, and have been typically motivated by the principle of “non-satiability” while dealing with international reserves. Over the last decade, developing countries, particularly those in East and South Asia, accumulate massive stockpile of international reserves. Emerging economies like China, South Korea, Russia, and India have acquired reserves in excess of $2.5 trillion by 2007. These massive scales of reserve accumulation have raised several questions about the cost of holding high volume of reserves given most of it is held in low yield government bonds. Such costs are extremely important for a country like India, where scarce resources are being diverted towards reserve accumulation, which has increased over five folds from 2001-02.

Prior to investigating the cost of holding reserves, it is important to understand the factors influencing the demand for international reserves. Central banks of most countries maintain a stockpile of international reserves to meet imbalances in current account financing, cover short-term debt obligations, prevent excessive volatility in the exchange rate etc. In line with these objectives, the empirical literature points out that the demand for international reserves is based on a number of structural variables like economic size, current account openness, financial liberalization, exchange rate regime, financial depth, etc.

Reserves provide self insurance against sudden stops and adverse fiscal shocks. Sudden stops are typically associated with large reduction in the flow of capital followed by major exchange rate depreciation leading to significantly lower rates of return, investment and growth. International reserves help mitigating the effects of such sudden stops. Ben-Bassat and Gottlieb (1992b) argue that international reserves reduce the probability and the intensity of an output drop due to a sudden stop. Burke and Lane (2001), point out that apart from trade openness, financial depth and external indebtedness also influence the demand for international reserves.

Aizenman and Marion (2004) find that the size of international transactions, their volatility, exchange rate arrangement and political stability are key determinants of international reserve holdings in most of East Asia. Countries characterized by sovereign risk, costly tax collection and large inelastic fiscal liabilities are likely to exhibit greater precautionary demand for international reserves. Countries would also hold large precautionary balances of international reserves if they attach more weight to bad outcomes than good ones. Using a simple empirical model Edison (2003) shows that real GDP per capita, the population level, ratio of imports to GDP and volatility of the exchange rate are found to be statistically significant determinants of reserve holdings.

The pattern of reserve accumulation has changed over the period of time. Aizenman and Marion (2004) point out that in the aftermath of the Asian crisis the pattern of reserve accumulation...
accumulation has changed considerably with Asian economies exhibiting increased demand for reserves for self insurance purposes. Focusing on Korea, Aizenman et al (2003) find evidence of a structural break in the pattern of reserve holding after the Asian crisis with financial openness and external indebtedness becoming significant and strong predictor of reserve holdings.

Reserves also help to lower the real exchange rate volatility, induced by terms of trade shocks. It has been widely argued that exchange rate volatility has an adverse impact on a country’s growth. In a recent paper, Aghion et al. (2006) showed that in countries characterized by low level of financial development, exchange rate volatility has a negative impact on the growth rate. Thus any mechanism that reduces the volatility of exchange rate will enhance the growth performance of an economy.

Dooley et al. (2003) point out that the growing stockpiles of international reserve can be attributed to a deliberate strategy, which facilitates growth by maintaining an undervalued exchange rate. This would imply that every time there is pressure on the domestic currency to appreciate, the central bank intervenes by printing domestic currency and buying up all the foreign currency, which translates into additional reserves.

Thus it is clearly evident that reserves are held to meet a wide range of objectives. However, this is in sharp contrast with bulk of the literature on cost of holding reserves, which has focused either on entire reserve holding, or reserves holdings in excess of a single adequacy measure like three to four months of import cover.

Early papers looking at the cost of holding reserves like Iyoha (1976) and Frenkel and Jovanovic (1981) treat the opportunity cost as the inverse of the discount rate and finds that demand for international reserves varies inversely with the opportunity cost. However, Shinkai (1979) points out that use of domestic discount rate to calculate the opportunity cost of holding reserves is erroneous as most the of reserves are held in dollar denominated assets. Thus it makes sense to use the difference between returns on such assets and a country specific interest rate, which measures the net gain (inverse cost) of holding reserves instead of investing the equivalent sum within the country.

Another measure usually employed to capture the cost of holding reserves is the return on investment in physical capital. Neely (2000), Ben-Bassat and Gottlieb (1992b) and Baker and Walentin (2001) assume that if assets were not held as reserves they would be available to fund domestic investment in physical capital. These papers conclude that the increase in reserves represents an enormous cost to the developing nations as they forego domestic investment in either physical or human capital. Baker and Walentin (2001) point out that these costs exceed 1% of GDP and possibly 2% of GDP for many developing economies.

In a recent paper Rodrik (2006) terms excess reserves as reserves held over and above what is required to meet three months of imports. Using this rule Rodrik (2006) finds that by investing resources in accumulation of reserves instead of reducing private sector’s short-term borrowing, the developing nations are losing about 1% of their GDP.
By taking into consideration the entire stockpile of reserves or reserves in excess of a single adequacy measure (import cover), the literature implicitly assumes that holding international reserves do not generate any benefits or they are held only to meet a single objective like current account financing. Such a perspective fitted well a world where financial markets were not integrated and trade openness reflected countries’ vulnerability to external shocks i.e. the Bretton Woods period. However, with increased financial integration in recent years, the emerging markets have increased their exposure to volatile short-term inflows of capital that are subject to frequent sudden stops and reversals.

In this paper we present a theoretical model and use empirical methods to evaluate the factors influencing the demand for international reserves in emerging markets. Using the results of our empirical analysis we generate a comprehensive reserve adequacy measure, incorporating the various objectives of holding reserves. This comprehensive reserve adequacy measure is then used to calculate the predicted volume of reserves, which tells us the quantum of reserves a country needs to hold. The difference between actual and predicted volume of reserves gives us the volume of excess reserves held by various emerging markets. Thereafter we focus on India and calculate the cost of holding these excess reserves. We consider three alternate uses of the resources employed in building up the stockpile of reserves i.e. financing physical investment, reducing private sector’s external commercial borrowing and lowering public sector debt.

The rest of the paper is structured as follows. Section 2 focuses on a model of a small open economy subject to sudden stops and highlights the principle factors affecting the demand for international reserves. In Section 3, we evaluate the predictions of the theoretical model using empirical methods. We also compare the reserve accumulation experience of major emerging markets vis-à-vis the predictions of our empirical model. Section 4 focuses on India and highlights the cost of holding excess reserves focusing on various alternative uses of resources. Finally, Section 5 lists out the main conclusions of the study.

2. A Small Open Economy Model

The model presented here is a variant of the model developed in Jeanne and Rancière (2008). In their paper, Jeanne and Rancière (2008) consider the case where the small open economy interacts with the rest of the world by borrowing from it in one period and repaying the external debt in the next period. We assume that apart from borrowing and repaying, the small open economy also engages with the rest of the world through international trade. We believe that this is an important issue as one of the key reasons for central banks to hold international reserves is to enable the economy to continue to import in the face of an economic crisis.

Following Jeanne and Rancière (2008), we focus on a small open economy which produces a single good that is consumed both at home and abroad. The economy faces the risk of being subject to sudden stops, in which case output falls by a fraction. This economy consists of representative agent whose consumption is given as

\[ C_t = Y_t + FD_t - (1 + r)FD_{t-1} + IM_t - X_t + Z_t \quad (1) \]
where \( Y_t \) is the domestic output, \( FD_t \) is the external debt, \( IM_t \) is the total amount of goods imported into the country, \( X_t \) is the volume of exports and \( Z_t \) is a transfer from the government, with a negative value implying a tax. The interest rate \( r \) is exogenously determined with the small open economy having no influence over it.

There is a limit on the output that can be used to repay foreign debt and the debt is repaid fully in period \( t \) only of

\[
(1 + r)FD_{t-1} = \alpha Y_t^g,
\]

where \( Y_t^g \) is the output in the good state of the world i.e. when the economy is not subject to a sudden stop and \( \alpha \) is the parameter indicating the proportion of output promised to be devoted to repayment of foreign debt. Both \( \alpha \) and \( Y_t^g \) is known in period \( t-1 \) thereby ensuring that there is no default on external debt.

In the good state of the world, the economy grows at a constant rate \( \xi \) and the value of output in period \( t \) is assumed to be

\[
Y_t^g = (1 + \xi)^t Y_0
\]

where \( Y_0 \) is the initial stage output. In the event of a crisis associated with a sudden stop, the economy switches to the bad state and output falls by fraction \( \gamma \). Moreover, the amount of output devoted to repayment of foreign debt falls to zero in this state.

\[
Y_t^b = (1 - \gamma)(1 + \xi)^t Y_0
\]

The representative consumer smoothens her consumption path by entering into a reserves insurance contract with the government. In good states the consumer pays a tax in the form of an insurance premium \( x_t R_t \). In the bad state also she pays the same tax but receives a transfer \( R_t \). So long as \( x_t < 1 \), the insurance contract transfers purchasing power from the good state to the bad state.

Similarly, the imports of the representative consumer are also related to the output according to the propensity to import \( m \). In the bad times, with a decline in output, imports also witness a similar decline.

\[
IM_t^g = mY_t^g
\]
\[
IM_t^b = m(1 - \gamma)Y_t^g
\]

Unlike imports, exports are assumed to remain unchanged during the sudden stop episode. Higgins and Klitgaard (2000) find that in the Asian crisis almost all the
adjustment in the merchandise trade balance, due to a sudden stop in capital flow, came from a steep decline in imports in dollar terms. Dollar exports largely remained unchanged during this period. This is largely because exports are largely influenced by destination countries' income and the real exchange rate, which are exogenous to our model.

Thus the representative agent’s consumption in good times is given as

$$C^g = Y^g + FD_i - (1+r)FD_{i-1} + IM^g - X_i - x_i R_i,$$  \hspace{1cm} (7)

while her consumption in bad times is

$$C^b = Y^b + FD_i - (1+r)FD_{i-1} + IM^b - X_i + (1-x_i) R_i.$$  \hspace{1cm} (8)

Finally, the inter-temporal utility function of the representative individual is given as

$$U_t = E_t \left( \sum_{t=0}^{\infty} (1+r)^{t} u(C_{i+1}) \right),$$  \hspace{1cm} (9)

where the period utility function is given as

$$u(C_t) = \frac{C_t^{1-\sigma}}{1-\sigma}, \sigma \neq 1$$  \hspace{1cm} (10)

and $u(C) = \log(C)$ for $\sigma = 1$ and $\sigma$ is the degree of relative risk aversion.

In normal times the country maintains, a constant ratio of short-term debt to GDP, $\lambda$, given by

$$\lambda = \frac{FD^g}{Y^g} = \frac{\alpha (1+\xi)}{(1+r)}.$$  \hspace{1cm} (11)

The representative agent chooses the level of reserves that maximizes the expected utility of period t+1 consumption.

$$L = \text{Max} \ (1-\pi)u(C^g_{i+1}) + \pi u(C^b_{i+1})$$  \hspace{1cm} (12)

where $\pi$ is the probability of the economy being subject to a sudden stop. The first order conditions can be rewritten as:
\[
\frac{u'(C_{t+1}^g)}{u'(C_{t+1}^b)} = \frac{\pi_r}{(1-\pi_r)} \frac{(1-x_t)}{x_t}
\]  

(13)

where consumption in good state is given as

\[
C_{t+1}^g = Y_{t+1}^g + FD_{t+1} - (1+r)FD_t + IMM_{t+1} - X_{t+1} + Z_{t+1}^g\]

\[
\Rightarrow C_{t+1}^g = (1+\xi) \left[ 1 - \frac{r-\xi}{(1+\xi)} \lambda + m - \bar{x} - x_t \rho_t \right] Y_0
\]

and \(\bar{x}\) is the ratio of exports to output, assumed to be constant. The consumption in bad state is given by

\[
C_{t+1}^b = Y_{t+1}^b + FD_{t+1} - (1+r)FD_t + mY_{t+1} - X_{t+1} + Z_{t+1}^b\]

\[
\Rightarrow C_{t+1}^b = (1+\xi) \left[ (1-\gamma) - \frac{1+r}{1+\xi} \lambda + (1-x_t) \rho_t + m(1-\gamma) - \bar{x} \right] Y_0
\]

Assuming the utility function to be of the type in equation (10), the first order condition can be written as

\[
\frac{C_{t+1}^g - \sigma}{C_{t+1}^b - \sigma} = q_t
\]

where \(q_t = \frac{\pi_r}{1-\pi_r} \frac{1-x_t}{x_t}\)

The optimal ratio of international reserves to output can be obtained by solving the above equation. The optimal ratio is given as

\[
\rho_t = \frac{\gamma + \lambda + m\gamma - \left( 1 - q^\sigma \right) \left[ 1 - \frac{r-\xi}{(1+\xi)} \lambda - m + \bar{x} \right]}{1 - x_t \left[ 1 - q^\sigma \right]}
\]

(14)

According to equation (14), the optimal level of reserves depend on the output loss due to sudden stop(\(\gamma\)), ratio of short-term debt to output(\(\lambda\)), probability of a crisis(\(\pi\)), ratio of imports to output(\(m\)), reserve insurance premium(\(x\)), share of exports in output(\(\bar{x}\)), risk free interest rate(\(r\)), degree of risk aversion(\(\sigma\)) and the
growth rate of the economy ($\xi$). The baseline parameters have been mostly taken from Jeanne and Rancière (2008).

<table>
<thead>
<tr>
<th>Table 1: Calibrated Parameters</th>
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<tbody>
<tr>
<td>$\pi = 0.1$</td>
</tr>
<tr>
<td>$\gamma = 0.065$</td>
</tr>
<tr>
<td>$\xi = 0.033$</td>
</tr>
<tr>
<td>$\lambda = 0.11$</td>
</tr>
<tr>
<td>$x = 0.20$</td>
</tr>
<tr>
<td>$\sigma = 2$</td>
</tr>
<tr>
<td>$m = 0.2$</td>
</tr>
<tr>
<td>$\mu = 0.15$</td>
</tr>
<tr>
<td>$r = 0.05$</td>
</tr>
</tbody>
</table>

Next, we look at how our model predicts change in optimal reserve ratio requirements as we change some of the key parameters of the economy like the probability of a crisis, propensity to import and the ratio of short-term debt to output. The optimal reserve ratio is going to differ according to how costly is it to purchase a reserve insurance contract, i.e., the insurance premium rate (x). As the cost of acquiring the reserve insurance contract increases the representative consumer would find it optimal to hold fewer reserves. Figure 1 below shows the results of our numerical analysis.

**Figure 1: Change in International Reserves**

(a) Change due to an Increase in Crisis Probability
An increase in crisis probability is associated with a monotonic increase in optimal reserve ratio. However, the increase in the reserve ratio is not linear with most of the increase coming at low probability levels. An increase in the probability of a crisis by three percentage points from its benchmark value of 10% raises the optimal reserve ratio from 13% to 28%. However, a similar increase in crisis probability when the probability is already high yields a much more modest increase. An increase in crisis probability from 22% to 25% raises the optimal reserve ratio by only 11 percentage points.

Our model also predicts that an increase in import propensity is associated with an increase in optimal reserve ratio. Thus as the economy opens itself to more imports, it finds it prudent to hold a greater volume of reserves. However, the increase in optimal
reserve ratio as a result of the rise in import propensity is relatively modest. At the benchmark value of insurance premium rate of 0.15, an increase in the import propensity from 20% to 80% results in an increase in the optimal reserve ratio from 23% to 29%. An increase in the ratio of short-term debt to GDP also leads to an increase in the optimal reserve ratio. An economy having a short-term debt to GDP ratio of 10% finds it optimal to hold nearly 23% of its GDP as reserves. On the other hand an economy holding short-term debt equivalent to half of the GDP will find it optimal to have a reserve-GDP ratio of more than 60%.

Across all the specifications we find that the optimal reserve ratio declines with an increase in the insurance premium rate. In the trivial case of high insurance premium \( (x > 0.2) \), coupled with low crisis probability, low import propensity and low short-term debt to GDP ratio, the individual prefers to hold negative reserves. In such circumstances, the net increase in utility in the bad state due to higher consumption on the back of available reserves is less than the decline in utility in the good state due to lower consumption as a result of paying high insurance premium rate.

3. Determinants of Reserves

In this section, we use empirical methods across 167 countries over the period 1980-2005 to identify the principal determinants of cross-country variation in the level of international reserves. The dependent variable is the ratio of reserves minus gold to GDP. The reserves include special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. Data on reserve holdings, imports, short-term debt and GDP are taken from the World Development Indicators (WDI). On the basis of the empirical analysis, we create a comprehensive reserve adequacy measure and calculate the predicted demand for international reserves. Comparing the predicted demand with actual reserve accumulation helps us to identify the volume of excess reserves held by various emerging markets.

We also consider several other variables that have been found in the literature as principal determinants of reserve holding. The first variable is a measure of real income per capita, which acts as a measure of the overall development of the economy and captures a wide range of factors affecting reserve holdings. Owing to the large variation in this variable across the countries, we use the log of real per capita GDP instead of level.

There is a close association between domestic financial development and exposure to external crises. To the extent that the liabilities of the domestic sector are partly denominated in foreign currency, financial deepening should be matched by an increase in international reserves. We measure financial depth with the ratio of money and quasi money (M2) to GDP. Data on M2 are taken from the WDI.

The volume of reserves is also crucially affected by the exchange rate regime. A country with a currency peg is likely to hold more reserves either to defend against attacks on the exchange rate or as a consequence of resisting an appreciation of the domestic currency. On the other hand in a flexible exchange rate regime, the exchange rate can freely float to reflect market reality and hence such a country is likely to hold fewer reserves. To control
for exchange rate regime, we use the exchange rate index formulated by Levy-Yeyati and Sturzenegger (2005), which is a *de facto* classification based on data on exchange rates. The index ranges from 1 to 5 with a lower number implying a more flexible exchange rate regime.

The degree of capital account liberalization is another variable that influences the precautionary motive of capital account liberalization. As a country opens up to greater capital flows, it needs to put in place adequate safeguards to protect it against sudden stops. Thus greater capital account openness is likely to be associated with higher volume of reserves. We measure capital account openness using Chinn-Ito index developed in Chinn and Ito (2006). The index ranges from -1.7 to 2.7 and a higher value of the index indicates greater financial openness.

Aizenman and Marion (2004) point out that political uncertainty will influence a country’s strategy regarding holding of reserves. Suppose alternatively the government in a country has a ‘tough’ administration that ensures responsible fiscal behavior and a ‘soft’ administration that behaves opportunistically in appropriating and allocating resources to special interest groups with high discount rates. A ‘soft’ administration would want to increase the consumption of special interest groups and reduce international reserve holdings and accumulate international debt to achieve that. On the other hand, a ‘tough’ administration would be reluctant to hold lot of reserves if there is a high probability that it will loose power in the near future and the future administration will be ‘soft’ and grab the rewards for the special interest rate groups. Thus, political instability can reduce the level of reserve holdings below the level supported by efficiency considerations. We use the political stability index developed by *Intra Country Risk Guide*. The index is made up of variables like government stability, socioeconomic conditions, conflicts, law and order etc. The index ranges from 0 to 100 with a higher number indicating a more politically stable regime.

Finally, we also include a series of dummy variables that indicate the behavior of the Asian and the Latin American economies after the crises of 1994 and 1997. These dummies intend to capture the change in the reserve holding behavior of these economies after they were hit by these crises.

The empirical model is given by following equation

\[
Y_{it} = \alpha_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + \beta_7 X_{7it} + u_i + \epsilon_{it} \quad (15)
\]

where \(i\) refers to the country and \(t\) represents the time period. Here \(Y\) is the dependent variable, measured as ratio of reserves (minus gold) to GDP. Among the explanatory variable, \(X_1\) is log of per capita GDP, \(X_2\) is a measure of trade openness, \(X_3\) is a measure of exchange rate regime, \(X_4\) is a measure of capital account openness, \(X_5\) measures

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3Another popular exchange rate regime measure is the one created in Reinhart and Rogoff (2002). However, this measure ends in 2001 and is thus not suitable for our purpose.
financial depth, $X_6$ is a measure of political stability and $X_7$ is the ratio of short-term debt to GDP.

In our sample of countries, a Woolridge test for autocorrelation, suggests the presence of first order serial correlation. In the presence of autocorrelation, the error term in equation 15 can be written as

$$\varepsilon_t = \rho \varepsilon_{t-1} + \mu_t \quad (16)$$

In the literature, there are several ways to estimate the model in the presence of serial correlation. One can use a feasible GLS with AR1 correlation. However, this procedure has been criticized for underestimating the standard errors. The panel corrected standard error estimates, which uses Prais-Winstein regression, addresses this problem. It assumes that the disturbances are heteroskedastic and contemporaneously correlated across panels. The panel corrected standard error estimates allow for first order correlation, AR(1), with a common coefficient of the AR(1) process across all the panels, $\left( \rho = \rho, \forall i \right)$, as well as a specific coefficient of the AR(1) process for each panel, $\left( \rho_i \neq \rho, i \neq j \right)$.

Table 2 displays the results of the Prais-Winstein regression with panel specific autocorrelation coefficients. We focus on all the countries in our sample as well as just the emerging market economies. Across the entire sample, log of per capita GDP has a positive and significant impact on reserve holding. Richer countries tend to have higher reserve holdings. Trade openness also exerts a strong positive and significant impact on reserve holding thereby highlighting the precautionary motive, where countries having higher share of trade want to hold enough resources to be able to finance their imports.

<table>
<thead>
<tr>
<th>Table 2: Prais Winstein Estimates with Panel Specific Correlation Coefficient</th>
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<tbody>
<tr>
<td>(I)</td>
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<tr>
<td>----</td>
</tr>
<tr>
<td><strong>Full Sample of Countries</strong></td>
</tr>
<tr>
<td>Import Share</td>
</tr>
<tr>
<td>[12.69]</td>
</tr>
<tr>
<td>Per Capita GDP</td>
</tr>
<tr>
<td>[3.82]</td>
</tr>
<tr>
<td>Exchange Rate Regimes</td>
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<tr>
<td>[3.27]</td>
</tr>
<tr>
<td>Capital Account Openness</td>
</tr>
<tr>
<td>[4.17]</td>
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<tr>
<td>Financial Depth</td>
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<tr>
<td>[6.08]</td>
</tr>
<tr>
<td>Political Stability</td>
</tr>
<tr>
<td>[1.92]</td>
</tr>
<tr>
<td>Short-term Indebtedness</td>
</tr>
<tr>
<td>[0.94]</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Number of countries</td>
</tr>
</tbody>
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Robust z statistics in parentheses

*** indicates significant at 1 % , ** indicates significant at 5 % and *indicates significant at 10 %
Across all specifications for the full sample exchange rate regime has a significant positive impact on reserves. According to the exchange rate regime measure used, a higher number indicates less flexible regime. Thus countries with fixed exchange rate regime tend to accumulate greater reserves. Like trade openness, capital account openness is also positively affects international reserve holdings. Thus countries that opened up the capital account tend to hold greater reserves to protect themselves against episodes of sudden stops.

We also find that greater financial depth tends to have a positive influence on reserve holdings. In many countries, the liabilities of the financial sector are denominated in foreign currencies and this is reflected in higher volume of reserves. Political stability also has the expected positive impact on reserve holding but the impact is not significant across all specifications. Finally, we find that the extent of external indebtedness has no significant influence on reserve holdings. Among the dummy variables, only the dummy for Asian economies after the Asian crisis has a strong positive and significant effect on reserves implying that post Asian crisis, the Asian economies made a deliberate attempt to bolster their reserve holdings to prevent another such attack.

When we focus only on emerging markets we find that political stability along with exchange rate regime are no longer a significant predictor of the volume of reserves. However, both trade and capital account openness along with per capita GDP, short-term indebtedness and financial depth continue to be the major determinants of reserve accumulation.\textsuperscript{4}

Next, we use the above empirical model to predict the demand for international reserves for various emerging countries and groups. In particular, we use the regression in Column (IX) of Table 1 to calculate the volume of reserves predicted by our model. If the actual reserves exceed predicted reserves then the difference is termed as excess reserves. Several papers like Gosselin and Parent (2005) and Edison (2003) have pointed out a structural break in the volume of reserves in 1997 due to the emergence of financial crisis in several countries in Asia. Consequently, in Column (IX) we focus on post 1998 period.

In Figure 2, we look at the reserve accumulation performance of some selected emerging markets in Asia and Latin America. Figure 5 brings out several interesting facts. There

\textsuperscript{4} The robustness of the results reported in Table 1 was checked using alternative explanatory variables. For financial depth, variables such as share of credit allocated to the private sector and ratio of liquid liabilities to GDP. Trade openness was measured using total trade as a percentage of GDP, while capital account openness was measured by looking at the volume of capital flows to GDP. Political stability was proxied by government stability, law and order and corruption from Intra Country Risk Guide. The results were broadly similar to the ones reported in Table 1.
are five countries whose actual reserve accumulation was significantly higher than what our model predicted. These include India, China, Korea, Russia and Malaysia. By 2005, the excess reserve accumulation in these countries stood at $22 billion, $390 billion, $26 billion, $83 billion and $13 billion, respectively. On the other hand, by 2005, Indonesia,
Figure 2: Reserve Accumulation in Selected Emerging Markets

(a) India

(b) China

(c) Korea

(d) Brazil

(e) Russia

(f) Malaysia

(g) Indonesia

(h) Philippines

(i) Thailand
Philippines and Thailand had accumulated reserves close to the amount predicted by our model. Finally, only Brazil faced a shortfall in excess reserves of $60 billion in 2005.

4 Cost of Reserve Holdings: The Indian Experience
Prior to the time of financial globalization, countries used to hold reserves mainly to manage foreign exchange demand and supply arising from current account transactions. India was no exception to this rule. It followed a restrictive foreign trade policy and used its reserves for essential items like petroleum and foodgrains. Consequently, the volume of international reserves was almost stagnant from 1950-51 to 1990-91. Since 1991, there has been major shift in the external policy with import substitution giving way to export promotion. For this policy to succeed, sufficiency of international reserves was a major requirement and the stockpile of international reserves increased from less than $6 billion in 1990-91 to over $270 billion by December 2007.

Today India is in a relatively comfortable position. Its stock of international reserves can finance more than a year’s imports and thus provides a comfortable cushion in the case of a terms of trade shock or a sudden reversal of capital flow. This massive accumulation of reserves has also meant that the ratio of short-term debt to international reserves has witnessed a steep decline from nearly 150% in 1990-91 to below 7% in 2006-07. Reserve hoarding is not a phenomenon that has been unique to India. Most of the Southeast Asian economies as well as Latin American economies have also been indulging in this kind of a behavior. This has been the primary response to currency crises these economies faced in the 1990s.

Figure 3 exhibits some of the key reserve adequacy indicators for major emerging economies. It can be clearly seen that, barring Argentina and Chile, most of the emerging economies have witnessed a significant increase in their import cover of international reserves as well as the ratio of international reserves to GDP. All the major developing countries also witnessed a fall in the ratio of short-term debt to reserves. The fall was again smallest for Argentina and Chile.

Comparing India’s performance with other emerging economies it can be clear seen that India has done remarkably well. Figure 4a shows that in terms of import cover of international reserves, India is better covered than most other major emerging markets. The only major emerging market, with a higher import cover is China. Similarly, according to Figure 4b India is well placed in terms of ratio of short-term debt to reserves.

5 Short-term debt has been redefined since 2005-06 to include suppliers’ credit up to 180 days. However, to maintain consistency we stick to the original definition. As per the new definition the ratio of short-term debt to foreign exchange reserves stood at 12.5% as at end-March 2005, but increased slightly to 12.9% as at end-March 2006 and further to 13.2% at end-March 2007, but declined to 12.4% at end September 2007.
international reserves. At 7%, this ratio is also smaller than most other developing countries. Even with the other two indicators, India is relatively comfortably placed. In terms of ratio of international reserves to GDP, India is behind economies like China, Thailand, Russia and Malaysia but ahead of most Latin American economies. On the other hand, at 25.53%, the ratio of international reserves to M2 in India is higher than China and Brazil but lower than most of the Latin American economies and Korea.

Figure 3: Cross Country Comparison of Reserve Adequacy Measures

(a) Import Cover of International Reserves
(b) Ratio of Short-term Debt to International Reserves
(c) Ratio of International Reserves to M2
(d) Ratio of International Reserves to GDP

Source: World Development Indicators 2007

In the Indian case the dominant policy objectives in regard to international reserves include maintaining confidence in monetary and exchange rate policies, limiting external vulnerability, and providing confidence in the market that external liabilities will always be met thereby adding to the comfort of the market participants. Thus in India lot of weight is put on the precautionary and self-reliance motive. A lot of this has to do with India’s historical experience. In June 1991 India faced a severe external crisis as volume of reserves dwindled down to levels that could finance less than three weeks of imports. At that point, the Government of India had to ship 47 tonnes of gold to Bank of England
to secure a loan of $415 million before the funds were arranged from the IMF to ride out
the crisis. One of the causes of the crisis in mid 1991, apart from widening current
account deficit and political uncertainty, was the loss of investor confidence. During this
period commercial bank financing became difficult to obtain. Moreover, outflows began
to take place on short-term external debt, as creditors became reluctant to roll over
maturing loans. There was also a reversal of the strong inflows on nonresident Indian
deposits. Again, an immediate aftermath of the Pokharan explosions was the imposition
of sanctions, which curtailed India’s access to global financial market. Reddy (2002)
points out that given these experiences an overwhelming desire for international reserve
buildup is understandable. However as highlighted by Lal et al. (2002), with current
reserves being able to finance more than a year’s import and India doing exceptionally
well on all reserve adequacy measures, continuation of such a policy is highly
questionable given the high costs associated with such a policy, some of which are
highlighted below. Lal et al. (2003) conclude that if capital flows were fully absorbed and
invested, instead of being neutralized by building up of foreign reserves, growth could
have been significantly higher.

In India, international reserves are managed by the RBI in consultation with the
Government of India. The main objectives of reserve management are liquidity and
safety with due attention being paid to the currency composition and duration of
investment so that a substantial part can be converted to liquid form at a short notice. The
framework for deployment of these international reserves is guided by the RBI Act, 1934.

Figure 4: Rates of Return on Foreign Currency Assets

The strategy to focus on safety and liquidity at the expense of return has had strong
implications for the rate of returns on investment of the international reserves. Given the
low interest rate prevailing in most of industrialized countries the direct financial return

Source: Reserve Bank of India, Handbook of Statistics

The strategy to focus on safety and liquidity at the expense of return has had strong
implications for the rate of returns on investment of the international reserves. Given the
low interest rate prevailing in most of industrialized countries the direct financial return
on holdings of international reserves has been low. RBI (2007) points out that the rate of earning on foreign currency assets and gold, after accounting for depreciation, was only 4.6% in 2006-07 and 3.9% in 2005-06. The inflation rates during these two years were around 5.42% and 4.38%, implying a real rate of return of -0.82% in 2006-07 and -0.48% in 2005-06. Indeed as shown in Figure 4, in recent years, the real rates of return on foreign currency assets have been largely negative.

Such low returns have raised several questions about the management of international reserves by RBI. In particular, there has been a focus on calculating the cost of holding reserves. As shown in Section 3, India is one of the countries that have accumulated more reserves than is predicted by our model. When we extend the analysis for India till 2007 by taking into account the behavior of the explanatory variables for additional two years, we find that in 1998, India’s actual accumulation of reserves were slightly less than predicted and this trend continued till 2001 with the gap between the two reducing significantly during the latter part of the period. However, since then actual volume of reserves have overtaken the predicted volume, mainly due to a current account surplus in some of these years and rising net investment inflows. There was a marginal moderation in the growth rate of reserves in 2005 but it picked up again in 2006. Increased opening up of trade and capital account along with financial deepening also meant that predicted volume of reserves also showed an upward trend but the gap between the two widened significantly by Dec 2007, and amount of excess reserves stood well over $80 billion.

Below we compute the cost of accumulating reserves instead of utilizing the resources to increase the productive capacity of the economy. All the costs are reported in terms of income foregone as well as loss in terms of percentage of GDP. In the literature, different measures have been used to calculate the cost of hoarding reserves. We look at some of the important measures and calculate the costs of holding excess reserves in India.

4.1 Cost in Terms of Physical Investment Foregone
Several papers like Ben-Bassat and Gottlieb (1992a) and Neely (2000) have pointed out that the opportunity cost of reserve holdings can be equated to the marginal product of capital. The underlying rationale being that resources that could have been used to increase the domestic capital have been employed in hoarding reserves. In such cases, the cost of holding reserves is given by the interest rate spread between the return on foreign currency assets and marginal product of capital, which is a proxy for the return on physical investment. We look at the opportunity cost in terms of actual income foregone as well as a percentage of the GDP.

Typically the marginal product of capital is seen as the inverse of the incremental capital-output ratio (ICOR), with the latter reflecting the amount of additional capital required to generate a unit increase in output. The growth rate of the real output y can be stated as

\[ y = 1 / \text{ICOR} \]

We extend the data on India for 2005 and 2006 by looking at various publications of the Reserve Bank of India and Ministry of Finance, Government of India. We reestimated our model using the additional information. However, there were only marginal change in the coefficients and their significance level (changes were only at the second decimal point).
\[ y = \frac{1}{Y} \frac{\Delta Y}{\Delta T}, \quad (17) \]

where \( Y \) is the real output, \( T \) is time and \( \Delta \) is the first difference operator. Multiplying the numerator and the denominator by \( \frac{\Delta K}{\Delta Y} \) we obtain

\[ y = \frac{\Delta K}{Y \Delta K}, \quad (18) \]

where \( K \) is the capital stock of the economy. In the above equation, \( \frac{\Delta K}{\Delta T} \) refers to the change in capital stock from one period to the next and is equal to the investment undertaken (I). Similarly, \( \frac{\Delta K}{\Delta Y} \) reflects the amount of capital required to raise output by one unit and can be approximated by the ICOR. Thus the above equation can be rewritten as

\[ y = \frac{1}{Y \ ICOR} \quad (19) \]

Thus the marginal product of capital, which is the inverse of the ICOR, is given by

\[ MP_k = \frac{y}{I} \quad (20) \]

Data on I and Y is obtained from Central Statistical Organization (CSO).

**Figure 5: Cost in terms of Physical Investment Foregone**

![Cost in terms of Physical Investment Foregone](image-url)
The opportunity cost of accumulating reserves is shown in Figure 5. By diverting resources from physical investment and employing them for reserve accumulation, India lost nearly $13 billion or 2.34% of the GDP in 2003-04. In the next couple of years, the loss was slightly lower due to a higher return on the foreign currency assets. However, with a relatively low ICOR and hence a high marginal product of capital in 2006-07, the loss rose sharply to nearly $18 billion or 2.16% of GDP. Thus, we find that in terms of physical investment foregone, India is paying a substantial cost.

4.2 Cost in Terms of Excess External Commercial Borrowing

Another opportunity cost of holding reserves can be formulated in terms of short-term borrowings that the private sector has to undertake. A country living by the Greenspan-Guidotti-IMF rule will increase reserves by the same amount by which the private sector increases its external short-term liabilities. In a recent paper, Rodrik (2006) calculates the social cost of holding reserves based on this idea.

Consider an economy that is made up of the central bank and the private sector. Now suppose that this country is abiding by the Greenspan-Guidotti-IMF rule. The private sector takes a short-term loan from abroad of X dollars. The central bank has to increase its reserves by an equivalent amount. The central bank will purchase foreign currency worth this amount in the domestic market to invest in short-term foreign securities. Thus its stock of international reserves will go up by X dollars. By selling domestic currency worth X dollars to the private sector, the overall money supply has gone up by X dollars. To sterilize the effect of this intervention on the money supply, the central bank will sell some of the private sector's domestic bonds it holds back to the private sector. Thus it sells back X dollars worth of domestic bonds issued by the private sector so its stock of domestic bonds decreases by X dollars. Similarly, due to this sell back, the value of domestic bonds outstanding for the private sector decreases by X dollars.

Rodrik (2006) points out three consequences of such transactions. Firstly, there is no net resource transfer from abroad as the increase in private sector’s liability is matched by an increase in central bank’s international reserves. Secondly, the short-term borrowing does not increase the availability of liquid resources available to the private sector for investment. The decline in total amount of debt issued by the private sector through domestic bonds is equivalent to the rise in short-term foreign debt. Finally, aggregating the balance sheets of the various sector, it can be seen that the economy has borrowed short-term abroad (at the domestic private sector’s cost of foreign borrowing) and has invested the proceeds in short-term foreign assets.

In such a setting, the cost of holding reserves would be measured by the interest rate spread between the private sectors’ cost of short-term borrowing abroad and the yield that the central bank earns on its liquid assets. Generally, there is no direct source of information on costs of short-term borrowing. Most of the short-term borrowing takes the form of commercial bank lending, information on which is generally not publicly available. In a recent article, Bhagwati (2006) pointed out that the average cost of short-term external commercial borrowings for the India private sector is roughly about 3-
month LIBOR+2.5%. Figure 6 shows the cost of hoarding excess reserves using this measure.

It can be seen that the cost of excess reserves has been increasing steadily and in 2006-07 stood in excess of $2.5 billion or 0.30% of GDP. The sharp increase in the cost in 2003-04, compared to previous year, is largely because of the low return on foreign currency assets that year. On the other hand, the increase in cost in 2005-06 and 2006-07 is largely explained by a sharp rise in the average 3 month LIBOR rate to 4.11% and 5.36%. As a result of monetary tightening in several industrialized countries, there was been a sharp increase in the cost of borrowing. On the other hand, during this period the dollar had become marginally stronger thereby providing some boost to the returns on international reserves.

4.3 Cost in Terms of Public Sector Borrowing
The rising burden of public debt and gross fiscal deficit should be an issue of serious concern for the Indian economy. The combined domestic liabilities of Centre and States have increased from 40.52% of GDP in 1980-81 to 77.25% in 2006-07. Ahluwalia (2002) points out that the growth of public debt in India has equaled or exceeded that in Russia, Turkey and Argentina before these countries hit a crisis. Using yields on public debt issued domestically to evaluate debt sustainability, Kletzer (2004) provides a strong argument for a fiscal adjustment. Following Kletzer (2004) and Mohan (2002), we use the weighted average yield on central and state government securities to calculate the opportunity cost of hoarding reserves. The results are shown below in Figure 7.
It can be clearly seen that using the spread between interest rate on domestic government bonds and the yield on reserves, the cost is quite significant and in excess of $2.5 billion or 0.31% of GDP. Again, the sharp increase in the cost in 2003-04 is explained by the low yield on foreign assets. In contrast, the increase in cost by $1 billion between 2005-06 and 2006-07 is largely explained by significant increase in the volume of excess reserves as well as an increase in the cost of borrowing for the public sector. The extent of this cost has been mitigated to an extent by the ability of the government to borrow at concessional rates. Since 1995-96, there has been a steady decline in the yield of central government securities along with a rise in maturity. However, this trend was reversed in 2004-05 and 2005-06, when there was a sharp increase in interest rates. With global hardening of monetary policy, and opening up of the Indian economy to capital flows, domestic interest rates will have to align themselves with international rates. This would imply that the government’s ability to borrow at concessional terms might get severely eroded in recent years, thereby increasing the cost of hoarding reserves.

4.4 Cost in Terms of Balance Sheet Risks

Another cost of holding international reserves arises when the exchange rate adjusts. The RBI has intervened actively in the currency market to keep the value of the rupee low vis-à-vis the US dollar, which has resulted in accumulation of the reserves. However, the central bank can only delay the inevitable process of appreciation and cannot prevent it. This was also observed in the case of India. After trying to keep the value of the INR around Rs. 48 during 2001-02, the RBI allowed the INR to appreciate. As a result, the value of dollar fell from Rs. 49.03 in May 2002 to Rs. 45.32 in October 2003. This adjustment would imply that there was a sharp fall in the rupee value of India’s
international reserves. For e.g., international reserves worth $1 billion, which was valued at Rs. 490.3 crores in May 2002 was worth only Rs. 453.2 crores in October 2003 – a loss of Rs. 37 crores. Similarly, the recent appreciation of the Indian rupee has resulted in a significant fall in the valuation of reserves in domestic currency.

7. Conclusion
The primary objective of this paper is to evaluate the cost of holding excessive reserves. We present a model of a small open economy identifying the major determinants of international reserve holdings. Thereafter we test the prediction of the theoretical model using empirical methods. We formulate a comprehensive measure of reserve adequacy to calculate the volume of excess reserves in several emerging markets including India. This is in contrast to most of the existing literature, which generally uses a single measure to calculate excess reserves.

Using the comprehensive measure of reserve adequacy we find that overall emerging markets have outperformed in their reserve accumulation objective compared to the predictions of our model. This result is primarily driven by the Asian economies who have amassed far more reserves than suggested by our model. Among these the Asian emerging markets that suffered the adverse impact of the Asian crisis have significantly increased their reserve accumulation endeavours compared to the predictions of the model. On the other hand, Latin American economies fall well short of the levels predicted by our model.

Looking at individual countries we find that Indonesia, Thailand and Philippines have accumulated reserves close to the amount predicted by our model. On the other hand Brazil’s reserve accumulation efforts have fallen short of our model’s prediction. Finally, China, India, Korea, Russia and Malaysia exhibited had accumulated significantly more reserves than compared by our model.

Next, focusing on India, we find that by end of 2007 India had accumulated more than $80 billion of excess reserves. We impute the costs of holding these reserves by considering various alternative uses of the resources employed in building up reserves. The cost is substantial across all specifications, both in terms of actual income foregone as well as loss in terms of percentage of GDP. India is loosing more than 2% of its GDP by accumulating reserves instead of employing resources to increase the physical capital of the economy. Even if the resources absorbed in reserve accumulation were utilized to reduce private sector’s external commercial borrowing or public sector debt, India could gain more than 0.3% of the GDP.
References


Edison, H. (2003). ‘Are Foreign Reserves In Asia Too High?’ In ‘World Economic Outlook and Staff Studies for the World Economic Outlook,’


