THE EFFECT OF OPENNESS ON FOREIGN RESERVES AND GROWTH IN THE EMERGING ECONOMIES

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Abstract

This study draws attention to some stylised facts suggesting that the rise of reserves in the Emerging countries is still partially unexplained. Emerging countries in the last decade seem to have reduced their exposure to the risk of short term foreign capital outflow, as they have increased GDP growth with little growth in new capital assets and short term foreign debt. Nevertheless, they have kept raising foreign reserves massively. This work constructs a model that is able to explain these stylised facts are the result of the same process of globalisation. As numerical simulations establish, the optimal solution depends crucially on two structural parameters newly introduced in this model, which account for the marginal cost of long term finance and for the competitiveness of the domestic industry.

Keywords: foreign reserves; short term foreign debt; long term finance; growth; investment.

1. Introduction

This study proposes a new approach to explain why emerging countries, especially those that exhibit high GDP growth rates, are responsible for massive accumulation of foreign reserves.

In the aftermath of the East Asian crisis, economists and international institutions argued that the stock of international reserves, in the absence of an international lender of last resort, is warranted as insurance against foreign short term debt withdrawal (Calvo, 1998; Feldstein, 1999; Radelet and Sachs, 1998; Greenspan, 1999; Fisher, 2001). Several recent studies, however, have reported that the average demand for international reserves from emerging economies has climbed since the 90s to reach levels never seen before, well above the coverage ratio of one recommended by the Greenspan-Guidotti rule (Rodrik, 2006). As section 2 of this study will document, such a ratio reached an average level above 7 in 2009.

Theoretical models explaining the stockpile of foreign reserves, in the approach of the precautionary (or self-insurance) view,[1] often describe emerging countries as financing long term investment with volatile short term foreign capital and building reserves to cushion the real output of the economy in the event of foreign capital outflow (Jeanne and Rancière, 2006; Jeanne, 2007; Aizenman and Lee, 2007; Cheung and Qian, 2007; Garcia and Soto, 2004).[2] The prevalent opinion is that the observed stocks of reserves are not optimally determined (Caballero and Panageas, 2004, 2005; Greenwald and Stiglitz, 2010; Jeanne, 2007).[3]

The evidence summarised in section 2 of this study draws attention to some stylised facts suggesting that the extent of reserves, rather than being suboptimal, is still partially unexplained. Emerging countries in the last decade seem to have reduced their exposure to the risk of short term foreign capital outflow: BRIC countries, which are the biggest and fastest growing economies, have managed to double their average growth rates with little growth in new capital assets and short term foreign debt; similarly, smaller emerging economies have even managed to increase growth despite a lower level of investment in new capital assets and a lower short term foreign debt. Nevertheless, emerging countries - especially those growing more - have kept raising foreign reserves massively.

This paper contributes to the analysis of optimal reserves in the emerging countries by deriving the aforementioned stylised facts as the solution of a new model, which innovates the theoretical analysis in many respects. Firstly, foreign reserves are not conceived of as a tool to simply balance short term foreign capital, but as a monetary policy instrument to coordinate investment, short term and long term finance, all of them being exposed to volatility of foreign capital. Secondly, the model introduces two structural parameters whose value may depend on

[1] Other explanations of reserves come from earlier models, surveyed in Flood and Marion (2002), and from the mercantilist view, by Dooley et al. (2003)

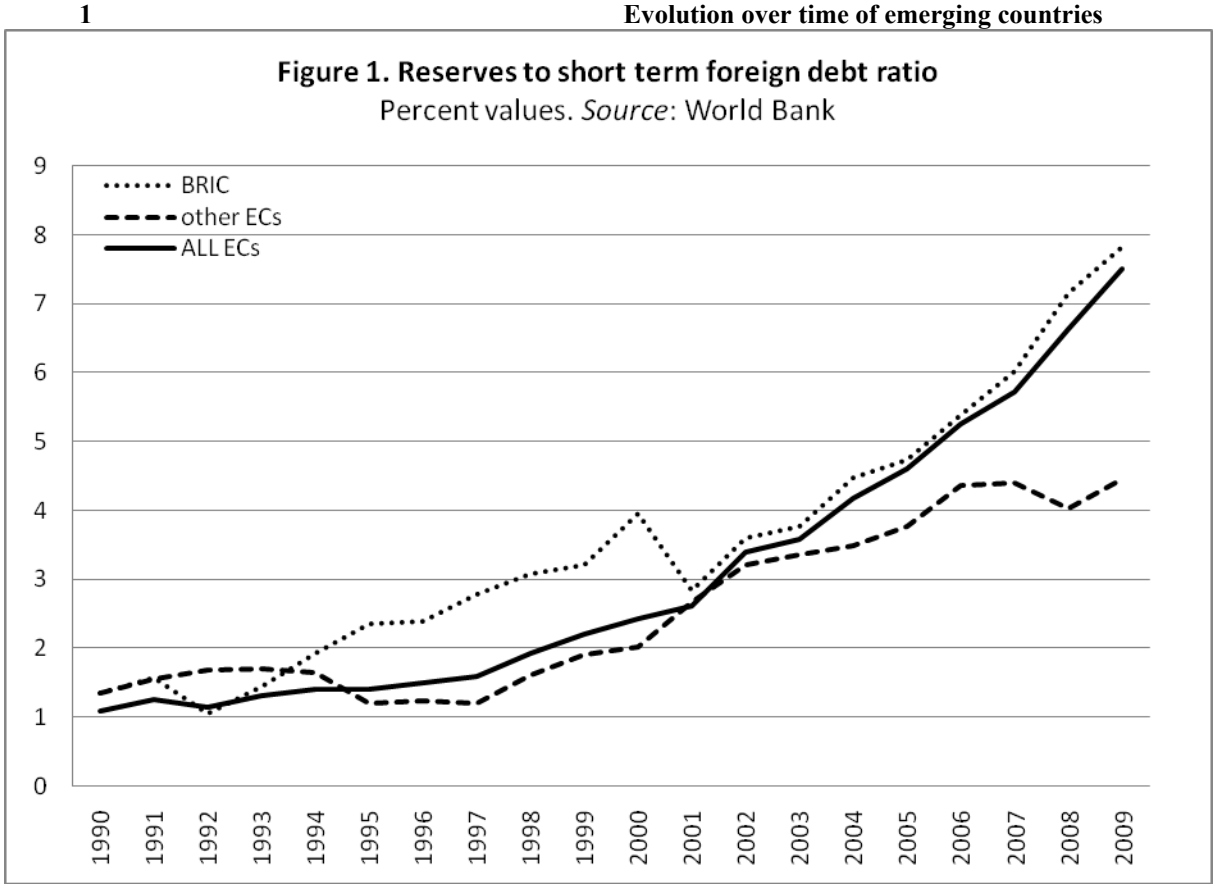
[2] Recent empirical studies on the effects of financial crises are Hutchison and Noy (2006) and Bordo, Meissner and Stuckler (2010). Other theoretical studies focus on the effect of capital outflows on the real exchange rate (Bar-Ilan and Marion, 2009; Kehoe and Ruhl, 2009) and on the determination of capital outflows as solutions of a general equilibrium framework (Devereux and Sutherland, 2009; Alfaro and Kanczuk, 2009).

[3] Devereux and Sutherland (2009), by contrast, argue that holding fixed income nominal bonds and issuing claims on capital (FDI) achieves a considerable degree of international risk-sharing.

the degree of openness to global goods and financial markets. These parameters, which account for the competitiveness of the domestic industry and for the marginal cost of long term finance, are crucial for deriving numerical solutions. Numerical simulations of the model are able to explain both the high GDP growth and the growing stock of reserves as the outcome of the same process of globalisation of the emerging economies.

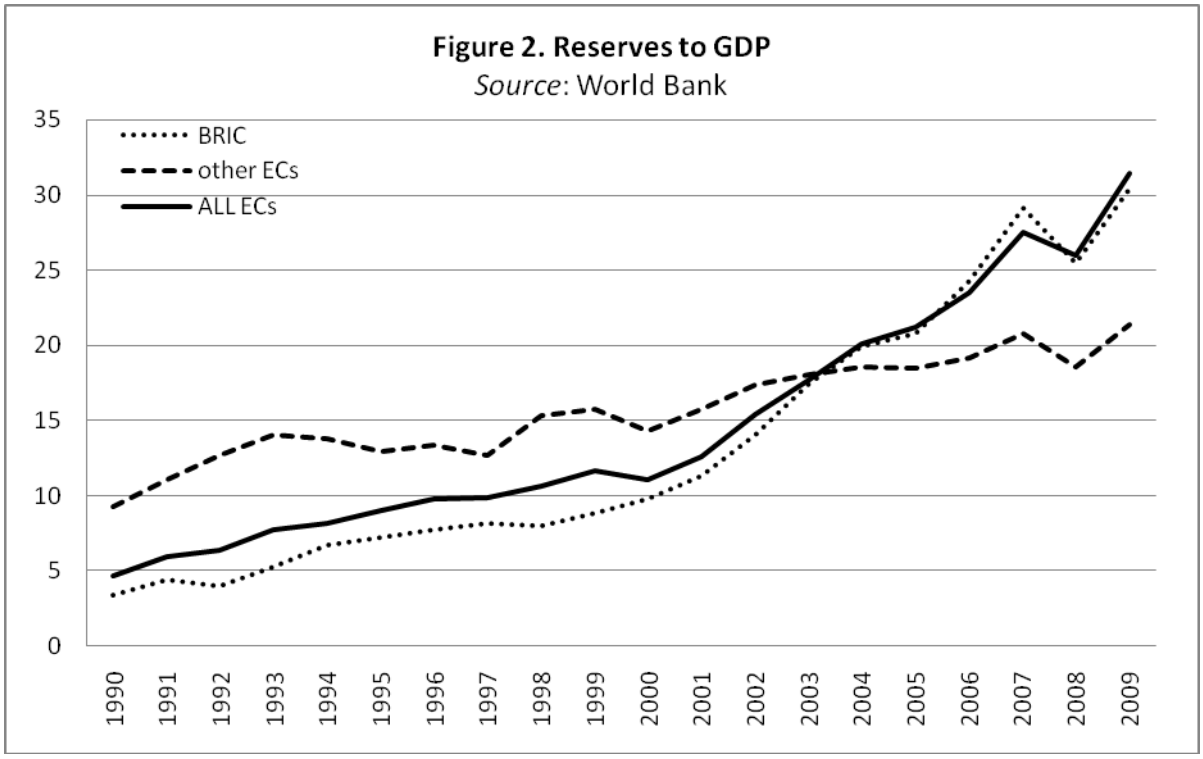
The remainder of the paper is organised as follows. In section 2, stylised facts are inferred from a descriptive analysis of the emerging countries. In section 3, the model is presented in the general formulation and the approximated analytical solution is derived. Section 4 derives numerical solutions compatible with observed stylised facts. Section 5 concludes.

1 Evolution over time of emerging countries

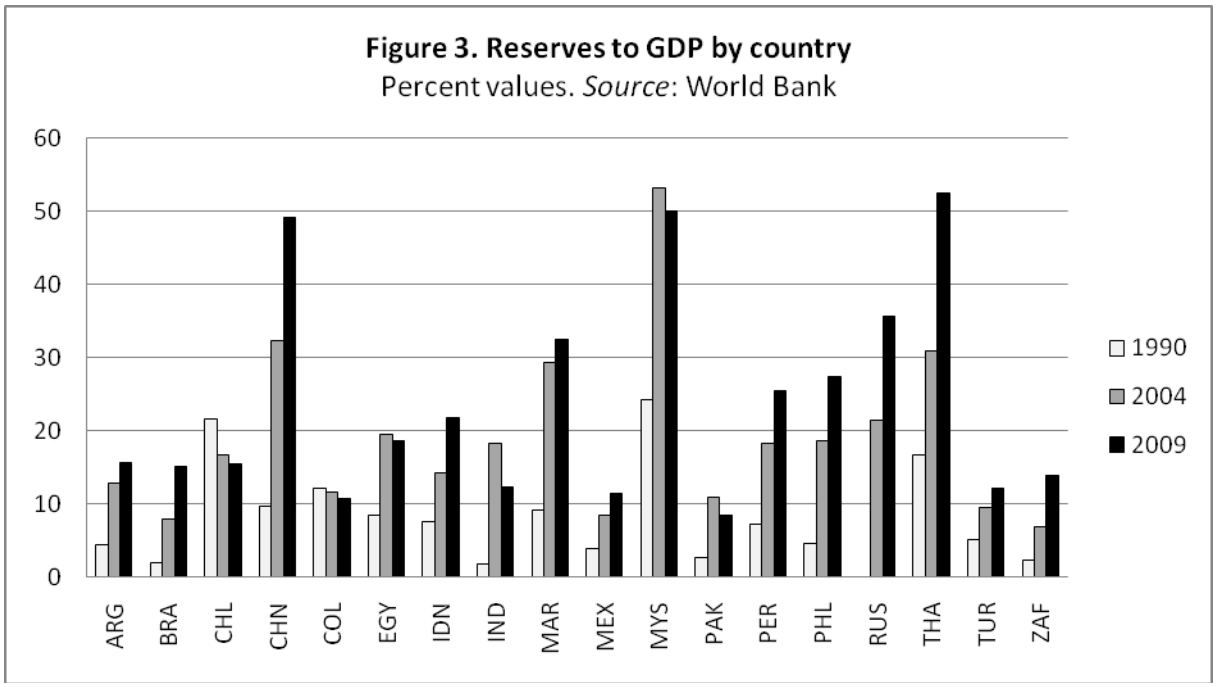


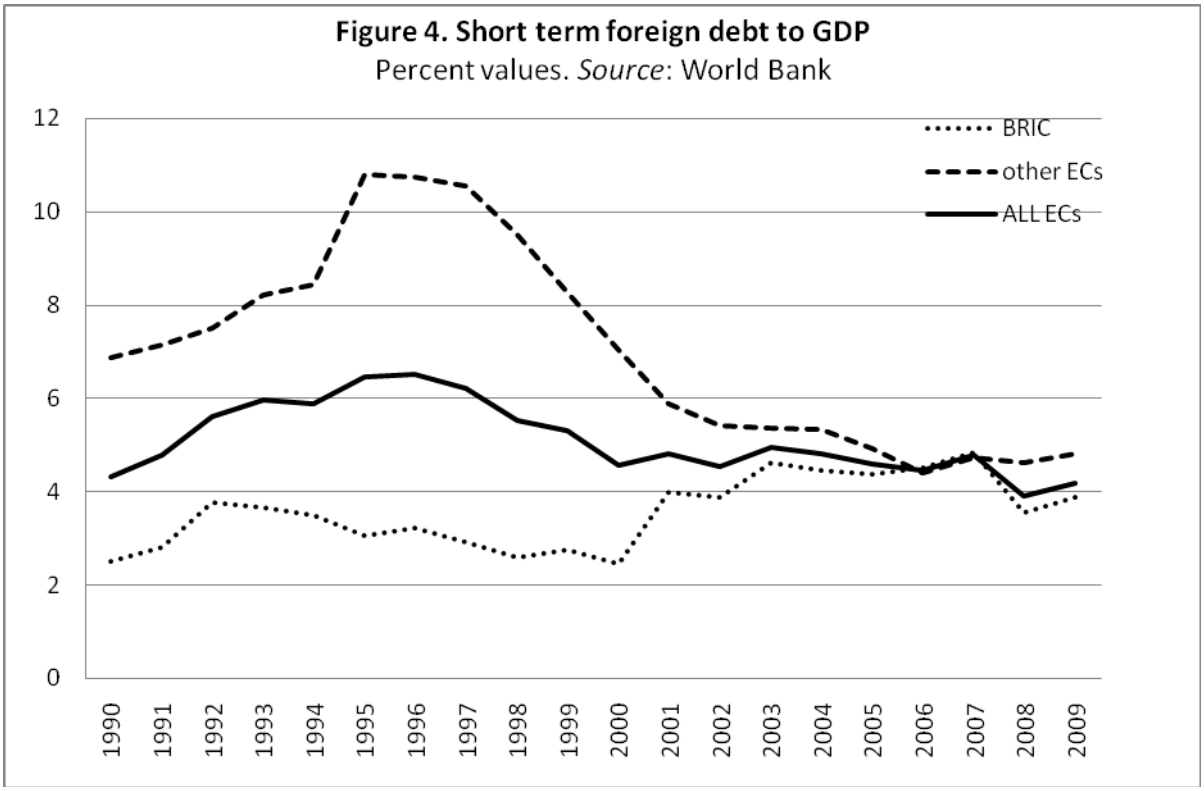
The empirical descriptive analysis of this section is based on a sample of 18 emerging countries distributed across Asia, Latin America and Africa from 1990 to 2009. The sample is split into two subsamples: the BRIC economies (Brazil, Russia, India and China), which in the last decade account for more than 60% of the sample's GDP, and the other 14 smaller economies (less than 40% of the sample's GDP).[4] Figures in this section report the evolution of variables for these two subsamples and for the weighted average of the full sample.

[4]Due to policy coordination, South Africa nowadays is often considered a new member of the group of strongest emerging (BRICS) economies. In this paper, however, it is considered more homogeneous with the smaller emerging countries as its GDP accounts for about 2.6% of the sample.



At the end of the 90s, leading institutions agreed on the policy guidance that holding reserves equal to short term debt was sufficient to counteract and prevent crises due to capital outflows (Greenspan, 1999, Fisher, 2001). However, as Figure 1 illustrates, the ratio of reserves to short term debt climbed from around 1 in 1990 to around 7.5 in 2009. The increasing level of this ratio was particularly pronounced in the group of bigger economies. Consistent with previous empirical studies (Aizenman and Lee, 2007; Devereux and Sutherland, 2009; Rodrik, 2006), Figures 2 indicates that the rise in the reserves to short term debt ratio is certainly due to the increasing demand for international reserves. This was around 5% of GDP in 1990 and rose constantly to around 30% in 2009, with the exception of difficult years (2000, 2008), when reserves were partially reduced. Figure 3 shows that the accumulation of reserves over two decades was a common attitude in all countries of the sample, except for Chile and Colombia.





The short term foreign debt (Figure 4) climbed during the 90s in the smaller countries group (from 6.9% in 1990 to 10.6% in 1997) and decreased after the Asian Crisis to reach values stably below 5% of GDP in the last five years. This performance, however, is smoother if we look at the full sample weighted average level (continuous line), suggesting that the rising values of the aforementioned reserves to short term ratio can be explained more by the increasing demand for foreign reserves than by the decreasing level of the short term foreign debt. The stylised fact that the demand for reserves continued to increase even during periods where the short term debt decreased suggests that the Greenspan-Guidotti rule is not perceived as a sufficient recommendation to prevent new crises and that the short term debt is not the only variable to take into account when the foreign reserve policy is decided.

A strand of the economic literature emphasises that short term foreign debt is used up by emerging countries to finance long term investment projects (Chang and Velasco, 2001; Aizenman and Lee, 2007; Jeanne and Rancière, 2006; Jeanne, 2007). Assessing the overall effect of short term foreign debt on the level of investment is a difficult task. On the one hand, this source of finance, as it is cheaper than alternative sources (such as new equity capital or longer term debt), might contribute to increased investment; on the other hand, it makes domestic investment exposed to liquidity shocks due to foreign capital outflow, thereby inhibiting investment. Raising reserves as a buffer stock against capital outflows reduces the effects of liquidity shocks, but, as Greenwald and Stiglitz (2010) point out, is equivalent to channelling domestic saving away from the domestic investment. Empirical evidence seems to confirm that the effect of short term foreign debt on the level of investment is mixed. Rodrik (2006) and Aizenman (2005) already stated that increasing short term foreign debt in the 90s cannot be associated to increasing investment. In our sample, merely comparing the average values in the years 1990-99 and 2000-09, reported in Table 1, both the net investment (defined as gross fixed capital formation less depreciation) and the short term debt decreased in the smaller economies and increased for the BRIC countries. From a closer look at the trends, it can be observed that the net investment increased after 1998 in the BRIC group and after 2002 in the other emerging countries (Figure 5), while the ratio of short term foreign debt to net investment (Figure 6) was stable in BRIC economies and fell after 2000 in the smaller countries.

Table 1 – Evolution of emerging economies: growth, investment, short term debt and reserves

Average values based on World Bank data of 2 years GDP growth (2y growth), net (start up) investment in fixed capital assets over GDP (NI/GDP), stock of short term foreign debt over GDP (STD/GDP), stock of foreign reserves over GDP (RES/GDP), reserves to short term foreign debt ratio (RES/STD), corrected index of reserves to short term foreign debt ratio (RES/STD corr). NI is defined as gross fixed capital formation less depreciation; RES/STD corr is computed multiplying RES/SDT by the ratio of cumulative inflows of short term foreign debt to the cumulative sum of short term foreign debt and net equity inflows (setting 1990=1). Values refer to two different time periods (1990-99 and 2000-09) for each single country of the sample and for the following groups: Full sample (average values and weighted average values), BRIC economies and smaller economies.

1990-99	2y growth	NI/GDP	STD/GDP	RES/GDP	RES/STD	RES/STD corr
Full sample (average)	8.36	13.56	7.31	11.62	1.590	1.302
Full sample (weighted av.)	9.26	13.60	5.67	8.38	1.478	1.115
BRIC	7.84	13.37	3.09	6.50	2.106	1.476
Smaller Economies	8.51	13.61	8.81	13.29	1.508	1.188
Argentina	9.41	5.59	7.66	6.48	0.846	0.645
Brazil	5.11	7.00	5.17	5.55	1.075	0.736
Chile	13.43	10.73	7.15	21.57	3.018	2.168
China	22.44	22.92	2.77	11.41	4.113	4.070
Colombia	5.32	8.19	5.34	11.60	2.172	2.120
Egypt, Arab Rep.	9.04	12.13	5.38	22.95	4.267	4.925
Indonesia	12.78	11.30	13.39	10.76	0.804	0.776
India	11.94	12.73	1.68	5.64	3.350	1.575
Morocco	4.45	25.96	2.66	12.62	4.744	6.415
Mexico	6.74	12.41	7.83	5.59	0.714	0.451
Malaysia	14.56	7.77	8.68	30.83	3.552	4.010
Pakistan	7.90	26.78	5.37	3.46	0.643	0.476
Peru	8.66	8.66	13.53	14.33	1.059	1.037
Philippines	6.35	11.89	9.55	11.82	1.238	1.152
Russian Federation	-8.13	10.84	2.78	2.79	1.004	0.995
Thailand	9.18	9.20	19.72	21.16	1.073	1.028
Turkey	7.53	30.05	8.48	7.10	0.837	0.761
South Africa	3.80	9.91	4.36	3.04	0.696	-0.713

2000-09	2y growth	NI/GDP	STD/GDP	RES/GDP	RES/STD	RES/STD corr
Full sample (average)	11.31	11.70	5.26	19.22	3.657	1.978
Full sample (weighted av.)	14.05	16.39	4.57	20.96	4.589	2.432
BRIC	14.08	15.00	4.07	20.23	4.976	2.634
Smaller Economies	10.52	10.76	5.26	18.78	3.572	1.885
Argentina	8.29	7.38	11.85	12.61	1.065	1.135
Brazil	7.06	5.59	3.50	9.02	2.574	0.979
Chile	8.04	8.85	8.03	16.87	2.100	1.206
China	22.01	28.68	4.90	32.26	6.588	4.619
Colombia	8.43	8.20	3.17	10.36	3.267	2.555
Egypt, Arab Rep.	9.98	12.12	2.15	19.37	9.004	10.453
Indonesia	32.30	8.74	6.82	14.06	2.063	2.389
India	14.98	18.11	1.77	16.95	9.599	2.226
Morocco	10.05	19.03	2.63	26.35	10.012	7.459
Mexico	4.29	17.06	1.87	8.34	4.467	1.327
Malaysia	10.10	9.00	8.95	44.00	4.918	4.509
Pakistan	9.69	13.93	1.42	9.11	6.407	2.076
Peru	11.29	6.84	4.57	19.72	4.315	3.280
Philippines	9.58	9.71	5.88	21.48	3.654	2.069
Russian Federation	12.30	7.64	4.80	22.87	4.767	4.006
Thailand	8.96	6.70	9.37	33.68	3.596	1.670
Turkey	8.37	16.31	7.36	10.93	1.485	1.193
South Africa	7.97	6.81	5.56	8.68	1.561	0.310

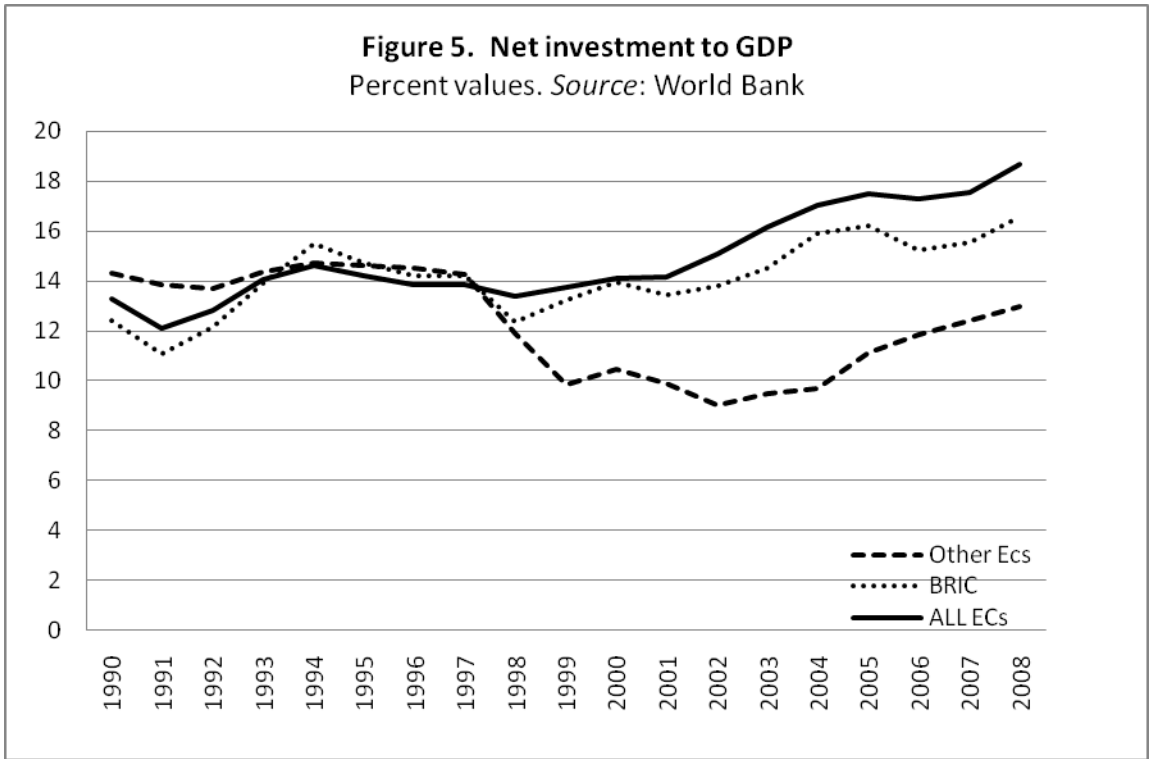


Figure 5. Net investment to GDP
Percent values. Source: World Bank
20
18
16
14
12
10
8
6
4
2
0
Other Ecs
BRIC
ALL ECs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

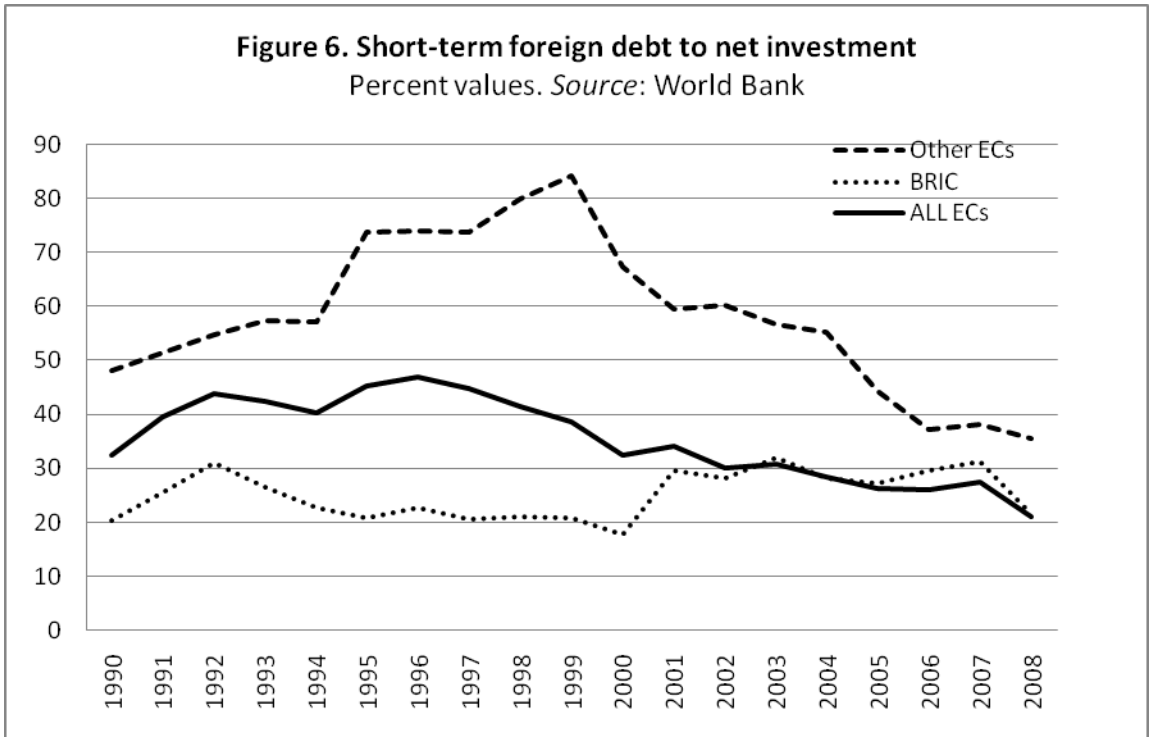


Figure 6. Short-term foreign debt to net investment
Percent values. Source: World Bank
90
80
70
60
50
40
30
20
10
0
Other ECs
BRIC
ALL ECs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

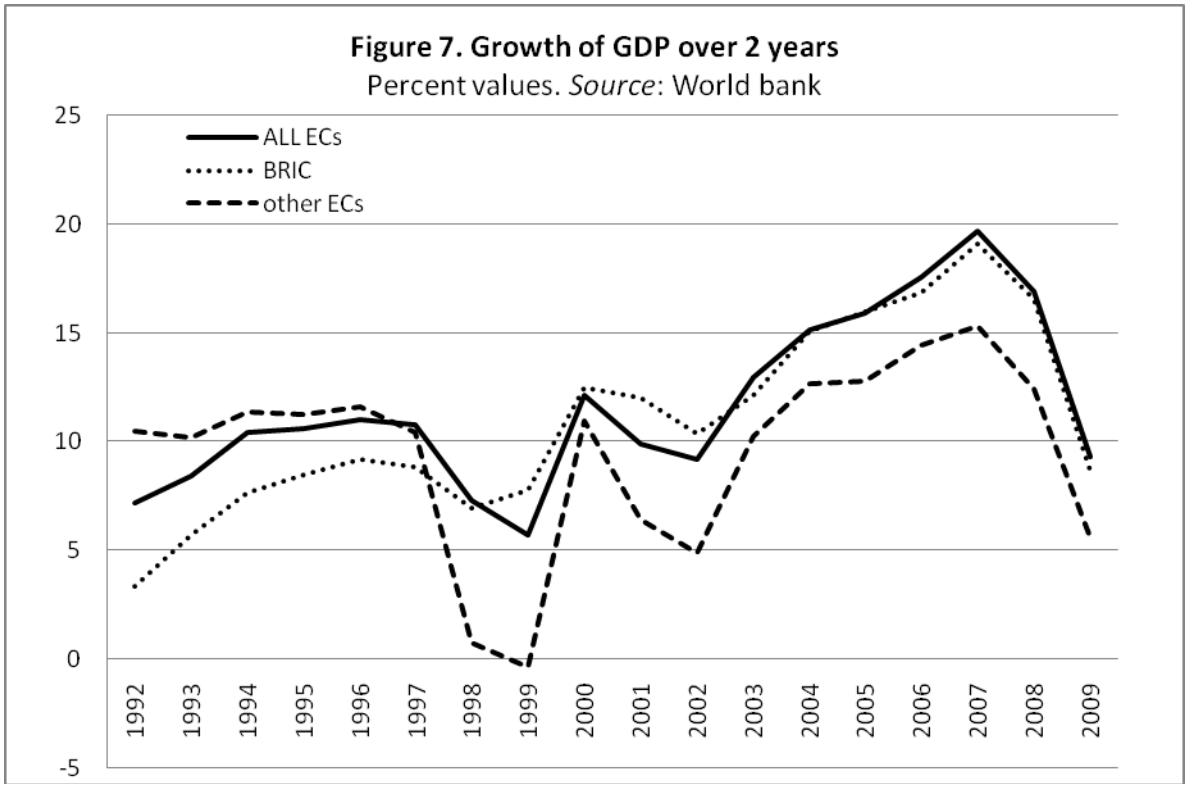


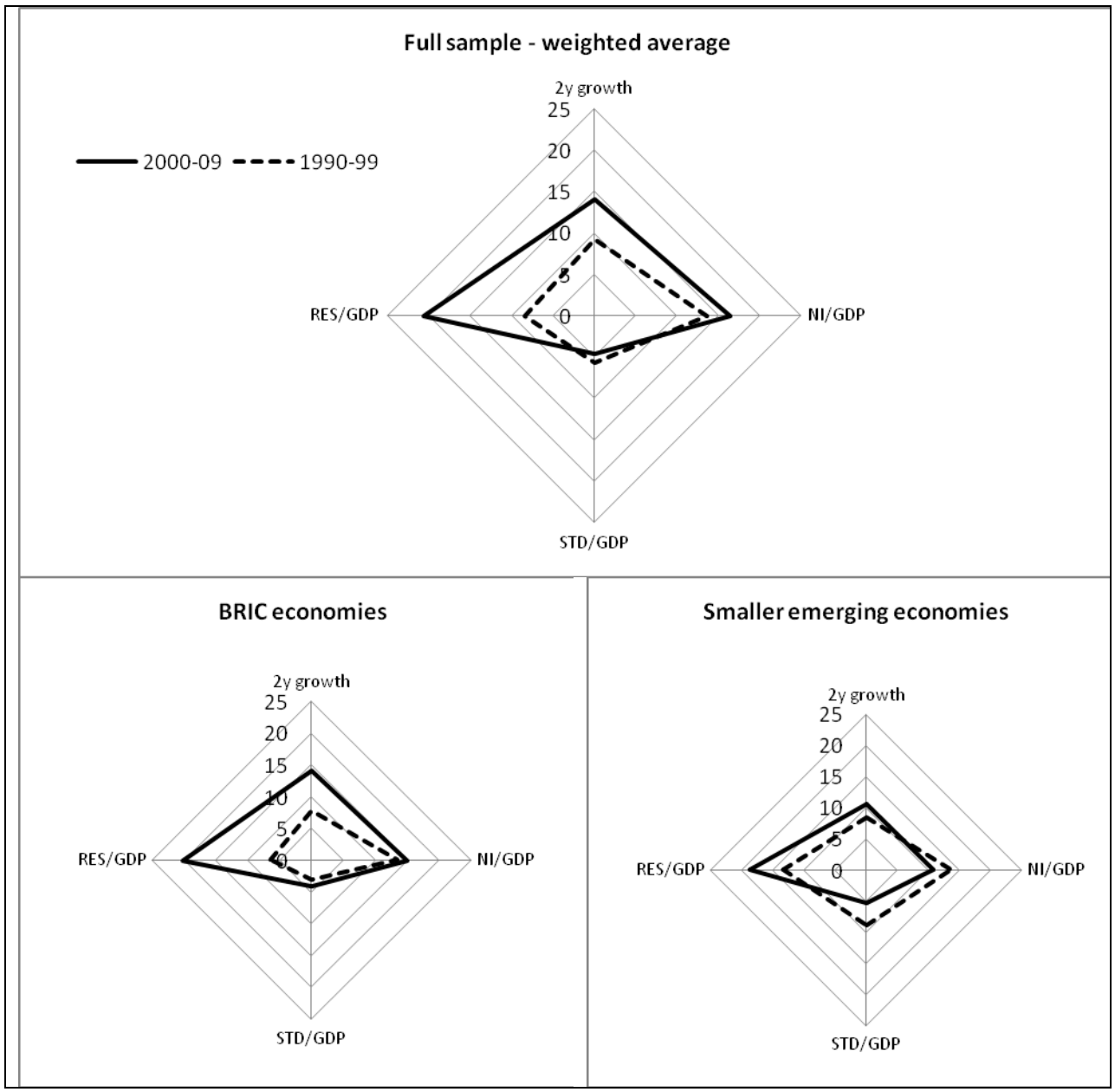
Figure 7 illustrates how the long term GDP growth (average on 2 years) increased sharply for 5 years from 2002 to 2007, to an extent that the growth in the net investment is not able to explain.[5] The average values reported in Table 1 confirm this result: 2 year growth rates doubled in the BRIC countries while the net investment increased by less than two percent of GDP, and increased in the smaller countries even though the net investment decreased.

Overall, the empirical descriptive analysis of this section allows us to establish the following stylised facts: firstly, the stock of reserves grows independently from short term foreign debt; secondly, there is not a clear relation between short term foreign debt and investment in new capital assets; thirdly, countries have been able to grow considerably in the last decade even though the investment in new capital assets has not changed to a relevant extent; fourthly, massive reserves accumulation, rather than causing underinvestment and slowing down the economy, seem to have grown so has GDP. These stylised facts are summarised in Figure 8, which illustrates the development of the economies based on mean values of the variables considered in this section over the last two decades.

While the evidence presented in this section seems to contrast with existing explanations of the rationale for (and consequence of) reserve accumulation, the next section finds a theoretical explanation which makes all the aforementioned stylised facts consistent with each other.

Figure 8 - Evolution of emerging economies
Source: World bank, average values reported in Table 1

[5]Variation in output unexplained by factors of productions are traditionally attributed to total factor productivity, which is, however, a residual, thus a `measure of our ignorance'. See Caselli (2005) and Sturgill (2009) for efforts to raise empirically the explanatory power of factors and factor shares.



3 Reserves, investment and finance

This section builds the theoretical model explaining the relation between growth, investment, short term foreign debt and foreign reserves, based on the characteristics of both the good industry and the financial market.

For simplicity, we assume that all firms are identical and that population size is equal to 1. Therefore the model describes a single firm but all variables involved denote national aggregate quantities. As in previous studies on the role of reserves, we assume that liquidity shock may force underinvestment, reducing second period output. As our focus is on developing countries, we assume that domestic long term investment of the firm is financed by (i) *cash flow* from preexisting assets, (ii) *short term finance* from banks and (iii) *long term finance*, from any sources (long term debt from banks, bonds, new equities, capital venture, etc.). Short term finance depends on two components: supply of foreign short term credit and supply of domestic credit. We assume that domestic credit is cheaper but scarce (for simplicity, interest rate is zero), whereas the cost of foreign short term credit is higher and constant ($r > 0$). We also set the interest rate on foreign reserves equal to zero, therefore r also represents the spread between the low yield on liquid reserve assets and the cost of external borrowing (Baker and Walentin, 2001; Rodrik, 2006; Stiglitz, 2006). Demand for short term credit to finance the investment is perfectly elastic, as the long term finance is more expensive. We assume that raising long term finance is costly and the cost increases with the quantity.

Investment starts at time 0 with a new fixed (start up) capital factor, K, and is completed at time 1 with a variable component, i. The variable investment I includes payment to all factors which are different from the initial

fixed capital (intangible capital, human capital, workers, capital replacement, etc.)

Physical output is realised at time 2 and given by

$$f(K,I) = \omega K^{\alpha} I^{\beta}. \quad (1)$$

We adopt the conventional (but unnecessary) assumption of constant return to scale: $\alpha + \beta = 1$. For simplicity, we assume that at time 0 the only source of short term finance is from foreigners, and the amount is given by D_0. Time 0's start up capital is thus

$$K = D_0 + V, \quad (2)$$

where V is cash flow from preexisting assets. Time 1's investment is financed with (domestic and foreign) short term finance, D_1, and long term finance, B:

$$I = D_1 + B. \quad (3)$$

At time 1, the firm must service the previous period's debt (principal and interests) and renewal of foreign debt is hit by a multiplicative shock ε, distributed as a normal $N(1, \sigma^2)$; therefore, available funds from foreigners are given by $D_0(\varepsilon - 1 - r)$; the firm at time 1 also raises short term debt from domestic credit, ΔDC. The latter is determined by the monetary policy. Recalling that change in money supply is the sum of changes in domestic credit and foreign reserves, i.e. $\Delta M = \Delta DC + \Delta R$, we assume that the central bank at time 1 fulfills the following simple rules:

1. *Precautionary policy*: the proportion of foreign reserves to private foreign short term capital inflow is constant (h) if the net capital inflow is positive ($\varepsilon > 0$), zero otherwise;
2. *Sterilisation of foreign currency operations*: if the net capital inflow is non negative at time 1, money supply is unchanged ($\Delta M = 0$ if $\varepsilon \geq 0$);
3. *Expansionary policy during a crisis*: if the net capital inflow is negative at time 1, new money is issued in proportion h of the net capital outflow ($\Delta M = -hD_0\varepsilon$ if $\varepsilon < 0$).

From the aforementioned rules, reserves at times 0 and 1 are given, respectively, by

$$R_0 = hD_0 \quad (4)$$

and

$$R_1 = \begin{cases} hD_0\varepsilon & \text{if } \varepsilon \geq 0 \\ 0 & \text{if } \varepsilon < 0 \end{cases}, \quad (5)$$

whereas domestic credit at time 1 is given by

$$\Delta DC = -hD_0(\varepsilon - 1). \quad (6)$$

Summing up domestic and foreign credit yields the total short term finance available to the firm at time 1:

$$D_1 = D_0[h + (1-h)\varepsilon - (1+r)]. \quad (7)$$

At time 2 the output is sold at price θ and revenues are given by $F(K,I) = \theta f(K,I)$. We make the assumption that a negative relation (even very small) exists between time 2's output price and time 1's capital inflow:

$$\theta = \eta(\varepsilon - 1) + 1 \quad (8)$$

with $\eta < 0$. The coefficient η captures the intensity of this relation and accounts for the competitiveness of the product's industry in this small open economy. The more the industry is exposed to local and global competition, the more any additional foreign capital inflow is likely to be related to a downwards shift in the supply curve. Marginal cost reduction could be due to the birth of new firms, to lower market power of previous existing companies, to lower power of trade unions. More competition, thus, leads to a lower final output price.

The cost of long term finance is a growing function of the total amount. To keep the analysis as simple as possible, we model this cost as an exponential function:

$$C(B) = sB^{1+\delta}, \tag{9}$$

where s is a scale parameter and the coefficient δ accounts for the cost that the firm has to pay to increase long term finance. δ takes positive values and is expected to be lower in more globalised emerging economies with a more developed financial market.

The firm enters time 1 with the given stock of capital K and with available short term finance D_1 and chooses investment I (and thereby the amount of long term finance B) to maximise net expected profits (assuming discount rate equal to 1 for simplicity):

$$\pi = \theta f(K, I) - I - D_0 sr - C(B). \tag{10}$$

The first order condition for this problem is:

$$\theta f_I = 1 + C_B, \tag{11}$$

where f_I and C_B are the first derivatives of (1) and (9), respectively, with respect to I and B.[6]

The Central Bank acts in the general interest of the economy and chooses optimal h by maximising the expected profit of the firm subject to available information at time 0, when the future foreign capital inflow is still uncertain:

$$\max_h E_0 \pi(D_1(s, h)). \tag{12}$$

Based on the result of Froot, Scharfstein, and Stein (1993)[7], the non-closed form solution to (12) is given by the following formula:

$$h^* = 1 + \frac{\eta}{D_0} \frac{E_0\left[\frac{-f_I C_{BB}}{\theta f_{II} - C_{BB}}\right]}{E_0\left[\frac{-2 f_{II} C_{BB}}{\theta f_{II} - C_{BB}}\right]}, \tag{13}$$

where f_{II} and C_{BB} are second derivatives of (1) and (9).

Expression (13) shows clearly that the reserve policy depends on the parameter η, capturing the relation between return on investment and foreign capital fluctuations. The closer to zero η is, the lower the reserves to short term debt ratio, h, which is equal to 1 (the value of the Greenspan-Guidotti rule) when there is no relation between capital inflow and return on investment.

4 Explaining the evidence

The solution of the model presented in section 3 crucially depends on two parameters, which account for the marginal cost of long term finance, δ, the competitiveness of the domestic industry, η. Their changing value can be associated to the process of globalisation.

Comparison is made, again, between years 1990-99 and 2000-09 average values. The model is calibrated to mimic observed average data reported in Table 1. In calibrating the model, we take as given time 0 data, i.e. the values of the fixed investment ($K = NI/GDP$) and short term foreign debt ($D_0 = STD/GDP$), and we infer the values of the parameters η and δ compatible with observed long period (2 years) growth and reserves to GDP ratio. We also assume that the elasticity and scale parameters of the investment function are fixed and take standard values, although the factors involved (K, I) are not defined in a standard way. The fixed capital share (NI in Table 1) is, thus, $\alpha = 0.25$ and the variable investment's share is $\beta = 0.75$.[8] The parameters multiplying the investment function (ω) and the cost of long term finance function (s), are set constant throughout all numerical simulations.[9] We also set a constant value of the interest rate on foreign short term debt, $r = 0.1$ (consistent with

[6] At time 1, D_1 is given, hence $\frac{dB}{dI} = 1$.

[7] See Froot, Scharfstein, and Stein (1993), note 18 pag.1639. The proof is based on a result by Rubinstein (1976).

[8] Estimates of physical product elasticity calculation in emerging countries are in Kehoe and Ruhl (2009).

[9] Constant ω is equivalent to assuming unchanged total factor productivity through time. This is obviously an unrealistic assumption, but methodologically helpful to focus on the potential effects of the structural parameters, η and δ.

Rodrik, 2006, and Stiglitz, 2006) and of the variance of the foreign capital inflows.[10] All panels in Table 2 compute solutions for the values of η from -0.01 to -0.13 and δ from 0.34 to 0.58. Each solution implies values for time 0's optimal reserves to short term foreign debt ratio and for time 1's expected variable investment, total investment, long term finance, average cost of long term finance, long period (2 years) growth. Bold characters are values of the 2 years growth and the optimal ratio h^* compatible with those observed in our sample (Table 1).

Numerical results suggest that lower cost of long term finance could explain, *ceteris paribus*, how BRIC economies, in the last decade, have managed to double their average growth rates with little increase in new capital assets and short term foreign debt, as well as how smaller economies have managed to increase growth despite a lower level of investment in new capital assets and a lower short term foreign debt. The value of δ compatible with the observed growth rates goes from 0.5 to 0.4 in the weighted average sample (panels A-B), from 0.56 to 0.38 in the BRIC subsample (panels C-D), from 0.53 to 0.4 in the smaller countries subsample (panels E-F). This change implies that the average cost of long term finance declines, in all countries, from 26% to 22% (recall that the cost of short term foreign debt, r, is set equal to 10%) while the quantity of long term finance increases (from 27.4% to 41.5% of GDP). Simulations imply a relevant difference between subsamples: while the declining average cost is a common trend in both subsamples (from 29% to 21% in BRIC economies, from 28% to 20% in smaller countries), this is associated to almost a double quantity of long term finance in the BRIC economies and a more modest change (one fifth higher) in the smaller economies. Adding the net start up investment (given by data) and the variable investment (found as optimal solution) yields the total investment, which increases in all numerical simulations (+56% in BRIC and +7% in smaller economies, +42% on average) as a pure result of the decreasing cost of long term finance.

Lower values of δ are not able, alone, to account for the observed increased ratios of reserves to short term foreign debt ratios, h^*. In principle, lowering the cost of long term finance should even induce reduction of the stock of reserves, as it reduces the incentive to substitute extra short term finance with extra long term finance. Reserves, however, rise, because a lower value of δ also boosts the expected level of variable investment, which in turn requires a higher expected level of long term finance. Considering the full sample, the average ratio h^* was 1.478 in 1990-99, which corresponds to $\delta = 0.5$ and η between -0.02 and -0.03 in panel A.

[10] Unreported sensitivity analysis suggests that volatility is irrelevant for values of η that are sufficiently low.

Table 2. Optimal solutions for different values of parameters

Numerical simulation of the solution of the model when the cost of external finance rises (δ from 0.34 to 0.58) and when the correlation between return on investment and short term foreign capital inflow rises (η from -0.01 to -0.13). Values of the short term foreign debt (STD) and the net (start up) investment (NI) are set equal to average values reported in Table 1. Panels from A to F report numerical results for different samples (Full sample, BRIC economies and smaller economies) in two different time periods (1990-99 and 2000-09). All Panels report solutions for optimal ratios of reserves to short term foreign debt ratio (h*) and for the expected values of the following variables: variable investment (VI), total investment (TI), long term finance (LTF), interest on short term foreign debt (Int. on STD), average cost of long term finance (AC on LTF), 2 years GDP growth (2y GDP growth). Other parameters of the model are set constant as follows: short term foreign debt volatility, σ=0.7; interest rate on short term foreign debt, r=0.1; scale parameters of the investment function, ω=2.2, and of the long term finance cost function, s=0.05; share of fixed capital (NI), α=0.25, and of other factors (VI), β=0.75.

Panel A. Full sample - Weighted average – Years 1990-99

RES to STD (h*)													
η \ δ	**0.34**	**0.36**	**0.38**	**0.4**	**0.42**	**0.44**	**0.46**	**0.48**	**0.5**	**0.52**	**0.54**	**0.56**	**0.58**
-0.01	1.300	1.284	1.268	1.253	1.239	1.225	1.212	1.200	1.189	1.179	1.169	1.159	1.151
-0.02	1.600	1.567	1.536	1.506	1.478	1.451	1.425	1.401	**1.378**	1.357	1.337	1.319	1.302
-0.03	1.901	1.852	1.805	1.760	1.717	1.676	1.638	1.602	**1.568**	1.536	1.506	1.479	1.453
-0.04	2.202	2.137	2.074	2.014	1.956	1.902	1.851	1.803	1.758	1.715	1.676	1.639	1.604
-0.05	2.504	2.422	2.343	2.268	2.197	2.129	2.065	2.005	1.948	1.895	1.845	1.799	1.755
-0.06	2.807	2.709	2.614	2.524	2.438	2.356	2.279	2.207	2.139	2.075	2.015	1.959	1.907
-0.07	3.112	2.996	2.886	2.780	2.680	2.584	2.494	2.410	2.330	2.256	2.186	2.121	2.060
-0.08	3.418	3.285	3.159	3.038	2.923	2.813	2.711	2.614	2.522	2.437	2.357	2.282	2.213
-0.09	3.725	3.576	3.433	3.297	3.167	3.044	2.928	2.818	2.716	2.619	2.529	2.445	2.366
-0.1	4.035	3.869	3.709	3.557	3.412	3.275	3.146	3.024	2.910	2.802	2.702	2.608	2.521
-0.11	4.346	4.163	3.987	3.819	3.659	3.508	3.365	3.231	3.105	2.986	2.876	2.772	2.676
-0.12	4.660	4.459	4.267	4.083	3.908	3.743	3.586	3.439	3.301	3.172	3.050	2.937	2.831
-0.13	4.977	4.758	4.549	4.349	4.159	3.979	3.809	3.649	3.499	3.358	3.226	3.103	2.988
TI/GDP	56.12	53.80	51.58	49.46	47.44	45.52	43.72	42.01	40.41	38.91	37.51	36.20	34.97
NI/GDP	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60
STD/GDP	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67
VI/GDP	42.52	40.20	37.98	35.86	33.84	31.92	30.12	28.41	26.81	25.31	23.91	22.60	21.37
LTF/GDP	43.09	40.77	38.55	36.42	34.40	32.49	30.68	28.98	27.38	25.88	24.48	23.16	21.94
Int. on STD/GDP	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57
AC of LTF	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30
2y GDP growth	14.23	13.65	13.06	12.45	11.83	11.22	10.60	9.98	**9.37**	8.77	8.17	7.59	7.02

Panel B. Full sample - Weighted average – Years 2000-99

Res to STD (h*)													
η \ δ	**0.34**	**0.36**	**0.38**	**0.4**	**0.42**	**0.44**	**0.46**	**0.48**	**0.5**	**0.52**	**0.54**	**0.56**	**0.58**
-0.01	1.432	1.407	1.383	1.360	1.339	1.318	1.299	1.281	1.265	1.249	1.235	1.221	1.209
-0.02	1.863	1.813	1.766	1.720	1.677	1.637	1.599	1.563	1.530	1.499	1.470	1.443	1.417
-0.03	2.296	2.221	2.149	2.081	2.017	1.956	1.899	1.845	1.795	1.748	1.705	1.664	1.626
-0.04	2.729	2.629	2.533	2.443	2.356	2.275	2.199	2.128	2.061	1.998	1.940	1.886	1.836
-0.05	3.164	3.038	2.919	2.805	2.697	2.596	2.500	2.411	2.327	2.249	2.176	2.108	2.045
-0.06	3.600	3.449	3.305	3.168	3.039	2.917	2.802	2.695	2.594	2.500	2.413	2.331	2.255
-0.07	4.037	3.861	3.693	3.533	3.382	3.239	3.105	2.979	2.862	2.752	2.650	2.555	2.466
-0.08	4.477	4.276	4.083	3.900	3.727	3.563	3.409	3.266	3.131	3.005	2.888	2.779	2.678
-0.09	4.920	4.692	4.475	4.268	4.073	3.888	3.715	3.553	3.401	3.259	3.127	3.004	2.890
-0.1	5.365	5.111	4.869	**4.639**	4.421	4.216	4.023	3.842	3.673	3.515	3.368	3.231	3.104
-0.11	5.813	5.533	5.266	5.012	4.771	4.545	4.332	4.132	3.946	3.771	3.609	3.458	3.318
-0.12	6.264	5.958	5.665	5.387	5.124	4.876	4.643	4.424	4.220	4.030	3.852	3.687	3.534
-0.13	6.719	6.386	6.068	5.765	5.479	5.209	4.956	4.719	4.497	4.290	4.097	3.917	3.750
TI/GDP	65.69	62.83	60.11	57.52	55.07	52.76	50.58	48.55	46.64	44.86	43.20	41.66	40.22
NI/GDP	16.39	16.39	16.39	16.39	16.39	16.39	16.39	16.39	16.39	16.39	16.39	16.39	16.39
STD/GDP	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
VI/GDP	49.30	46.44	43.72	41.13	38.68	36.37	34.19	32.16	30.25	28.47	26.81	25.27	23.83
LTF/GDP	49.75	46.90	44.18	41.59	39.14	36.83	34.65	32.61	30.71	28.93	27.27	25.73	24.29
Int. on STD/GDP	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46
AC of LTF	0.19	0.20	0.21	0.22	0.23	0.24	0.26	0.27	0.28	0.29	0.30	0.31	0.32
2y GDP growth	16.67	15.92	15.15	**14.37**	13.59	12.80	12.01	11.23	10.46	9.70	8.96	8.23	7.52

From panel B, it can be verified that lowering δ and holding η constant would imply a ratio increasing to a value between 1.72 and 2.081 only. The observed value, however, is 4.589 and is consistent with η around -0.1. Similarly, the values of η implied the subsamples go from -0.04 to -0.1 for the BRIC economies and from -0.045 to -0.11 for the smaller economies.

Panel C. BRIC Economies – Years 1990-99

Res to STD (h*) η δ	0.34	0.36	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.52	0.54	0.56	0.58
-0.01	1.544	1.514	1.486	1.459	1.434	1.409	1.386	1.365	1.345	1.325	1.308	1.291	1.275
-0.02	2.088	2.029	1.973	1.919	1.868	1.819	1.773	1.730	1.689	1.651	1.615	1.582	1.551
-0.03	2.633	2.545	2.460	2.379	2.302	2.229	2.160	2.095	2.034	1.977	1.924	1.873	1.827
-0.04	3.179	3.061	2.948	2.840	2.737	2.640	2.548	2.461	2.380	2.304	2.232	**2.165**	2.103
-0.05	3.726	3.579	3.438	3.302	3.174	3.052	2.937	2.828	2.727	2.631	2.541	2.458	2.380
-0.06	4.276	4.099	3.929	3.766	3.612	3.465	3.327	3.196	3.074	2.959	2.852	2.751	2.657
-0.07	4.828	4.620	4.422	4.232	4.051	3.880	3.718	3.566	3.423	3.288	3.163	3.045	2.935
-0.08	5.382	5.145	4.917	4.699	4.492	4.296	4.111	3.937	3.773	3.619	3.475	3.340	3.215
-0.09	5.940	5.672	5.415	5.169	4.936	4.715	4.506	4.309	4.124	3.951	3.789	3.637	3.495
-0.1	6.501	6.202	5.916	5.642	5.382	5.136	4.903	4.684	4.478	4.284	4.104	3.935	3.777
-0.11	7.065	6.736	6.420	6.118	5.831	5.559	5.302	5.060	4.833	4.620	4.420	4.234	4.060
-0.12	7.634	7.274	6.927	6.597	6.283	5.985	5.704	5.439	5.191	4.957	4.739	4.535	4.345
-0.13	8.208	7.816	7.439	7.080	6.738	6.414	6.109	5.821	5.550	5.297	5.060	4.838	4.631
TI/GDP	55.37	53.10	50.93	48.85	46.87	44.99	43.22	41.55	39.98	38.51	37.13	35.84	34.64
NI/GDP	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37
STD/GDP	3.09	3.09	3.09	3.09	3.09	3.09	3.09	3.09	3.09	3.09	3.09	3.09	3.09
VI/GDP	42.00	39.73	37.56	35.48	33.50	31.62	29.85	28.18	26.61	25.14	23.76	22.47	21.27
LTF/GDP	42.31	40.04	37.86	35.79	33.81	31.93	30.16	28.49	26.92	25.45	24.07	22.78	21.58
Int. on STD/GDP	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31
AC of LTF	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30
2y GDP growth	14.04	13.47	12.90	12.31	11.71	11.11	10.50	9.90	9.31	8.72	8.14	**7.58**	7.03

Panel D. BRIC Economies – Years 2000-99

Res to STD (h*) η δ	0.34	0.36	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.52	0.54	0.56	0.58
-0.01	1.452	1.427	1.402	1.379	1.357	1.336	1.317	1.298	1.281	1.265	1.250	1.236	1.223
-0.02	1.904	1.853	1.805	1.758	1.715	1.673	1.634	1.597	1.563	1.530	1.500	1.472	1.446
-0.03	2.357	2.281	2.208	2.138	2.072	2.010	1.951	1.896	1.844	1.796	1.751	1.709	1.669
-0.04	2.811	2.709	2.612	2.519	2.431	2.348	2.269	2.196	2.126	2.062	2.002	1.945	1.893
-0.05	3.266	3.139	3.017	2.900	2.790	2.686	2.588	2.496	2.409	2.328	2.253	2.183	2.117
-0.06	3.723	3.570	3.423	3.283	3.151	3.026	2.908	2.797	2.693	2.596	2.505	2.420	2.341
-0.07	4.181	4.002	3.831	3.668	3.513	3.366	3.228	3.099	2.977	2.864	2.758	2.659	2.567
-0.08	4.642	4.437	4.241	4.054	3.876	3.708	3.550	3.402	3.263	3.133	3.012	2.898	2.793
-0.09	5.106	4.874	4.652	4.441	4.241	4.052	3.874	3.707	3.550	3.403	3.266	3.139	3.020
-0.1	5.572	5.314	**5.067**	4.832	4.609	4.398	4.199	4.013	3.838	3.675	3.523	3.380	3.248
-0.11	6.041	5.756	5.484	5.224	4.978	4.746	4.527	4.321	4.128	3.948	3.780	3.623	3.477
-0.12	6.514	6.202	5.904	5.620	5.350	5.096	4.856	4.631	4.420	4.223	4.039	3.867	3.707
-0.13	6.991	6.651	6.327	6.018	5.725	5.448	5.188	4.943	4.714	4.499	4.299	4.113	3.939
TI/GDP	60.98	58.40	55.93	53.57	51.34	49.22	47.23	45.36	43.61	41.97	40.44	39.01	37.68
NI/GDP	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
STD/GDP	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07
VI/GDP	45.98	43.40	40.93	38.57	36.34	34.22	32.23	30.36	28.61	26.97	25.44	24.01	22.68
LTF/GDP	46.39	43.81	41.33	38.98	36.74	34.63	32.64	30.77	29.02	27.38	25.85	24.42	23.09
Int. on STD/GDP	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41	-0.41
AC of LTF	0.18	0.19	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31
2y GDP growth	15.47	14.81	**14.13**	13.44	12.74	12.04	11.34	10.64	9.95	9.27	8.60	7.95	7.32

Panel E. Smaller Emerging Economies – Years 1990-99

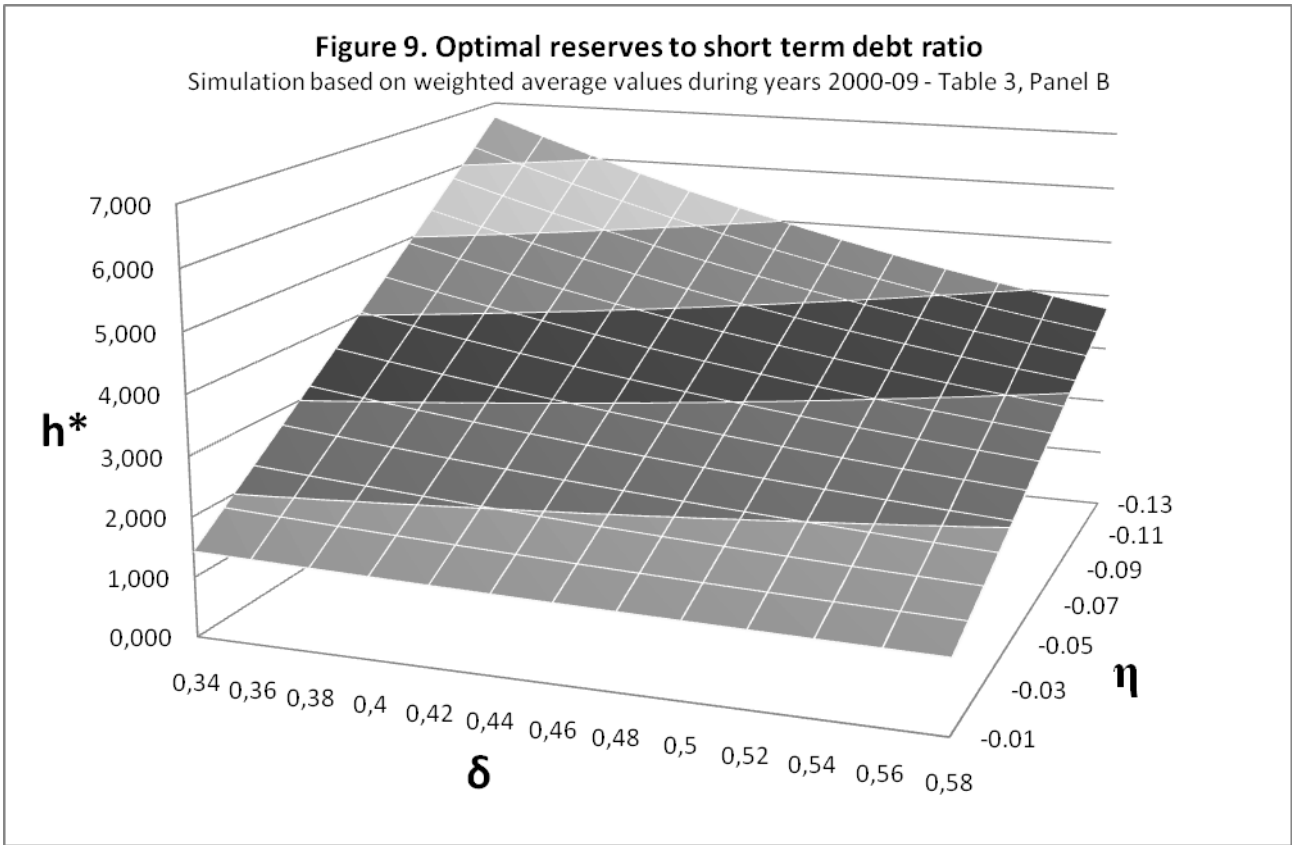
Res to STD (h*) η δ	0.34	0.36	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.52	0.54	0.56	0.58
-0.01	1.193	1.182	1.172	1.163	1.153	1.145	1.136	1.129	1.121	1.114	1.108	1.102	1.096
-0.02	1.386	1.365	1.345	1.325	1.307	1.289	1.273	1.257	1.243	1.229	1.216	1.204	1.193
-0.03	1.579	1.548	1.517	1.488	1.460	1.434	1.409	1.386	1.364	1.344	1.324	1.306	1.290
-0.04	1.773	1.731	1.690	1.651	1.614	1.579	1.546	1.515	1.486	**1.459**	**1.433**	1.409	1.386
-0.05	1.967	1.914	1.863	1.815	1.769	1.725	1.683	1.644	1.608	**1.574**	**1.541**	1.511	1.483
-0.06	2.162	2.098	2.037	1.979	1.923	1.871	1.821	1.774	1.730	1.689	1.650	1.614	1.581
-0.07	2.358	2.283	2.212	2.144	2.079	2.017	1.959	1.904	1.853	1.805	1.760	1.718	1.678
-0.08	2.555	2.469	2.387	2.309	2.235	2.164	2.098	2.035	1.976	1.921	1.869	1.821	1.776
-0.09	2.752	2.656	2.564	2.475	2.392	2.312	2.237	2.166	2.100	2.038	1.980	1.925	1.874
-0.1	2.951	2.844	2.741	2.643	2.549	2.461	2.377	2.298	2.225	2.155	2.090	2.030	1.973
-0.11	3.152	3.033	2.920	2.811	2.708	2.610	2.518	2.431	2.350	2.273	2.202	2.135	2.072
-0.12	3.354	3.224	3.099	2.981	2.868	2.761	2.660	2.565	2.476	2.392	2.314	2.240	2.172
-0.13	3.557	3.416	3.281	3.151	3.029	2.912	2.803	2.699	2.602	2.511	2.426	2.347	2.272
TI/GDP	56.09	53.76	51.53	49.40	47.38	45.45	43.64	41.93	40.33	38.82	37.41	36.09	34.86
NI/GDP	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61
STD/GDP	8.81	8.81	8.81	8.81	8.81	8.81	8.81	8.81	8.81	8.81	8.81	8.81	8.81
VI/GDP	42.48	40.15	37.92	35.79	33.77	31.84	30.03	28.32	26.72	25.21	23.80	22.48	21.25
LTF/GDP	43.36	41.04	38.80	36.67	34.65	32.73	30.91	29.20	27.60	26.09	24.68	23.36	22.13
Int. on STD/GDP	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88
AC of LTF	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30
2y GDP growth	14.22	13.64	13.04	12.43	11.81	11.19	10.57	9.95	9.33	**8.72**	**8.12**	7.53	6.96

Panel F. Smaller Emerging Economies – Years 2000-99

Res to STD (h*) η δ	0.34	0.36	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.52	0.54	0.56	0.58
-0.01	1.268	1.255	1.242	1.229	1.217	1.206	1.195	1.185	1.175	1.166	1.157	1.149	1.142
-0.02	1.537	1.510	1.484	1.459	1.435	1.412	1.390	1.370	1.350	1.332	1.315	1.299	1.284
-0.03	1.806	1.765	1.726	1.689	1.653	1.618	1.586	1.555	1.526	1.499	1.473	1.448	1.426
-0.04	2.075	2.021	1.969	1.919	1.871	1.825	1.782	1.741	1.702	1.665	1.631	1.598	1.568
-0.05	2.345	2.278	2.212	2.150	2.090	2.032	1.978	1.927	1.878	1.832	1.789	1.749	1.711
-0.06	2.617	2.535	2.457	2.381	2.309	2.240	2.175	2.113	2.055	2.000	1.948	1.899	1.853
-0.07	2.889	2.794	2.702	2.614	2.529	2.449	2.373	2.300	2.232	2.168	2.107	2.050	1.997
-0.08	3.163	3.053	2.948	2.847	2.751	2.658	2.571	2.488	2.410	2.336	2.267	2.202	2.141
-0.09	3.438	3.315	3.196	3.082	2.973	2.869	2.771	2.677	2.589	2.506	2.428	2.354	2.285
-0.1	3.715	3.577	3.445	3.318	3.197	3.081	2.971	2.867	2.769	2.676	2.589	2.507	2.430
-0.11	3.994	3.842	3.696	**3.556**	3.422	3.294	3.173	3.058	2.950	2.847	2.751	2.661	2.576
-0.12	4.274	4.108	3.949	3.795	3.648	3.508	3.376	3.250	3.132	3.020	2.915	2.816	2.723
-0.13	4.558	4.377	4.203	4.036	3.877	3.725	3.580	3.444	3.315	3.193	3.079	2.971	2.871
TI/GDP	46.04	44.27	42.55	40.91	39.34	37.84	36.42	35.07	33.80	32.60	31.47	30.40	29.41
NI/GDP	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76
STD/GDP	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26
VI/GDP	35.28	33.51	31.79	30.15	28.58	27.08	25.66	24.31	23.04	21.84	20.71	19.64	18.65
LTF/GDP	35.81	34.03	32.32	30.68	29.10	27.61	26.18	24.84	23.56	22.36	21.23	20.17	19.17
Int. on STD/GDP	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53
AC of LTF	0.17	0.18	0.19	0.20	0.21	0.22	0.22	0.23	0.24	0.25	0.26	0.27	0.28
2y GDP growth	11.64	11.22	10.80	**10.36**	9.91	9.46	9.01	8.55	8.10	7.65	7.21	6.77	6.35

Numerical simulations, thus, suggest that the increasing level of reserves to short term foreign debt ratios are mainly explained by the increasing competitiveness of the domestic industry, which implies a negative relation (although weak) between capital inflow and output price. The higher (in absolute value) this relation is, the higher the extent of the unpredictable fluctuations of the most expensive sources of finance associated to net foreign capital inflow, thus the higher is the stock of reserves needed to stabilise expensive finance around its expected level. While affecting unexpected fluctuations of the examined variables, competitiveness of domestic industry does not affect expected levels, which are only determined by δ, as Table 2 clearly shows.

The determination of the value of h^* as a function of the two parameters δ and η examined in this subsection is synthesised in Figure 9, taking data from 2000-09 full sample's simulated solutions (panel B of Table 3). It can be observed that the optimal ratio h^* is a decreasing function of the marginal cost of long term finance, δ, and an increasing function of the competitiveness of the domestic industry (decreasing function of η), and that its sensitiveness on the level of δ is lower when η is closer to zero.



5 Conclusion

In the last decade, emerging economies kept short term foreign debt and investment in net fixed capital nearly unchanged (or even reduced them), but increased reserves disproportionately and simultaneously managed to increase GDP growth. This work has constructed a model that is able to explain how both the high GDP growth and the growing stock of reserves are the result of the same process of globalisation of the emerging economies.

The model is built on the assumption that short term finance, which depends on foreign capital inflow and domestic monetary policy, is volatile but cheaper, whereas long term private finance is more costly and the cost increases with quantity. A variable component of the investment is decided, and simultaneously long term finance is raised, once the available short term finance is known with certainty. The optimal solution depends crucially on two structural parameters newly introduced in this model and representative of the openness of the emerging countries to global markets: they account for the marginal cost of long term finance and for the competitiveness of the domestic industry.

Numerical simulations of the model have explained the rising level of reserves in connection with rising GDP growth as the consequence of two simultaneous changes in the aforementioned structural parameters: a falling cost of long term finance and increasing competitiveness of the domestic industry. Both changes could be ascribed to the higher openness of the emerging economies to global goods and financial markets.

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