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RESERVES OVER THE TRANSITIONS TO FLOATING AND TO INFLATION TARGETING: LESSONS FROM THE DEVELOPED WORLD

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RESERVES OVER THE TRANSITIONS TO FLOATING AND TO INFLATION TARGETING: LESSONS FROM THE DEVELOPED WORLD

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Resumen

Este trabajo destaca la evolución de las reservas internacional oficiales en países desarrollados que han transitado a esquemas de metas de inflación y/o flotación cambiaria. Encontramos varios resultados que son de interés para las políticas económicas de países emergentes, tales como Brasil, Chile y México, que han transitado a esquemas monetarios y esquemas en estas líneas. Primero, la flotación cambiaria junto con un esquema de metas de inflación, se asocia con una disminución persistente de 10 a 20% en el nivel de reservas oficiales mantenidas en el Banco Central. Segundo, esta reducción corresponde mayormente a una reasignación de liquidez internacional hacia el sector privado financiero, que acomoda así parte del efecto en el nivel y composición de la posición de inversión externa neta. Tercero, se aprecia un claro cambio en la correlación entre el diferencial de tasas y la dinámica de las reservas oficiales, apoyando fuertemente la predicción de Mundell-Fleming respecto a la exogeneidad de la oferta de dinero bajo flotación cambiaria. Cuarto, lo último también muestra que, una vez que las restricciones sobre la volatilidad del tipo de cambio se eliminan, el stock de reservas puede determinarse de forma independiente por el Banco Central, de acuerdo a consideraciones de costo-beneficio, sin afectar la credibilidad del esquema cambiario de flotación junto con metas de inflación.

Abstract

This paper highlights the evolution of official international reserves in developed countries that transited towards Inflation Targeting (IT) and/or floating exchange rates. We find several results that are of interest to policymakers in emerging countries, such as Brazil, Chile and Mexico, which have revamped their monetary and exchange rate arrangements along those lines. First, the adoption of a floating exchange rate and an IT framework are associated with a persistent 10% to 20% reduction in real official reserves held at the Central Bank. Second, this reduction in official reserves corresponds mainly to a reallocation of international liquidity towards the private financial sector, that accommodates part of the effect on the level or composition of the net foreign asset position of the countries. Third, there is a clear change in the correlation between interest rate differentials and the dynamics of official reserves, strongly supporting the Mundell-Fleming result regarding the exogeneity of money supply under floating exchange rates. Fourth, the latter also shows that, once constraints on exchange rate volatility are removed, the stock of reserves can be determined independently by the Central Bank, according to cost-benefit analysis, without hindering the credibility of the combination of a floating regime and inflation targeting.

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1. Introduction

Recently a number of emerging economies have adopted formal Inflation Targeting (IT) frameworks to guide the conduct of their monetary policy (see Mishkin and Schmidt-Hebbel, 2002 for more details on this trend). The reasons for adopting this framework vary, but seem to be associated with the exhaustion of exchange rate targets, as well as the need to bolster the credibility of monetary policy and anchor expectations in a floating exchange rate regime. Indeed, Brazil, Chile and Mexico all adopted a floating scheme in the aftermath of costly defenses of their respective currencies. Note, however, the differences. In Chile, the Central Bank successfully defended the exchange rate band, after only a slight loss in reserves. Moreover, the decision to float was taken in September 1999, a year after the last speculative attack that followed the Russian default and the financial turmoil after the LTCM bailout. Mexico, on the other hand, was forced to float after massive reserve losses and a failed attempt at a controlled devaluation in December of 1994. Brazil, finally, voluntarily suspended the defense of the peg in January 1999, after providing increased hedging to the private sector and only at a moderate loss of reserves.

After these countries decided to float, then a question arises about what is the appropriate level of reserves once the transition has happened. Since Mundell-Fleming, it is known that reserves are uncorrelated with changes in the money supply under a floating regime. However, the *level* of reserves is indeterminate in that model: as an extension of IS-LM, the only portfolio choice endogenously given is the allocation of financial wealth between money and bonds. Even a portfolio-balance approach that considers imperfect substitutability of foreign and domestic bonds will not give an equilibrium level of reserves. Moving to an intertemporal setting does not help either: indeed, the intertemporal approach to the current account stresses the role of the *net* foreign asset position in determining the equilibrium path of asset prices. Given that these models generally assume perfect capital mobility, it is not easy to find a justification for *gross* demand of *liquid* foreign assets. One then needs to look elsewhere for a theoretical justification of an equilibrium level of reserves.[1]

One option is the currency crisis literature. However, crises are more likely in fixed or semi-fixed exchange rate arrangements, where it is obvious that, *ceteris paribus*, a larger pool of reserves at the Central Bank will bolster the sustainability of the exchange rate commitment. A similar approach can be derived from the venerable and almost forgotten literature on optimal demand for reserves, but unfortunately it is of not much help in a world of capital mobility and floating exchange rates.

[1] A previous question is related with the origin of the demand for reserves. Bordo and Eichengreen (1998) develop a complete historical description of the origins and trend of the country demand for international and gold reserves.

Calvo and Reinhart (2000) have made the point that even in a free floating exchange rate regime the exchange rate actually does not float freely because the countries, especially the developing ones, have "fear of floating", and in general are wary of large currency swings. Consequently, in the practical ground is not easy to differentiate a free-floating regime from a soft peg or a managed regime. However, they also show that the form of intervention has moved from direct interventions in the exchange rate market to changes in interest rates aiming to affect exchange rate (in managed or free floating regimes). Hence, there is not a very clear-cut evidence from the point of view of emerging economies, regarding what the appropriate level of reserves should be.[2]

In this context it is possible to point out that the utilization of reserves (and, consequently, the appropriate level of them) *vis a vis* interest rate depends on the effectiveness of monetary policy. In this sense an inflation-targeting framework, which in general will increase monetary policy effectiveness and efficiency, means that the demand for reserves will decrease. In addition, some papers suggest than in an inflation-targeting scheme the pass-through from exchange rate to prices diminishes. If these results are right and the fear of floating is mainly explained by fear of inflation, the inflation-targeting regime will imply a lower demand for international reserves.

Feldstein (1999) pointed out that the key point in self-protection from international crises is building a stock of international liquidity. Countries with enough international liquidity could better address international crises. However, the availability of international liquidity can take different forms: official reserves, international liquidity at commercial banks, or ready sources of foreign currency loans. Hence, in the grounds of avoiding international currencies the important point is how to build international liquidity and necessarily the optimum level of official international reserves. The latter could be true in a context of market failures that make it difficult for the private sector to accumulate international liquidity.

Also, in a world with imperfect (international and national) capital markets, lower levels of international reserves have been associated with higher probability of contagion and liquidity crises and bank runs (Chang and Velasco, 1999).

Moreover, in an inefficient intertemporal allocation of international liquidity, due to the weak links of a country with international capital markets and the existence of under-developed financial markets, it would be optimal for the monetary authority to accumulate reserves during

[2] In this sense Bordo and Eichengreen (1998) state that under certain conditions the demand for reserves could increase in a free floating regime.

booms and to spend them during periods of shortage. Caballero and Krisnamurthy (2000) developed this point, and Caballero (2000) applied it to the experience of three Latin American countries).[3]

Thus, a theoretical motivation for holding reserves under a floating exchange rate is hard to come by, especially if the exchange rate regime is fully credible and there are varying degrees of access to international financial markets. On the other hand, cross-country evidence has not been able to find a consistent and systematic negative effect of a free-floating regime on the desired level of reserves (see García 1999, Lane and Burke, 2001; and Bordo and Eichengreen, 1998), even though this sort of evidence can be misleading, because of noise and institutional idiosyncrasies. That is why we adopt a pragmatic approach in this paper, putting low weight on theory and cross-country comparisons, and focusing instead on a group of case studies. However, it is necessary to give at least a broad look at the cross-country data, which we do in section 2.

As will be shown in the rest of the paper, the emergence of inflation targeting seems to be a complementary device to diminish the level of reserves. Put differently, the inflation targeting framework diminishes the demand for reserves.

The core of the empirical part of the paper is in section 3. There we focus on four stylized facts that emerge from the direct analysis of the data:

i. The switch to inflation targeting is associated with a persistent reduction in real official reserves, of 10% to 20%.

ii. The effect of the liberalization of the exchange rate is not clear. In some estimates it is negative, in others positive, and in most of them statistically not different from 0.

iii. The correlation between the interest rate spread and reserves is positive under a fixed or managed regime, and becomes insignificant or even negative under the float and IT schemes.

iv. Although the evolution of the net foreign asset position of these countries cannot be traced directly to the regime switch, there does seem to be an increase in the international liquidity holdings of the financial sector, which partly offsets the reduction in official reserves.

Finally, we present the conclusions in section 4.

2. Cross-country evidence

In this section we use a cross-country perspective to study, at a level of stylized facts, the relation between (public and total) international reserves and the exchange rate regime and the

[3] However, if the efficiency and completeness of financial markets (in terms of both internal markets and access to external markets) were related to the level of economic development, the demand for international reserves would be lower as the country developed. The empirical evidence strongly supports this hypothesis.

existence of an inflation targeting scheme for the conduct of monetary policy. The objective is to motivate the analysis of the next section, when we study in detail the experience of six countries in the path from fixed or managed exchange rate regimes to a flexible system.

Our approach is as follows. We relate the level of international reserves (scaled in five different ways) in 1997 with its lagged level in 1990, 1980, and 1970, and a variable that measures the switch of the exchange rate regime towards floating and the effect of a switch to a floating regime and inflation targeting. We define reserves as official reserves excluding gold plus international liquidity in the financial sector. The main regression to be estimated is:

$$\ln(R_{97}) = q + a\,\ln(R_{lagged}) + cD\,,$$

where R is total holdings of reserves, D is the dummy for the change in exchange rate regime, and θ, α, and χ are parameters to be estimated. The results are presented in table 1 and figures 1 to 3. Several facts stand out from this exercise.

First, it is possible to appreciate that reserves are persistent. This is consistent with the fact that gross external assets are also highly persistent over time (see Kraay, Loayza, Servén, and Ventura, 2000). However, in floating regimes this persistence is lower, especially when they conduct their monetary policy using an inflation targeting scheme. Indeed, as shown in table 1 (panel A), the effect of the change to (from) a floating regime is related to a decrease (increase) in total and official reserves. This suggests that in floating regimes the level of international reserves is lower than in managed or fixed regimes. As they adopt inflation targeting there is an additional and more significant decrease in the stock of reserves. More interestingly, in this case total reserves (public and private) are also decreased.

Second, the level of official international reserves in floating countries is not zero. In fact, the level of reserves scaled to GDP, total imports, and M2 in free-floating countries (not free-floating countries) is 0.05 (0.10), 0.18 (0.33), and 0.24 (0.33), respectively. This can indicate one of two possibilities:

(i) Even in free floating regimes official reserves play a role, that goes beyond the traditional one related to supporting a peg.

(ii) The transition of the level of international reserves from fixed or managed exchange rate regimes is not fast, because of potentially negative macroeconomic effects. For instance, the credibility and sustainability of the free-floating regime could be affected by fast sales of public reserves, or a swift exchange rate appreciation could reveal other problems in the financial sector.

Third, the effect of a floating regime seems to be related mainly to changes in official reserves, but not the case of inflation targeting, as is apparent from the estimated coefficients of

table 1. This suggests that the ratio of private reserves to total reserves would decrease in more flexible exchange rates. In fact, the world average (median) of the share of the private sector in total international reserves is 0.47 (0.45) in the countries where the exchange rate floats freely; otherwise this proportion is 0.36 (0.30), and the difference is statistically significant. This difference could imply that the main effect of a floating regime is the reallocation of international liquidity towards the financial sector, away from the Central Bank, while in inflation targeting countries there is a decrease in both sectors.

This fact can be related with the development of financial markets, in the sense that non-flexible exchange rate regimes create a kind of public insurance for exchange rate fluctuations. As the exchange rate is liberalized, the demand for private coverage of the exchange rate risk is privatized and, consequently, the demand for reserve from the private sector increases. The result for free floating countries that have implemented inflation targets is unclear and needs additional research, which is beyond the scope of this paper.

Finally, it is interesting to analyze the temporal trend in the ratio of private to total reserves. As is apparent in figure 4, there is a significant change in this ratio after the collapse of the Bretton-Woods system. This trend remains up to the early 1990s and, during the last two decades the ratio is stable (with some negative trend in the 1990s).

Summing up these four stylized facts, first free-floating countries have both less international reserves, and a larger share of the private sector in total reserves, and, second, the increasing trend in private reserves is not related with a global phenomenon. The first fact is augmented in the case of inflation targeters. These trends motivate our next section, where we address the transition to free-floating in terms of international reserve management.

Table 1 –Cross-Country Evidence

A. The effect of floating regime:

Scaling Variable **Reserve Variable**	GDP	Imports	M2	Wealth	Gross International Assets
	1990-97				
Public	-0.02	-0.14	0.02	0.00	0.01
Total	-0.02	-0.08	0.11*	-0.00	-0.18
	1980-97				
Public	-0.06*	-0.20***	-0.05	-0.01*	-0.04
Total	-0.06	-0.23**	-0.04	-0.03	-0.06
	1970-97				
Public	-0.09*	-0.09	-0.11**	-0.01**	-0.10
Total	-0.14*	-0.65***	-0.05	-0.05**	-0.22*

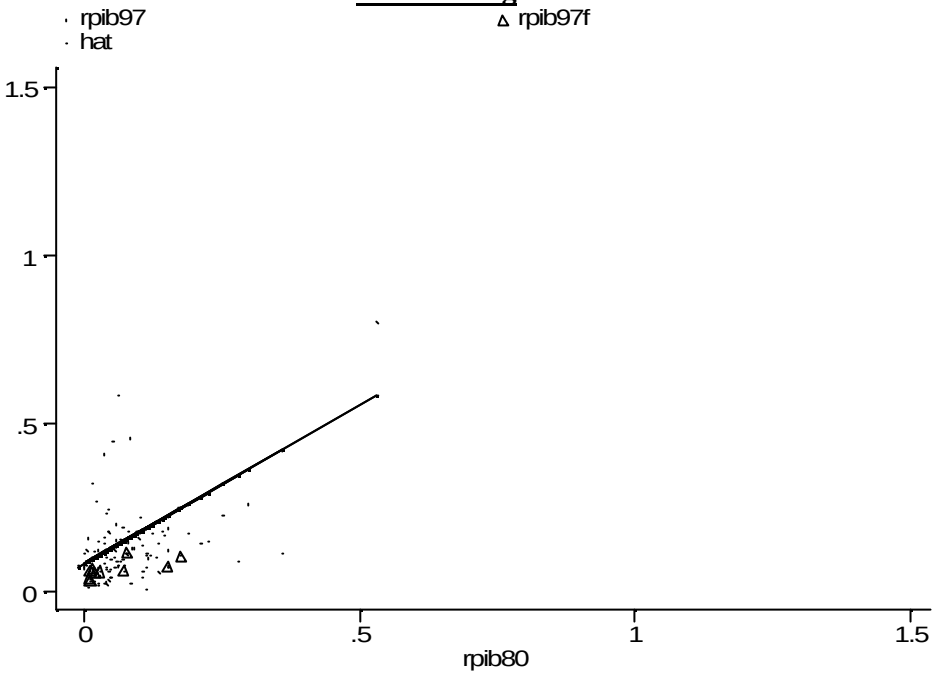
Notes: Every regression includes at least 115 countries. The effect of float is measured as the coefficient on the change in an exchange rate regime dummy. This takes the value +1 if it changed to free exchange rate, 0 if it did not change, and –1 if it changed from a free exchange rate—after controlling by the initial level of reserves (scaled to each variable). *, **, *** indicate statistically significant at 10%, 5%, and 1%, respectively.

B. The effect of floating regime *and* inflation targeting

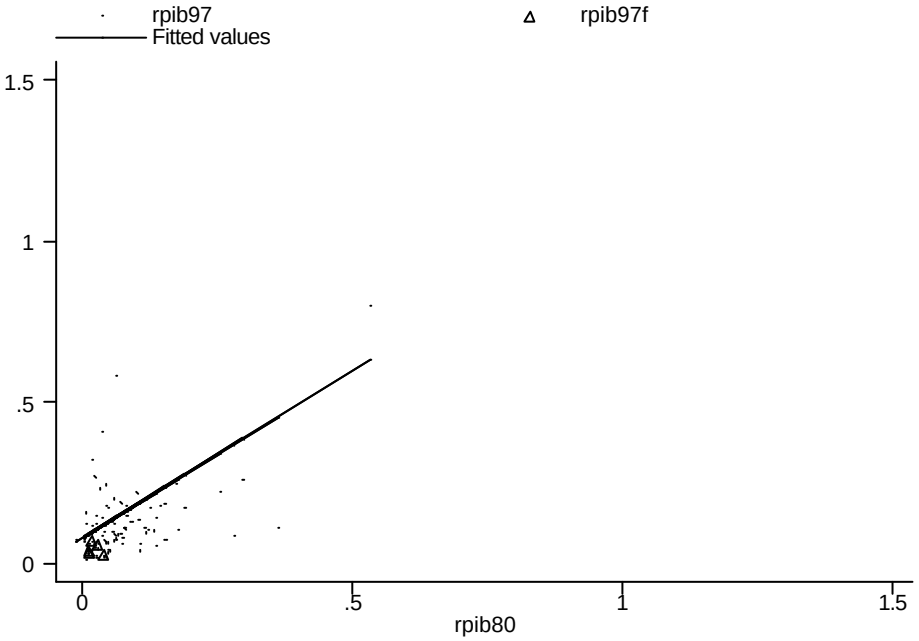
Scaling Variable **Reserve Variable**	GDP	Imports	M2	Wealth	Gross International Assets
	1990-97				
Public	-0.07*	-0.23***	-0.15***	-0.01**	-0.16**
Total	-0.08**	-0.27***	-0.19***	-0.02**	-0.27**
	1980-97				
Public	-0.05	-0.24***	-0.21***	-0.01	-0.12
Total	-0.04	-0.25	-0.26***	-0.04	-0.27*
	1970-97				
Public	-0.08**	-0.27***	-0.20***	-0.02**	-0.20***
Total	-0.08	-0.59***	-0.29***	-0.06*	-0.39***

Notes: Every regression includes at least 115 countries. The effect of float is measured as the coefficient on the change in an inflation-targeting dummy. This takes the value +1 if it changed to inflation targeting, 0 if it did not change, after controlling by the initial level of reserves (scaled to each variable). *, **, *** indicate statistically significant at 10%, 5%, and 1%, respectively.

Figure 1
Reserves to GDP (1997 vs. 1980)
Free floating



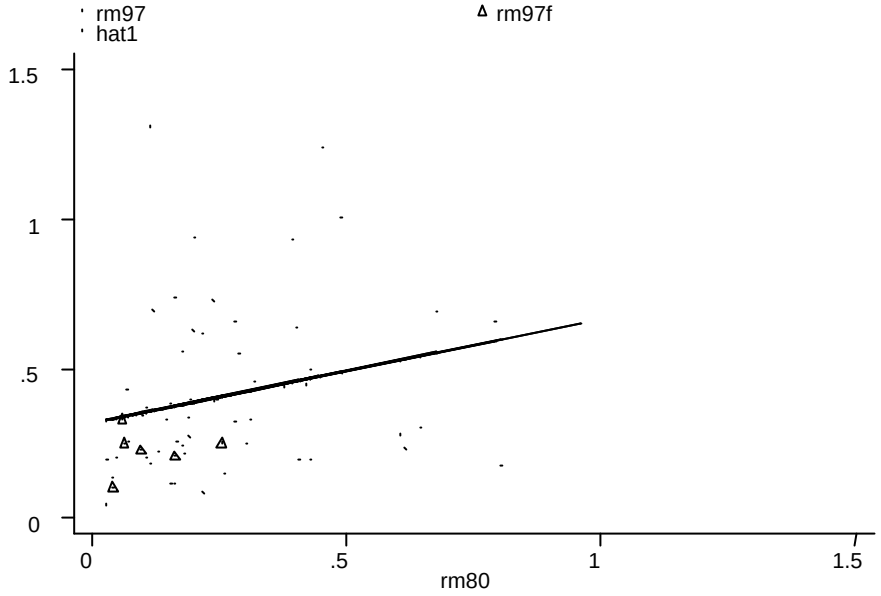
Inflation targeting



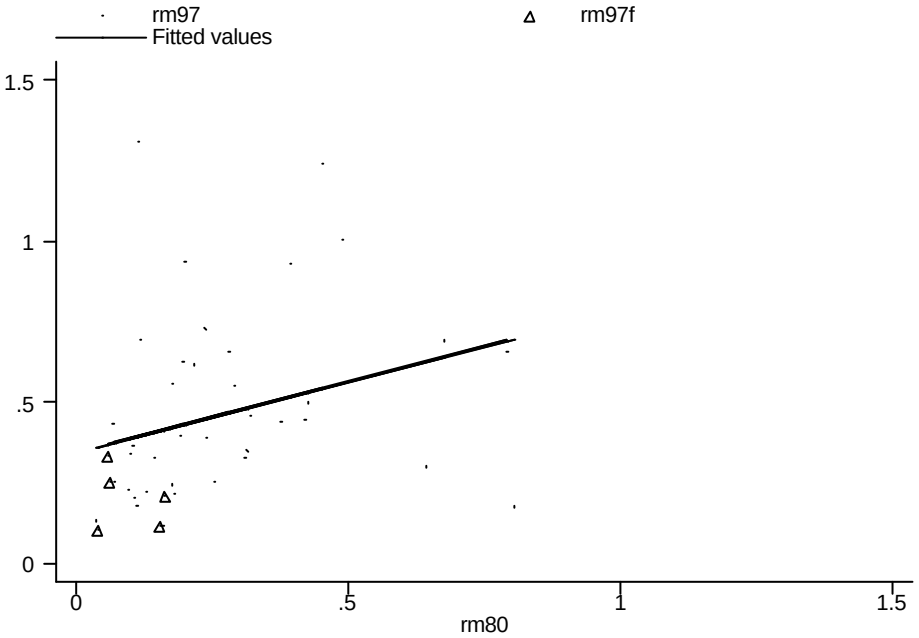
Notes: the solid line indicates the slope in the regression between reserves and GDP in 1997 and in 1980, the triangles identify free-floating or inflation-targeting countries in 1997.

Figure 2
Reserves to Imports (1997 vs. 1980)

Free floating

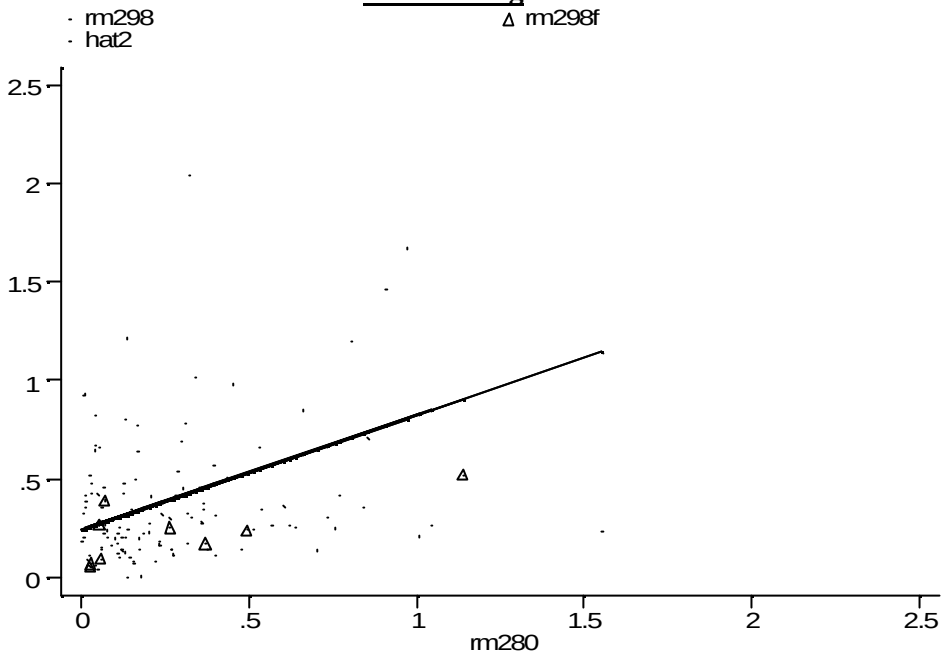


Inflation targeting

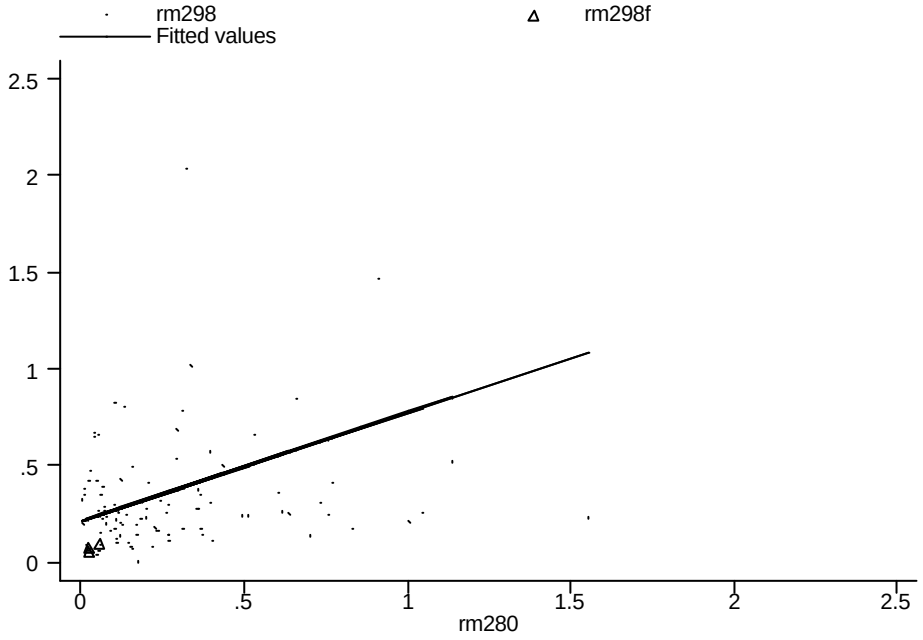


Note: the solid line indicates the slope in the regression between reserves and imports in 1997 and 1980, the triangles identify free-floating or inflation targeting countries in 1997.

Figure 3
Reserves to M2 (1997 vs. 1980)
Free floating

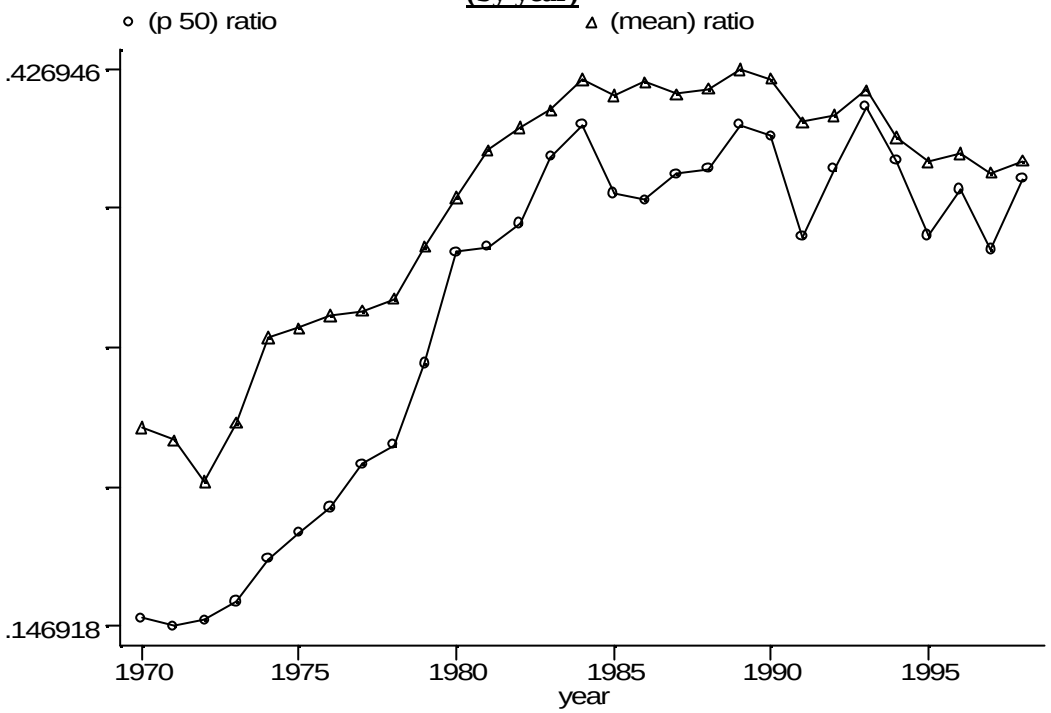


Inflation targeting



Note: the solid line indicates the slope in the regression between reserves and M2 in 1997 and in 1980, the triangles identify free-floating or inflation-targeting countries in 1997.

Figure 4
Average and Median of the Ratio of Private to Total International Reserves (by year)



Note: the solid line with circles indicates the median, and the line with triangles indicates the mean.

3. Framework and main results

The choice of specific countries and the econometric methodology to consider is difficult. First, the date of the change in regime towards floating must be known with some certainty, as well as the circumstances surrounding the decision. Secondly, the floating exchange rate and inflation-targeting regime must be credible, in that agents do not perceive the existence of implicit exchange rate targets. Finally, data availability must be such that high frequency (monthly) regressions are possible, with a sufficient span of data for both fixed and floating regimes.

Satisfying these conditions allows us to identify a clear regime switch and a good empirical strategy. If the date is not clear, then it is hard to select the different samples. Also, if the floating exchange rate regime is not credible, then the comparisons are not interpretable.

We end up with six countries: Australia, Canada, New Zealand, the UK, Switzerland, and France. We acknowledge that any choice of countries might be disputable, for example by pointing out that the experiences of developed countries are not useful for emerging market economies. One avenue of critique is pointing out the weakness of the latter's institutions. However, in our view this is not a valid criticism. First, the growth literature widely recognizes that over the long run, catch-up depends on the quality of institutions. Hence, it is natural to look at the developed world for hints

at the different paths that institutional development can take. Secondly, an important specific avenue of institutional improvement lies in achieving better macroeconomic policy and increasing macroeconomic stability. This is precisely what has been happening with Inflation Targeting, where the experiences of a few countries (that actually belong to our sample of case studies) has guided the design of monetary policy in recent years in a number of emerging countries.

Another way to criticize the choice of cases is to mention the wide differences in the pattern of trade and production between the developed world and emerging market economies. On one level, it is possible that this difference is permanent, given the heterogeneity of natural resource endowments. However, this is not the case for countries like Australia, New Zealand and Canada, that despite substantial diversification remain important natural resource exporters. Nevertheless, on a more fundamental level, the same process of convergence mentioned above should allow for an endogenous change in the pattern of trade. Thus, the observation of differences in this respect is not a deterrent for a comparative analysis.

3.1 Analytical framework

The focus of this paper is empirical, but in any case we need some structure to guide it. For this purpose, we rely on the traditional literature on the optimal determination of reserves. Some caveats apply to a straightforward application of this framework, however. Indeed, this literature spawned during Bretton-Woods and the inter-war period, which witnessed a very different institutional arrangement from the one seen today. First, pervasive capital controls limited substantially the openness of the capital account, consistently with the widespread use of fixed exchange rates. Some exit clauses existed that allowed countries to realign their exchange rates or obtain support from the IMF in case of temporary balance of payments difficulties. These were triggered mainly by shocks to the current account, for example because of terms of trade shocks. Thus, the prototypical model of reserve determination implies the following demand for reserves[4]

$$\overline{R} = a_0 + a_1(i^* + \hat{e} - i) + a_2 M + a_3 s_{tt} \quad (1)$$

A higher *stock* demand for reserves results from a lower opportunity cost, given by the spread of foreign interest rates over domestic interest rates ($i^* + \hat{e} - i$); a higher volatility of the terms of trade (s_{tt}), that increases the hazard of running into balance of payments difficulties; or a higher *flow* of imports (M), which captures the appropriate scaling variable.

Nowadays, however, in a world of floating exchange rates and free movement of capital across countries, it is recognized that shocks to the capital account might be more relevant that

[4] Frenkel and Jovanovic (1981) present a carefully derived version of this prototypical model. Lane and Burke (2001), García (1999), and Bordo and Eichengreen (1998) present empirical estimations of the model.

those to the current account. Indeed, in a world of perfect capital mobility, temporary terms of trade disturbances should not pose any difficulties to the real economy, as long as they can be financed through increased borrowing. However, weak financial links with the world capital markets might require adjustment to these real shocks, and they might be themselves sources of fluctuations for the real economy. An extension of the model might suggest that the *stock* demand for reserves depends also on the stock of foreign exchange liabilities as well as on the stock of domestic credit in the economy. Moreover, the sterilization of capital inflows, which has been a prevalent fact in emerging economies over the last decades, in practice puts some doubts on the expected sign of a_1[5]. In any case, interest rate differentials are determined endogenously.

Given these considerations, we take an approach that relates the level of reserves *in the long run* to the flow of imports (*M*), the stock of foreign assets (*FA*) and liabilities (*FL*), the stock of central bank credit (*CBC*), GDP, and the volatility of the terms of trade (s_{tt}). We do not include interest rate differentials in the long run specification, but in the short run dynamics of the model, because they are likely to be endogenous to the stock variables and, consequently, the space for their exogenous movements is only temporary. However, we add a measure of the volatility of the terms of trade to capture exogenous changes in this spread.

(1') $$\overline{R} = a_0 + a_1 M + a_2 FA + a_3 FL + a_4 CBC + a_5 GDP + a_6 s_{tt}$$

In the short run, we postulate an error correction mechanism that governs the dynamics of reserves. Even though in the long run specification we assume that monetary policy is neutral, it can have effects in the short run. Thus we include in the error correction specification the spread between domestic and foreign interest rates. Also, the dynamics can be affected by the choice of exchange rate regime.

(2) $$\partial R = b_0^{er} + b_1^{er} (i - i^* - E[\hat{e}]) + b_2^{er} \partial R_{-1} + b_3^{er} (R_{-1} - \overline{R}_{-1})$$

In this expression, $b_3^{er} = b_3^{fx} + b_x^{fl} D_{fl} + b_x^{it} D_{it}$, where D_{fl} is a dummy that takes the value 1 after the switch to a floating exchange rate regime (or to a flexible exchange rate regime in France and Switzerland), and D_{it} is a dummy that takes the value 1 when a formal IT framework is adopted (or when a floating exchange rate regime is adopted in these same countries). Several options are open to modeling expected devaluations. We take two extreme cases: the exchange rate is a random walk, therefore expected devaluation is a constant, and the case where expected devaluation equals actual devaluation.

[5] This fact is highlighted in García (1999), where a positive correlation between reserves and international interest rates is observed across non-OECD countries.

The estimation also included the *US$/DM* and *Yen/US$* exchange rates, to capture movements in reserves associated with capital gains or losses. Most of the time these did not come out statistically significant, and therefore are excluded from the results presented below.

In addition, in order to check the robustness of the results using a different econometric methodology, we estimate the equations as a system, using a Seemingly Unrelated Regression Estimation (SUR). We use this technique because it is likely that in the determination of the level (and the change) of the stock of reserves is correlated among the countries included in the analysis. However, due to the loss of degrees of freedom, in this case we restrict the use of interactive dummies only to study potential changes in the effects of the main variables of interest.

Finally, in order to take advantage of the cross-country and the time series dimensions of the problem, we estimate the above-mentioned long run relation using a panel data approach. Table 2 reports a description of the variables used and their respective sources.

Table 2 – Variables used in the estimation

Variable		Description
R	Reserves	Log of real official reserves in dollars, excluding gold, deflated by U.S. WPI.
M	Imports	Log of real imports in dollars, deflated by U.S. WPI.
CBC	Central Bank credit	Log of real central bank credit in dollars, deflated by U.S. WPI.
FA	Total foreign assets	Log of real foreign assets in dollars, deflated by U.S. WPI. From Kray *et al*. (2000), monthly interpolation with cubic spline.
FL	Total foreign liabilities	Log of real foreign liabilities in dollars, deflated by U.S. WPI. From Kray *et al*. (2000), monthly interpolation with cubic spline.
GDP	Gross domestic product	Log of real gross domestic product in dollars, deflated by U.S. WPI. Monthly interpolation using industrial production.
σ_{tt}	Terms of trade volatility	Log of terms of trade variance, constructed as the second difference of log terms of trade, with a 12 month moving window. The terms of trade are defined as the ratio of unit export and import values.
D_{fl}	Dummy variable, indicates free float.	From Goldfjan and Valdés (1999), extended until 1999
D_{fx}	Dummy variable, indicates fixed regime.	Same as above.
D_{it}	Dummy variable, indicates IT	Several sources.

3.2 Main Results

Here we focus on four main results that emerge from the direct analysis of the data. These are as follows:

v. The switch to a inflation targeting is associated with a persistent reduction of real official reserves, of around between 10 and 20%.

vi. The effect of the liberalization of the exchange rate is not clear. In some estimations is negative, in others positive, and in most of them statistically not different from 0.

vii. The correlation between the interest rate spread and reserves is positive under a fixed or managed regime, and becomes insignificant or even negative under the float and IT schemes.

viii. Although the evolution of the net foreign asset position of these countries cannot be traced directly to the regime switch, there does seem to be an increase in the international liquidity holdings of the financial sector, which partly offsets the reduction in official reserves.

Table 3 presents the estimates of the long run relationship between official reserve holdings and various macroeconomic aggregates. Table 4 uses the results of this estimation in an error correction model of the dynamics of reserve accumulation.[6] Table 5 presents the results of estimating the estimation as a system using SURE.

Table 3 – Long-run estimations

Country Variable	Australia	Canada	France	New Zealand	Switzerland	United Kingdom
Dependent Variable: Log (Real International Reserves in US$)						
Constant	-0.87 (1.41)	-10.86 (2.22)	1.18 (1.73)	-2.04 (1.97)	0.12 (0.24)	-2.27 (2.36)
M	-0.11 (0.95)	2.41 (5.59)	-0.67 (2.39)	-0.43 (2.23)	0.88 (3.54)	1.74 (12.03)
CBC	-0.51 (9.38)	-2.57 (3.24)	0.04 (0.28)	-0.06 (0.55)	-0.02 (0.27)	-2.26 (5.26)
FA	4.46 (6.14)	-0.32 (0.65)	3.80 (5.42)	1.26 (4.71)	-	0.14 (0.56)
FL	-3.46 (6.08)	0.14 (0.19)	-3.08 (4.34)	0.15 (0.59)	-	-0.13 (0.68)
σ_{tt}	0.03 (1.48)	-0.15 (3.38)	0.03 (0.92)	0.06 (1.46)	0.07 (2.08)	0.03 (1.20)
GDP	0.52 (3.42)	0.27 (0.32)	0.69 (1.69)	0.12 (0.74)	0.64 (2.70)	-0.09 (0.48)
Sample	1967:12 1997:12	1966:12 1997:12	1968:12 1997:12	1977:04 1997:12	1967:01 1999:12	1966:12 1997:12
R^2	0.84	0.55	0.79	0.90	0.87	0.84
DF Test for Residuals	-3.43	-2.71	-4.46	-3.59	-3.38	-3.25

Note: Absolute Newey-West of t-statistics are presented in parenthesis.

[6] In general, long run estimations present some instability in the different policy periods (tested using Chow-tests). This instability, however, does not produce significant changes in the four main results mentioned before. These findings from re-estimated long-run equations for each specific period were used in the ECM and, despite changes in dynamic and impact effects, the results hold.

Table 4 - Error correction models

Country Variable	Australia	Canada	France	New Zealand	Switzerland	United Kingdom
Dependent Variable: Change in Log (Real International Reserves in US$)						
Constant	0.00 (0.79)	-0.02 (1.96)	0.00 (0.16)	-0.01 (0.89)	0.03 (2.25)	0.00 (0.47)
Free	-0.04 (2.76)	0.00 (0.21)	-0.11 (7.26)	-0.54 (19.94)	-0.10 (11.57)	0.01 (0.46)
Flexible	-	-	-0.08 (4.26)	-	0.04 (1.14)	-0.04 (4.51)
Target	-0.09 (7.27)	-0.16 (10.22)	-	-0.04 (2.38)	-	-0.10 (4.61)
Target 1	-	-	-	-	-	-0.11 (18.23)
Error correction	-0.11 (2.94)	-0.04 (0.76)	0.05 (2.25)	-0.25 (4.42)	-0.15 (2.20)	-0.06 (1.39)
* Free	-0.00 (0.05)	0.04 (0.74)	-0.08 (2.50)	-0.13 (1.38)	0.06 (0.84)	0.03 (0.69)
* Flexible	-	-	-0.11 (3.52)	0.38 (3.65)	-0.13 (1.54)	0.02 (0.43)
* Target	0.09 (1.35)	0.04 (0.32)	-	-	-	0.01 (0.24)
* Target 1	-	-	-	-	-	0.01 (0.34)
Lagged change in reserves	0.28 (2.74)	-0.26 (2.32)	0.12 (1.08)	-0.24 (1.99)	-0.34 (4.92)	-0.00 (0.03)
* Free	0.09 (0.67)	-0.04 (0.19)	0.16 (1.08)	0.36 (2.07)	-0.02 (0.33)	-0.06 (0.29)
* Flexible	-	-	-0.16 (1.04)	-	0.21 (1.36)	-0.38 (1.78)
* Target	-0.52 (4.14)	0.12 (0.61)	-	-0.32 (2.16)	-	-0.16 (0.98)
* Target 1	-	-	-	-	-	0.20 (1.60)
Interest rate spread (i-i*)	0.44 (2.01)	1.42 (2.48)	1.66 (2.74)	1.30 (2.00)	1.20 (2.06)	-0.13 (0.76)
* Free	-0.48 (1.68)	0.71 (0.72)	-2.21 (3.08)	-0.63 (1.00)	-0.77 (1.55)	0.20 (1.13)
* Flexible	-	-	-1.47 (2.36)	-	-0.60 (0.58)	0.24 (1.65)
* Target	0.04 (0.08)	-1.86 (1.97)	-	-0.26 (0.75)	-	-0.31 (1.35)
* Target 1	-	-	-	-	-	-1.17 (2.03)
R^2	0.15	0.12	0.10	0.26	0.20	0.04

Note: Absolute Newey-West of t-statistics are presented in parenthesis.

Table 5

The Effect of the Exchange Rate Regime and Inflation Targeting on International Reserves Accumulation: Seemingly Unrelated Regressions Estimation

	Australia		Canada		France		New Zealand		Switzerland		United Kingdom	
	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error
Error Correction	-0,09	0,02	-	-	-0,19	0,03	-0,34	0,04	-0,22	0,03	-	-
Constant	-2,66	2,22	-0,03	0,01	2,37	0,86	-5,89	2,76	1,18	0,38	-0,01	0,02
M	-0,44	0,37	-	-	0,01	0,31	-0,23	0,18	0,21	0,31		
CBC	-0,47	0,13			0,19	0,17	0,18	0,15	-0,23	1,37	-0,83	0,33
FA	5,82	1,96	-	-	3,52	0,55	0,97	0,29	-	-	1,36	0,58
FL	-4,54	1,49	-	-	-3,19	0,49	0,75	0,52	-	-	-0,32	0,44
σ_{tt}	3,54	2,53	0,06	0,43	-2,50	5,10	6,37	3,40	1,75	0,90	-0,29	0,45
GDP	0,80	0,48	0,97	0,41	0,37	0,36	0,07	0,22	0,88	0,29	-0,60	0,15
Dummy 1	-0,46	0,39	-0,05	0,39	-0,70	0,31	0,19	0,36	0,01	0,29	0,01	0,02
Dummy 2	0,17	0,36	0,08	0,39	-1,19	0,24	-0,90	0,52	0,06	0,18	0,02	0,13
Lagged Dependent Variable	-	-	-0,25	0,06	-	-	-	-	-	-	-	-
Interest rate spread (i-i*)	0,004	0,002	0,02	0,00	0,01	0,01	0,02	0,01	0,03	0,01	0,002	0,003
* Dummy 1	-0,004	0,003	0,01	0,08	0,00	0,01	-0,02	0,01	-0,04	0,02	-0,002	0,003
* Dummy 2	-0,014	0,012	-0,03	0,08	-0,02	0,01	0,02	0,01	-0,03	0,01	-0,031	0,091
R^2	0.07		0.14		0.26		0.22		0.14		0.10	
Sample	1967:02-1999:12											
Dummy 1 Definition	Free Floating		Free Floating		Flexible Floating		Free Floating		Flexible Floating		Free Floating	
Dummy 2 Definition	Inflation Targeting		Inflation Targeting		Free Floating		Inflation Targeting		Free Floating		Inflation Targeting	
Total Effect on Interest Rate Differentials of Dummies												
Base+Dummy 1	0,000		0,03		0,01		0,00		-0.01		0,000	
Base+Dummy 1+Dummy 2	-0,014		0,00		-0,01		0,02		-0.04		-0,031	

The results mentioned above appear quite clearly. First, for all countries the adoption of a floating regime is associated with a reduction in the growth rate of real official reserves. This is also the case for the switch to an IT framework. All but three of the fourteen regime switching dummies are large, negative and statistically different from zero. The three other cases are non-statistically different from zero. Although the size of these coefficients varies, they range from a low of –0.56 to a high of –0.04. Most of them are clustered around –0.1. That is, the regime switch (either the float or IT framework) is associated with a 10% drop in real official reserves. These results are less clear in the estimation using SURE. Hence, to check the robustness of them we will return to this point below, using panel data results.[7]

Across fixed or managed exchange rate regimes, the positive correlation between the short term domestic interest rates and the change in reserves is readily apparent. This reveals the strong effect of sterilized intervention on interest rates, a phenomenon that is not unknown in emerging economies. However, the switch in regime allows a sharp reversal of this correlation, revealing a recovery of monetary independence under floating exchange rates and IT. Mundell-Fleming has implications along these lines, but that are strictly related to the correlation between money supply and reserves. We see here that this correlation also shows up between interest rates and reserves.

Finally, table 6 presents the results of panel data estimation of (1) in the sample of four inflation targeters included in our sample. The pattern confirms that the stock of public reserves is reduced in these countries as they adopt an inflation target. However, the results regarding the exchange rate liberalization are less clear and, in some cases they even present positive effects. This result seems to suggest that the more important regime shift is the adoption of an inflation-targeting scheme. The adoption of a free floating regime does not allow the central bank to diminish the amount of reserves it holds probably because of a kind of fear of floating behavior.[8]

[7] Notice that in the estimation using SUR we must severely restrict the number of interactions. This explains why some variables were deleted (for instance, error correction terms are not significant for Canada and United Kingdom) and might be related with the results.

[8] Notice that Lahiri and Végh (2001) build a model to rationalize this kind of behavior by incorporating a monetary policy rule.

Table 6

Panel Data Estimation: The Effects of Exchange Rate Regime and Inflation Targeting on International Reserves (Four Developed Inflation Targeters)

Estimation Method	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**
GDP	0.27* (0.05)	0.14* (0.03)	0.36* (0.05)	0.21* (0.03)	0.22* (0.05)	0.07* (0.03)
Imports	0.47* (0.06)	0.16* (0.06)	0.25* (0.06)	0.03 (0.05)	0.23* (0.06)	-0.03 (0.05)
Central Bank Credit	-0.43* (0.03)	0.04* (0.01)	-0.48* (0.03)	0.02* (0.01)	-0.48* (0.03)	-0.00* (0.01)
TOT Volatility	-0.17 (0.64)	-0.90 (0.76)	0.01 (0.60)	-0.42 (0.72)	0.21 (0.56)	-0.20 (0.71)
Gross External Assets	0.86* (0.08)	0.57* (0.05)	0.97* (0.07)	0.62* (0.04)	0.96* (0.07)	0.68* (0.04)
Gross External Debt	-0.49* (0.05)	-0.24* (0.04)	-0.31* (0.05)	-0.23* (0.04)	-0.30* (0.05)	-0.31* (0.04)
Free Floating	**0.04** **(0.06)**	**0.12*** **(0.07)**	**0.15*** **(0.06)**	**0.22*** **(0.07)**	**0.13*** **(0.06)**	**0.19*** **(0.07)**
Flexible Floating	**-0.32*** **(0.06)**	**-0.43*** **(0.07)**	**-0.33*** **(0.06)**	**-0.40*** **(0.07)**	**-0.33*** **(0.06)**	**-0.34*** **(0.07)**
Inflation Targeting	**0.05** **(0.04)**	**-0.13** **(0.04)**	**-0.07*** **(0.04)**	**-0.31*** **(0.04)**	**-0.10*** **(0.04)**	**-0.28*** **(0.04)**
Time Controls	None	None	Time Dummies	Time Dummies	Time Dummies + US Interest Rate + OECD Economic Cycle	Time Dummies + US Interest Rate + OECD Economic Cycle
Adjusted R^2	0.86	0.83	0.89	0.86	0.90	0.87
Hausman-Test	0.00*		0.00*		0.00*	
Total (Cross-Country) Observations	1078 (4)	1078 (4)	1078 (4)	1078 (4)	1078 (4)	1078 (4)

Notes: Standard errors are presented in parentheses. The sample corresponds to the post-Bretton Woods period.

Now, it is not only relevant to observe the reduction in official reserves, but it is necessary to assess how the economy accommodates this reduction. The traditional literature on optimal reserve accumulation assumes that the opportunity cost of holding reserves is related to the marginal productivity of capital, or interest payments on foreign liabilities. Thus, one possibility is that the reduction in official reserves held at the Central Bank is associated with a higher current account deficit, through more investment or a reduction in foreign debt. In the first case, there would be a fall in the net foreign asset position of the country, while in the second both gross foreign assets and liabilities would fall. What is the evidence?

Table 7 – Structure of the International Investment Position

	Pre-float				
Period	United Kingdom 1966-90	France 1970-75	Canada 1966-84	New Zealand 1973-84	Australia 1973-82
Total foreign assets (US$ mill.)	557230	110694	90309	3310	13170
Composition:			*(% of total foreign assets)*		
official reserves	*3.7*	*11.8*	*11.6*	*30.8*	*34.1*
int´l liquidity	*0.1*	*57.1*	*35.3*	*14.1*	*2.9*
rest	*96.2*	*31.1*	*53.1*	*55.1*	*63.0*
Total foreign liabilities (US$ mill.)	430505	110311	191470	27657	66934
Net Foreign asset position					
(US$ mill.)	126725	383	-101161	-24347	-53764
(% of GDP)	*21.3*	*0.0*	*-29.6*	*-60.8*	*-24.9*

	Post-float					
Period	United Kingdom 1992-97	France 1976-80	Canada 1985-97	New Zealand 1985-1997	Australia 1983-97	Switzerland 1983-1996
Total foreign assets (US$ mill.)	2040084	2548565	1235212	142067	907674	610031
Composition:			*(% of total foreign assets)*			
official reserves	*2.3*	*7.1*	*5.9*	*37.1*	*18.9*	*8.1*
int´l liquidity bk	*0.1*	*59.9*	*26.1*	*14.5*	*13.7*	*42.0*
rest	*97.6*	*33.1*	*68.0*	*48.3*	*67.4*	*49.9*
Total foreign liabilities (US$ mill.)	1653197	215314	376537	48673	203048	213708
Net Foreign asset position						
(US$ mill.)	386887	2333250	858675	93393	704626	396323
(% of GDP)	*-2.4*	*6.3*	*-29.5*	*-77.6*	*-40.4*	*104.4*

Table 7 shows the changing structure of the international investment position in the selected countries. The econometric results above pointed at a reduction in the absolute level of official reserves through the change in regime. As can be appreciated, there is a compositional effect also. The share of official reserve holdings in total foreign assets drops in all countries except New Zealand. This shift is quite substantial, almost by half. Moreover, part of this fall is accommodated by an increase in international liquidity held at the financial sector. This is more apparent by looking at figure 5, which tracks the share of total reserves (defined as official reserves plus liquidity holdings at the financial sector) held by the private sector. In most cases there is a clear trend upward after the switch to a floating regime.

This could be merely a reflection of a worldwide trend towards the privatization of reserve holdings, which is apparent in figure 4. However, we do not believe this to bethe case, except perhaps for Switzerland and France. Their shift towards floating and the increase in the share of private reserves in these countries coincided with the break up of Bretton-Woods and the first oil shock. These events are likely candidates to explain figure 4. However, for the rest of the countries selected, the shift to floating and the increase in the share of private reserves occurred later, when the worldwide trend was flat. The test performed in section 2 showed that, on average, the share of reserves held at the financial sector was higher for floating countries.

4. Conclusions

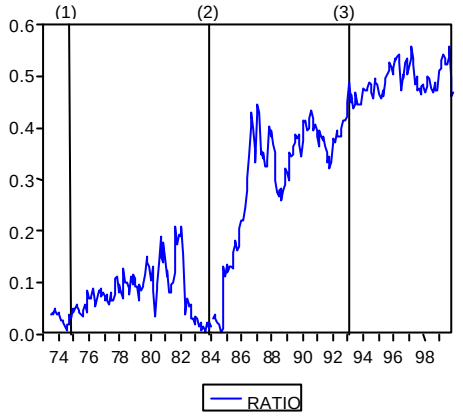
This paper studies the effects of the transition from a fixed or semi–rigid exchange rate regime to a flexible regime. The main findings indicate an average reduction in the accumulation of reserves between 10% and 20% when a country adopts an inflation-targeting regime. Regarding the effect of adopting a free floating parity, as other papers, the results are less clear and depend on the econometric methodology used.

Moreover, an interesting and robust result is that the reduction in official reserves in the countries that adopt a flexible exchange rate regime is partially compensated by the reaction of the private sector. This sector tends to accumulate reserves after the establishment of the new regime. The main hypothesis for this reaction is that the private sector has to insure itself to the exchange rate risk, because the implicit guarantee of a fixed exchange rate regime disappears.

As was mentioned in the paper, the analysis of the developed country experiences is useful for emerging economies that have implemented flexible exchange rate regimes and adopted inflation-targeting frameworks. Certainly, the results of this paper could give some light to the design and implementation of strategies to manage international reserves.

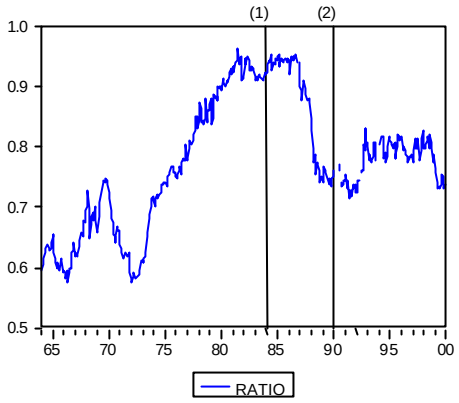
Figure 5 – Share of total reserves held by commercial banks.

AUSTRALIA



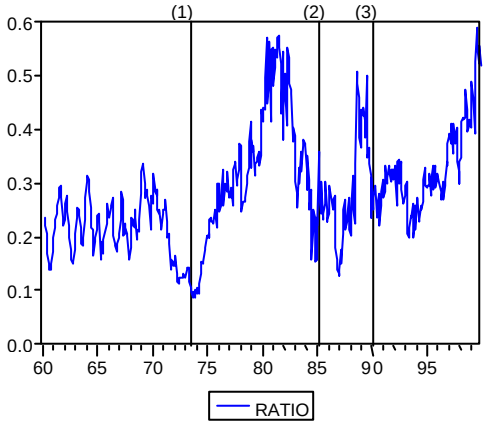
(1): fixed to flexible
(2) flexible to free
(3): inflation targeting

CANADA



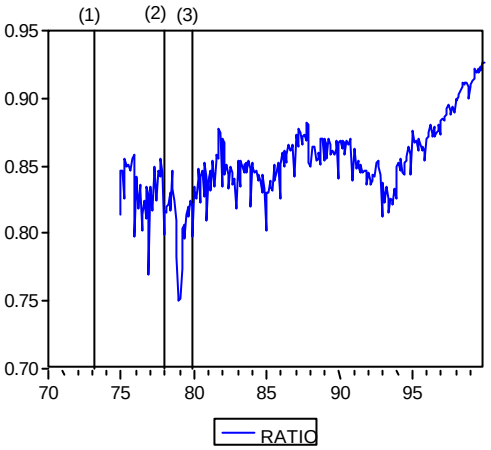
(1) flexible to free
(2) inflation targeting

NEW ZEALAND



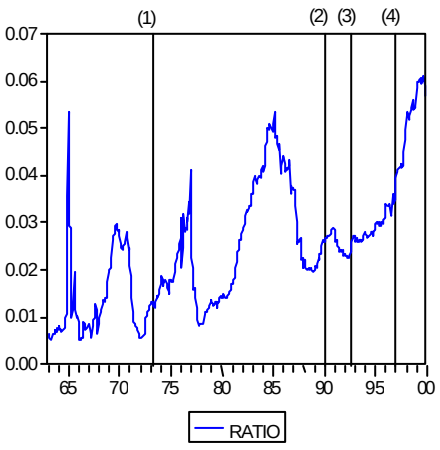
(1) fixed to flexible
(2) flexible to free
(3) inflation targeting

SWITZERLAND



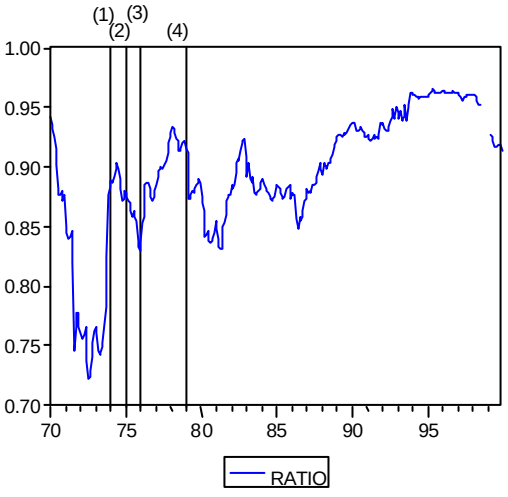
(1) fixed to free
(2) free to flexible
(3) flexible to free

UNITED KINGDOM



(1) fixed to free
(2) free to flexible
(3) flexible to free
and inflation targeting I
(4) inflation targeting II

FRANCE



(1) fixed to free
(2) free to flexible
(3) flexible to free
(4) free to flexible

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