



WP/06/274

# IMF Working Paper

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## The IMF's Reserves Template and Nominal Exchange Rate Volatility

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**IMF Working Paper**

Statistics Department

**The IMF's Reserves Template and Nominal Exchange Rate Volatility**

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Authorized for distribution by J. R. Rosales

December 2006

**Abstract**

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The effects of the adoption of the IMF's International Reserves and Foreign Currency Liquidity Data Template on nominal exchange rate volatility are investigated for 48 countries. Estimation of panel data models indicates that nominal exchange rate volatility decreases following dissemination of reserves template data while the effects of indebtedness and reserve adequacy on volatility exhibit statistically significant changes.

JEL Classification Numbers: F31, F33, G14

Keywords: Exchange rate volatility, foreign exchange reserves, transparency, SDDS

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<sup>1</sup> The authors are grateful to William Alexander for suggesting this topic and to IMF colleagues for their helpful comments and suggestions.

Contents	Page
I. Introduction .....	3
II. Data and Estimation Methodology .....	4
A. Data .....	4
B. Modeling Exchange Rate Volatility .....	4
III. Conclusion .....	8
Appendix	
I. Data, Model Selection, and Robustness .....	13
References .....	22
Text Tables	
1. Dates of Initial Reserves Template Data Dissemination and Sample Periods .....	9
2. Panel Unit Root Tests .....	11
3. Log Nominal Exchange Rate Volatility (ln(VOLER)) Regressions .....	12
Appendix Tables	
A.1. Model Selection .....	17
A.2. Instrumental Variables Estimations .....	17
A.3. Investigating the effects of SDDS Subscription .....	18
A.4. Alternative Standard Error Estimates .....	18
A.5. Investigating the Effects of Liquidity Conditions .....	19
Appendix Figures	
A.1. Estimated Period Effects and Linear Trend .....	20
A.2. Recursive Coefficient Estimates .....	21

## I. INTRODUCTION

The Asian crisis of 1997 revealed a need for the dissemination of more comprehensive data on foreign currency liquidity positions.<sup>2</sup> In 1998, the IMF began working on initiatives in this area in collaboration with working groups of the Euro-Currency Standing Committee of the Central Banks of the Group of Ten (G-10) Countries and the Group of Twenty-two (G-22) Finance Ministers and Central Bank Governors. The resulting International Reserves and Foreign Currency Liquidity Data Template (hereinafter referred to as the “Reserves Template”), became a prescribed element of the IMF’s Special Data Dissemination Standard (SDDS). Data reporting under this initiative began in June 1999; and after a short transition period, SDDS subscribers were required to observe the standard as of April 2000.

The aims of introducing the Reserves Template were not limited to improving dissemination of data on official reserve assets, but also included providing markets with a broader picture of national authorities’ foreign currency liquidity position. In the Reserves Template, detailed data dissemination is required on the following elements of the foreign currency liquidity position: official reserve assets and other foreign currency assets, and predetermined and contingent short-term inflows and outflows of foreign currency. In addition, subscribers may report any relevant supplementary information, including the currency composition of reserves, in memorandum items.<sup>3</sup>

Both the SDDS initiative, at a general level, and the adoption of the Reserves Template were aimed at increasing transparency and accountability, and promoting the efficient functioning of markets. In particular, for the Reserves Template, the G-10 Working Group considered that greater transparency on foreign currency liquidity would help to remove a source of financial instability. The literature on the market-efficiency benefits of standards and codes is limited, but empirical evidence indicating that emerging market subscribers to the SDDS face lower borrowing costs than nonsubscribers is accumulating.<sup>4</sup> To our knowledge, the exchange market efficiency effects of the SDDS or the Reserves Template data dissemination standards have yet to be examined. To fill this gap, this paper investigates whether the dissemination of Reserves Template data has affected the volatility of nominal exchange rates. We hypothesize that providing markets with more information about a country’s foreign currency liquidity position could affect exchange rate volatility through two channels; first, through an overall calming effect related to increased transparency and, second, by allowing market participants to better assess the implications of a country’s indebtedness and reserve adequacy.

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<sup>2</sup> See Group of Ten (1998).

<sup>3</sup> See Kester (2001).

<sup>4</sup> Cady and Pellechio (2006), Cady (2005), Christofides, Mulder and Tiffin (2003), Glennerster and Shin (2003), and the Institute of International Finance (2002).

Estimation of panel data models indicates that nominal exchange rate volatility decreases after dissemination of Reserves Template data, and that the effects of indebtedness and reserve adequacy exhibit statistically significant changes. First, after controlling for country-specific macroeconomic developments and policies, we find a reduction in the level of nominal exchange rate volatility following Reserves Template subscription. Second, as expected, we find a positive effect on volatility of higher debt-to-GDP ratios, which diminishes following Reserves Template data dissemination. Third, again as expected, we find a negative effect of reserves-to-short-term debt ratios on exchange rate volatility, and that subscription to the Reserves Template reinforces this negative effect. These general findings appear quite robust to different estimation techniques, country groupings, estimation periods, and control variables.

## **II. DATA AND ESTIMATION METHODOLOGY**

### **A. Data**

The panel dataset is comprised of quarterly time-series observations generally spanning the period 1991Q1 to 2005Q4 covering a broad cross-section of 48 countries, including 12 industrial countries and 36 emerging markets and low-income countries. Among those countries, 39 are SDDS subscribers that initiated the dissemination of the Reserves Template at different dates after mid-1999, when it was approved by the IMF. In addition, while not an SDDS subscriber, New Zealand reports reserves template data that are redisseminated by the IMF. The remaining eight countries serve as controls, since they neither subscribe to the SDDS nor disseminate reserves template data.<sup>5</sup> Table 1 shows the list of countries considered, the dates of initial reserves template data dissemination and the sample periods used for each country. In general, the time frame used for the estimation, covers approximately nine years prior to and six years after the introduction of the Reserves Template, but is unbalanced due to differences in the availability of data among countries.

### **B. Modeling Exchange Rate Volatility**

As we intend to apply tools from the policy evaluation literature to quarterly panel data, we need to calculate a quarterly volatility measure from very high frequency exchange rate data. The highest frequency data for readily available real or effective exchange rate measures is monthly, and clearly this is inadequate to calculate quarterly standard deviations. Therefore, this study focuses on daily nominal exchange rate volatility. Our measure of exchange rate volatility is the quarterly standard deviation of the first difference of the natural logarithm of

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<sup>5</sup> Eight control countries represents 20 percent of the subscribing countries in the sample. Clearly, in a clinic trial, one would prefer a larger number of controls. However, this represents a natural experiment in which the pool of potential control countries was limited because many candidate countries had fixed exchange rate regimes and exhibited no exchange rate variability at all over long periods, while other candidate countries could not be considered due to insufficient macroeconomic time series data.

daily bilateral exchange rates vis-à-vis the U.S. dollar.<sup>6</sup> Over short horizons, nominal and real exchange rates are highly correlated as nominal volatility is the main determinant of real exchange rate volatility. Furthermore, we consider that the first observable effects of the dissemination of Reserves Template data on the functioning of markets may be present in foreign exchange and capital markets, where transactions are made in nominal terms.

Following the approach from the empirical policy evaluation literature,<sup>7</sup> the influence of reserves template data dissemination on volatility is examined using dummy variables, while controlling for the trajectories of the fundamental macroeconomic determinants of volatility, which may in part derive from changes in policies, and country-specific effects.

Nominal exchange rate volatility (*VOLER*) is modeled as a function of the following variables: indicators of indebtedness (*DGDP*) and reserve adequacy (*RA*); the change in fiscal stance ( $\Delta$ *GBAL*); real GDP growth ( $\Delta$ *GDP*); inflation (*INF*); the volatility of money growth (*VOLM*); the current account relative to GDP (*CAB*); a measure of openness of the economy (*OPEN*); dummy variables indicating periods of fixed exchange rates and periods of “managed” floating or intervention (*FIX*) and (*INT*), respectively; and a time trend (*TREND*).<sup>8</sup> All variables included in the model can be considered stationary series, according to panel unit root tests (Table 2).

In order to investigate the influence of the dissemination of reserves template data on exchange rate volatility, a dummy variable for each country taking the value of zero up to the quarter before initial dissemination and unity thereafter (*RT*) is considered to test for shifts in the level of nominal exchange rate volatility. In addition, interactive terms involving the dummy variable (*RT*) and indicators of indebtedness (*DGDP*) and reserve adequacy (*RA*) are included to test for changes in their effects on exchange rate volatility.

The basic estimating equation can be written as:

$$\begin{aligned} \ln(VOLER_{i,t}) = & \beta_0 + \beta_1 RT_{i,t} + \beta_2 \ln(DGDP_{i,t}) + \beta_3 \ln(DGDP_{i,t}) * RT_{i,t} + \\ & \beta_4 \ln(RA_{i,t}) + \beta_5 \ln(RA_{i,t}) * RT_{i,t} + \beta_6 \Delta GBAL_{i,t-2} + \beta_7 \Delta GDP_{i,t} + \\ & \beta_8 INF_{i,t} + \beta_9 \ln(VOLM_{i,t}) + \beta_{10} CAB_{i,t-3} + \beta_{11} \ln(OPEN_{i,t}) + \\ & \beta_{12} FIX_{i,t} + \beta_{13} INT_{i,t} + \beta_{14} TREND_t + u_{i,t} \end{aligned} \quad (1)$$

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<sup>6</sup> This measure is commonly used in the literature as it is unbiased by trends in the exchange rate series since it tends to zero when the exchange rate closely follows a trend.

<sup>7</sup> For example, see Blundell and Costa Dias (2000).

<sup>8</sup> The selection of variables was guided by recent literature on exchange rate volatility, including Devereux and Lane (2003) and Hviding, Nowak, and Ricci (2004). A detailed description of the variables used can be found in the Appendix I. The dummy variables indicating the choice of exchange rate regimes were constructed using the Levy-Yeyati and Sturzenegger (2005) *de facto* 3-way classification of exchange rate regimes.

Estimation of equation (1), may involve issues of endogeneity and the choice of appropriate estimation techniques. These issues are dealt with in the Appendix I, together with the model selection criteria and robustness tests. Suffice it to indicate here that the application of instrumental variables estimation generally found no significant changes in the signs, size, or statistical significance of the coefficient estimates, diminishing the importance of endogenous regressors as a practical issue.

OLS estimation of equation (1) with data for 48 countries, controlling for country-specific effects, is reported in Column 1 of Table 3. The estimated coefficients of all macroeconomic variables have the expected signs, and, except for the measure of openness, are all statistically significant. As one might expect, exchange rate fixing and episodes of managed floating or intervention tend to reduce volatility.<sup>9</sup> As concerns macroeconomic fundamentals, increasing levels of reserve adequacy, real GDP growth, and improvements in the fiscal and external current account balances reduce exchange rate volatility.<sup>10</sup> On the other hand, increases in volatility stem from higher indebtedness, inflation, and volatility of money growth. Column 2 of Table 3, shows estimates of the preferred model in which the non-significant effect of openness has been omitted.

This specification also permits testing for level shifts and changes in the slope coefficients of the estimated relationships between volatility and key macroeconomic variables.<sup>11</sup> First, the coefficient estimate attached to the Reserves Template dummy is negative and statistically different from zero, indicating that dissemination of Reserves Template data is associated with a downward shift in the level of nominal exchange rate volatility. For the preferred model, the estimated coefficient indicates a decline in mean volatility of just under 20 percent following dissemination of reserves template data.<sup>12</sup>

Second, the positive coefficient estimate attached to the indicator of indebtedness implies that highly indebted countries tend to have more volatile nominal exchange rates. However, the coefficient estimate attached to the indebtedness–Reserves Template interaction term is negative and statistically different from zero, suggesting that for Reserves Template subscribers, higher external debt-to-GDP ratios have a diminished, yet still positive, effect on nominal exchange rate volatility.

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<sup>9</sup> For a theoretical perspective see Flood and Rose (1999).

<sup>10</sup> This implies that a country with large enough current account surpluses would, other things equal, be able to eliminate exchange rate volatility.

<sup>11</sup> Initially, a basic model allowing the constant term and all of the coefficients of the macroeconomic variables to change was estimated. Only the changes in the coefficients attached to indebtedness and reserve adequacy were statistically different from zero; when re-estimated, dropping the non-significant interactive terms, the constant term also shows a statistically significant change after Reserves Template subscription.

<sup>12</sup> Note, however, that this does not imply that Reserves Template subscribers will experience an absolute decline in nominal exchange rate volatility, as the macroeconomic variables determine the path of volatility along with the trend component.



Third, the estimates indicate a statistically significant negative relationship between nominal exchange rate volatility and reserve adequacy, suggesting that currencies of countries with higher reserve-to-short term debt ratios tend to be more resilient and generally less susceptible to large exchange rate variations. Concerning the interaction of the Reserves Template dummy with the reserve adequacy variable, the estimated coefficient is negative and statistically significant, indicating that increases in reserve adequacy have an enhanced dampening effect on nominal exchange rate volatility for template subscribers.

The preferred model was re-estimated using different country groupings: 12 industrial countries; 36 emerging market and low-income countries; and, 16 emerging market countries that experienced episodes of exchange market pressure during the sample period<sup>13</sup> (Table 3, columns 3–5). Estimates from these three regressions confirm the results obtained with the full sample, indicating that dissemination of reserves template affects the level of nominal exchange rate volatility and its relationships with indebtedness and reserve adequacy. For all three groups, the estimated coefficient attached to the reserves template dummy variable is negative and statistically significant from zero, indicating a reduction in nominal exchange rate volatility following subscription to the Reserves Template.

In the case of industrial countries, reserve adequacy has a statistically significant negative effect, but the positively signed indebtedness coefficient is not significant. However, the interactive terms have statistically significant coefficient estimates with the expected signs. For the groups of emerging and low-income countries and the 16 emerging market countries having experienced exchange rate market pressure, the effect of increasing indebtedness on nominal exchange rate volatility is reduced following the dissemination of the reserves template data. However, there is no statistically significant change in the estimated coefficient attached to reserve adequacy.

These results suggest for the industrial countries being studied, that the level of reserve adequacy tends to reduce the volatility of nominal exchange rates and that this effect has become stronger after dissemination of the Reserves Template. The coefficient attached to indebtedness is positive but not statistically significant while the negative interactive term is significant, precluding a clear conclusion. For emerging market and low-income countries, increasing indebtedness is associated with higher exchange rate volatility, but this effect is diminished following the dissemination of Reserves Template data. On the other hand, while reserve adequacy is an important determinant of exchange rate volatility for these countries, the dissemination of Reserves Template data does not appear to have changed this relationship.

We have applied a battery of tests to the basic model, all of which suggest that the reported estimation results are robust (Appendix I, Section 3). First, the basic model was fitted using data up to 1999Q4; this estimation indicated that the preferred specification worked reasonably well and that the applicability of the basic model is not dependant on

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<sup>13</sup> Brazil, Bulgaria, Chile, Colombia, Hungary, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, South Africa, Thailand, Turkey, Uruguay, and Venezuela; based on Ramakrishnan and Zalduendo (2006).

developments after the introduction of the Reserves Template. Second, we examined the stability of the coefficient estimates using recursive estimation (Figure A.2) and found them to be relatively stable over time. Third, we tested for the possibility that the Reserves Template dummy variable was actually picking up the influence of SDDS subscription, and found that the effects captured by the Reserves Template dummy variable are independent of SDDS participation. Fourth, using different options for the calculation of the variance-covariance matrix of the model did not alter inference about the statistical significance of the coefficient estimates. Finally, we tested if the estimates involving the Reserves Template dummy variable were influenced by the easing of international liquidity conditions that coincided with the period of initial subscription to the Reserves Template (2000–01). Regressions including differing measures of the slope of the U.S. yield curve, a proxy for international liquidity, featured non-significant coefficients; meanwhile, those associated with the Reserves Template dummy variable remained broadly unchanged in sign, size and significance.

### **III. CONCLUSION**

Using panel data analysis involving 48 countries, in which nominal exchange rate volatility is specified as a function of fundamental macroeconomic variables, we investigated the effects of dissemination of Reserves Template data. Robust econometric results indicate that providing markets with additional information about foreign currency liquidity positions has served to reduce nominal exchange rate volatility via an overall calming effect and by allowing market participants to better assess the implications of a country's indebtedness and reserve adequacy. More specific results suggest that for industrial countries, the diminishing effect of reserve adequacy on nominal exchange rate volatility is enhanced following Reserves Template data dissemination; while for emerging market and low-income countries, the influence of indebtedness in raising exchange rate volatility is reduced.

Table 1. Dates of Initial Reserves Template Data Dissemination and Sample Periods

Country	Date of Initial Reserves Template Data Dissemination	Sample period
1 Argentina	March 22, 2000	1993Q2–2005Q3
2 Australia	February 22, 2000	1991Q1–2005Q3
3 Bolivia	Control, non-SDDS	1994Q1–2004Q4
4 Brazil	March 14, 2001	1994Q3–2005Q3
5 Bulgaria	Control, non-SDDS	1997Q3–2005Q3
6 Canada	September 17, 1999	1991Q1–2005Q3
7 Chile	June 1, 2000	1996Q2–2005Q3
8 China	Control, non-SDDS	1999Q3–2005Q3
9 Colombia	June 12, 2000	1994Q2–2005Q3
10 Croatia	May 31, 2000	1997Q2–2005Q3
11 Czech Republic	April 10, 2000	1994Q1–2005Q3
12 Denmark	June 23, 2000	1991Q1–2005Q3
13 Estonia	April 1, 2000	1997Q2–2005Q3
14 Hungary	July 2000	2000Q1–2005Q3
15 Iceland	January 24, 2001	1997Q2–2005Q3
16 India	December 2001	1997Q1–2005Q1
17 Indonesia	July 7, 2000	1991Q1–2005Q3
18 Israel	November 9, 2000	1991Q1–2005Q4
19 Japan	June 9, 2000	1991Q1–2005Q3
20 Jordan	Control, non-SDDS	1994Q1–2004Q2
21 Kazakhstan	March 24, 2003	1999Q3–2005Q2
22 Korea, Rep. of	June 2000	1995Q1–2005Q2
23 Latvia	June 14, 2000	1997Q2–2005Q3
24 Lithuania	June 16, 2000	1997Q2–2005Q3
25 Malaysia	May 31, 2000	1991Q2–2005Q3
26 Mauritius	Control, non-SDDS	1999Q2–2005Q1
27 Mexico	April 17, 2000	1991Q1–2005Q3
28 New Zealand	March 20, 2000, non-SDDS	1991Q1–2005Q3
29 Nigeria	Control, non-SDDS	1994Q1–2003Q4
30 Norway	June 9, 2000	1992Q1–2003Q4

Table 1. Dates of Initial Reserves Template Data Dissemination and Sample Periods  
(Concluded)

Country	Date of Initial Reserves Template Data Dissemination	Sample period
31 Paraguay	Control, non-SDDS	1999Q2–2005Q1
32 Peru	September 12, 2000	1994Q1–2005Q3
33 Philippines	January 17, 2001	1991Q1–2005Q4
34 Poland	May 31, 2000	1995Q2–2005Q3
35 Russia	January 31, 2005	1997Q1–2005Q3
36 Singapore	June 21, 2000	1991Q1–2005Q4
37 Slovak Republic	July 2000	1995Q1–2005Q3
38 Slovenia	June 2000	1997Q2–2005Q3
39 South Africa	May 31, 2000	1991Q1–2005Q3
40 Sweden	April 2000	1993Q2–2000Q4, 2002Q1–2005Q4
41 Switzerland	August 11, 1999	1991Q1–2005Q3
42 Thailand	May 16, 2000	1993Q2–2005Q3
43 Tunisia	December 4, 2000	2000Q2–2005Q3
44 Turkey	June 9, 2000	1991Q1–2005Q3
45 Ukraine	January 10, 2003	1998Q4–2005Q3
46 Uruguay	February 12, 2004	1991Q1–2004Q4
47 United Kingdom	September 17, 1999	1991Q1–2005Q3
48 Venezuela, República Bolivariana de	Control, non-SDDS	1991Q1–2002Q4

Source: IMF Statistics Department records.

Notes: A break in Swedish monetary data for 2001Q1–Q4 resulted in a small gap in the sample.

Table 2. Panel Unit Root Tests

Variable	Test	Cross-Sections	Test* Value (Probability) [Lags]	Test** Value (Probability) [Lags]	Null Hypothesis of Unit Root (1 percent level)
<i>ln VOLER</i>	LLC	48	-10.573 ( 0.000 ) [0-5]	-11.394 ( 0.000 ) [0-9]	Rejected
	IPS	48	-13.987 ( 0.000 ) [0-5]	-14.687 ( 0.000 ) [0-9]	Rejected
<i>ln DGDP</i>	LLC	48	-1.421 ( 0.078 ) [0-8]	0.921 ( 0.821 ) [0-8]	Rejected at 10%
	IPS	48	-0.763 ( 0.223 ) [0-8]	0.496 ( 0.690 ) [0-8]	Not rejected
<i>ln RA</i>	LLC	48	-3.321 ( 0.000 ) [0-8]	-4.954 ( 0.000 ) [0-8]	Rejected
	IPS	48	-3.448 ( 0.000 ) [0-8]	-4.302 ( 0.000 ) [0-8]	Rejected
<i>ΔGBAL</i>	LLC	48	-40.022 ( 0.000 ) [0-7]	-36.637 ( 0.000 ) [0-7]	Rejected
	IPS	48	-40.298 ( 0.000 ) [0-7]	-38.109 ( 0.000 ) [0-7]	Rejected
<i>ΔGDP</i>	LLC	48	0.137 ( 0.555 ) [0-8]	3.699 ( 1.000 ) [0-8]	Not rejected
	IPS	48	-6.193 ( 0.000 ) [0-8]	-2.990 ( 0.001 ) [0-8]	Rejected
<i>INF</i>	LLC	48	-6.637 ( 0.000 ) [0-10]	-11.058 ( 0.000 ) [0-10]	Rejected
	IPS	48	-22.901 ( 0.000 ) [0-10]	-26.038 ( 0.000 ) [0-10]	Rejected
<i>ln VOLM</i>	LLC	48	-4.057 ( 0.000 ) [0-8]	-2.029 ( 0.021 ) [0-6]	Mixed (rejected at 5%)
	IPS	48	-9.402 ( 0.000 ) [0-8]	-8.501 ( 0.000 ) [0-6]	Rejected
<i>CAB</i>	LLC	48	-4.623 ( 0.000 ) [0-5]	-7.496 ( 0.000 ) [0-5]	Rejected
	IPS	48	-7.203 ( 0.000 ) [0-5]	-9.028 ( 0.000 ) [0-5]	Rejected
<i>ln OPEN</i>	LLC	48	-2.002 ( 0.023 ) [0-6]	-2.730 ( 0.003 ) [0-5]	Mixed (rejected at 5%)
	IPS	48	-1.480 ( 0.069 ) [0-6]	-4.607 ( 0.000 ) [0-5]	Mixed (rejected at 10%)

Source: Author's calculations.

Notes: LLC and IPS mean Levin, Lin and Chu test and the Im, Pesaran and Shin test, respectively. Asterisks indicate unit root tests based on individual effects (8) and individual effects and linear trends (\*\*) with automatic lag length (minimum to maximum) using the Schwarz information criterion.

Table 3. Log Nominal Exchange Rate Volatility ( $\ln(VOLER)$ ) Regressions

	48 Countries			48 Countries (only significant variables)			12 Industrialized Countries			36 Emerging and Low-Income Countries			16 Emerging Countries		
	Coefficient	Standard error		Coefficient	Standard error		Coefficient	Standard error		Coefficient	Standard error		Coefficient	Standard error	
Constant	-5.741	0.328	***	-5.598	0.234	***	-5.582	0.342	***	-5.496	0.333	***	-4.934	0.442	***
Reserves Template ( $RT$ )	-0.193	0.087	**	-0.203	0.088	**	-0.288	0.156	*	-0.194	0.116	*	-0.339	0.152	**
Debt-to-GDP ratio ( $\ln D GDP$ )	0.376	0.103	***	0.324	0.088	***	-0.153	0.113		0.361	0.118	***	0.468	0.166	***
Reserves Template * Debt-to-GDP ratio ( $RT * \ln D GDP$ )	-0.192	0.047	***	-0.197	0.047	***	-0.143	0.062	**	-0.177	0.071	**	-0.279	0.083	***
Reserves Adequacy ( $\ln RA$ )	-0.136	0.054	**	-0.152	0.055	***	-0.154	0.080	*	-0.153	0.073	**	-0.342	0.125	***
Reserves Template * Reserves Adequacy ( $RT * \ln RA$ )	-0.111	0.038	***	-0.109	0.039	***	-0.154	0.054	***	-0.133	0.106		-0.124	0.168	***
Change in Fiscal Balance-to-GDP ratio ( $\Delta GBAL$ )	-1.482	0.522	***	-1.495	0.528	***	-4.340	0.919	***	-1.252	0.646	*	-0.882	0.818	***
GDP growth ( $\Delta GDP$ )	-1.770	0.589	***	-1.902	0.594	***	-1.065	0.818		-2.111	0.765	***	-2.758	0.914	***
Inflation ( $\ln F$ )	2.397	0.635	***	2.468	0.641	***	1.479	1.410		2.562	0.785	***	1.012	1.041	
Volatility of money ( $\ln VOLM$ )	0.121	0.044	***	0.103	0.045	**	0.056	0.038		0.124	0.066	*	0.168	0.085	**
Current Account Balance-to-GDP ratio ( $CAB$ )	-0.576	0.276	**	-0.494	0.264	*	-1.706	0.391	***	-0.331	0.322		-0.846	0.701	
Openness ( $\ln OPEN$ )	-0.135	0.127		--	--	--	--	--	--	--	--	--	--	--	--
Fixed Exchange Rate Regime ( $FIX$ )	-0.305	0.068	***	-0.313	0.069	***	-0.084	0.073		-0.354	0.092	***	-0.307	0.118	***
Intermediate Exchange Rate Regime ( $INT$ )	-0.143	0.056	**	-0.158	0.057	***	-0.201	0.070	***	-0.178	0.076	**	-0.195	0.103	*
Trend	0.013	0.003	***	0.013	0.003	***	0.005	0.003	*	0.017	0.004	***	0.018	0.005	***
Adjusted R <sup>2</sup>	0.808			0.804			0.673			0.799			0.762		
Sample	1991Q1–2005Q3			1991Q1–2005Q4			1991Q1–2005Q4			1991Q1–2005Q3			1991Q1–2005Q3		
Pooled observations	1977			2019			658			1361			741		
Durbin-Watson statistic	2.096			2.044			2.230			2.018			2.027		
Mean of dependent variable ( $\ln$ )	-5.627			-5.632			-5.262			-5.811			-5.607		
Mean of dependent variable (natural units)	0.0036			0.0036			0.0052			0.0030			0.0037		

Source: Authors' calculations.

Notes: \*, \*\* and \*\*\* indicate significance at 10, 5, and 1 percent levels, respectively. Fixed effect estimates and other control variables not reported for brevity. Column 3 considers Australia, Canada, Denmark, Iceland, Israel, Japan, New Zealand, Norway, Singapore, Sweden, Switzerland, and the United Kingdom. Column 5 considers Brazil, Bulgaria, Chile, Colombia, Hungary, Indonesia, the Republic of Korea, Malaysia, Mexico, Peru, the Philippines, South Africa, Thailand, Turkey, Uruguay, and the República Bolivariana de Venezuela.

## APPENDIX I: DATA, MODEL SELECTION, AND ROBUSTNESS

### Section 1: Data and Sources.

*VOLER*: is the quarterly standard deviation of the first difference of the natural logarithm of daily bilateral exchange rates (domestic currency units per U.S. dollar). Source: Datastream.

*RT*: dummy variable indicating dissemination of reserves template data. Dates for initial dissemination of reserves template data were determined from IMF records. Text Table 1 shows the list of countries considered, their dates of initial dissemination of reserves template data and the sample period of the data for each country. In our dataset, the first country reporting the reserves template data is Switzerland in August 1999 and the latest Russia in January 2005.

*DGDP*: ratio of government debt to gross domestic product (GDP). Data on debt stocks were taken from the World Economic Outlook (*WEO*) database and for GDP from IMF's *International Financial Statistics (IFS)*. Annual debt stocks were used as quarterly estimates by repeating the annual figure each quarter.

*RA*: ratio of international reserves to short-term external debt outstanding on a remaining maturity basis, in the case of the 36 low-income and emerging market countries. For industrial countries, the debt stocks used refer to total general government debt. Quarterly data on international reserves was drawn from the *IFS*. Annual debt stocks, taken from the *WEO*, were used as quarterly estimates by repeating the annual figure each quarter.

$\Delta GBAL$ : change in general government balance-to-GDP ratio. General government balances were drawn from IMF's *WEO*. Annual figures were used to represent quarterly values using the same value every quarter divided by quarterly nominal GDP drawn also from *IFS*.

$\Delta GDP$ : GDP growth rates, measured on a Purchasing Power Parity basis, expressed in U.S. dollars. GDP series were drawn from the *WEO* database and deflated using the U.S. GDP deflator. Again, we used the annual figures to represent quarterly values.

*INF*: annual rate of growth of consumer price indexes, taken from *IFS*.

*VOLM*: standard deviation of month-to-month broad money growth rates for the 12-month period ending each quarter. Monthly monetary data were obtained from *IFS*.

*CAB*: ratio of current account balance-to-GDP ratio. Quarterly data on current account balances and GDP were drawn from the *IFS*.

*OPEN*: openness is the sum of exports and imports of goods and services divided by GDP, both measured in U.S. dollars. Both items were drawn from the *IFS*.

*FIX* and *INT*: Dummy variables indicating, respectively, periods of fixed exchange rates or dirty floating; periods of floating serve as the benchmark category.<sup>14</sup> Before including the dummy variables to model the choice of exchange rate regimes, we investigated the variability of reserves stocks as a proxy for exchange rate market intervention but found no statistically significant effects.

U.S. interest rates: the 3- and 10-year Treasury bond yields, the three-month Treasury bill rate and the Fed Funds rate were obtained from the *IFS* to calculate different yield curve slopes.

## Section 2: Model Selection and Estimation Issues

In the initial OLS estimations we tested for the absence of correlation between random effects in both the cross-section and period dimensions and the explanatory variables. These tests yielded, respectively, chi-squared test statistics of 46.185 and 39.566, both with 13 degrees of freedom, indicating that consistent parameter estimates can be obtained using fixed effects. The estimates are reported as Model 1 in Table A.1. In this equation, the effects of the explanatory variables on the volatility of the nominal exchange rate have the expected signs and are statistically significant, except for the measure of openness and the change in the fiscal stance. As shown by the low Durbin-Watson statistic, this estimation exhibits residual serial correlation.

In order to correct the serial correlation of residuals by including an AR(1) term, it is necessary to omit the fixed period effects to permit estimation. Consequently, fixed period effects have been modeled using a trend variable; this approach was motivated by the observation that the period effects show an increasing effect over time (Figure A.1). Model 2 in Table A.1 reports an estimation including a common AR(1) for all countries and a linear time trend.

In Model 3 in Table A.1, we included dummy variables to capture currency crisis in various countries producing outliers in the estimated residuals. These dummies are country specific and are unity in the quarter in which a residual outlier occurs; a total of 32 dummies are included.

In addition, Model 3 specifies country-specific AR(1) terms and permits testing of the appropriateness of the restriction of a common AR(1). This restriction was rejected using a likelihood ratio test with a chi-squared statistic value of 188.698 with 48 degrees of freedom.

Estimation of these models may be affected by endogeneity issues with implications for the choice of an appropriate estimation techniques. In this case, the potential endogeneity may arise from two sources: the possibility that a country's decision to subscribe to the Reserves

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<sup>14</sup> See Levy–Yeyati and Sturzenegger (2005).



Template is influenced by observed nominal exchange rate volatility, and the more general problem of simultaneous determination of macroeconomic outcomes in individual countries.

Some readers may argue that the decision to disseminate reserves template data could be considered as endogenous; however, the Reserves Template was an addition to the requirements of the established SDDS, therefore, it was an exogenous event for those countries who had already subscribed to the SDDS. Only 5 countries, representing about 10 percent of the sample, subscribed to the SDDS after the Reserves Template became a required element, when one could argue that the decision to subscribe may have been related to observed nominal exchange rate volatility.

To investigate the effects of other potentially endogenous regressors, the preferred model (Table 3, Column 2) was estimated using instrumental variables. Model A in Table A.2 reports the results of a regression treating the debt-to-GDP and reserve adequacy ratios (as well the associated interaction terms) as endogenous variables, using lagged values as instruments.<sup>15</sup> Model B, in addition, treats as endogenous variables GDP (PPP basis) growth rates, year-over-year inflation, and the volatility of money growth. These regressions are quite similar to the OLS estimates of the preferred model, and can be interpreted as diminishing the importance of the potential endogeneity of regressors as a practical issue.

### Section 3: Robustness

To check that the applicability of the basic model is not dependant on developments after the introduction of the Reserves Template, the preferred model was estimated using data up to 1999Q4. In this estimation, the adjusted  $R^2$  is 0.805, the effects of all macroeconomic variables have the expected signs, similar magnitudes to full sample estimates, and only the coefficient associated to the fiscal balance is not statistically significant.<sup>16</sup>

Figure A.2 shows recursive estimates of the coefficients of interest in our model. As can be observed, the estimates corresponding to the dummy variable indicating the dissemination of Reserves Template and the associated interactive terms show stability over time. The initial estimation used a sample ending in the last quarter of 2000 and subsequently four quarters were added to the sample at each step, except for 2005 for which only three quarters can be added to the sample period.

To explore the possibility that the effects captured by the Reserves Template dummy and the associated interactive terms are related to subscription to the SDDS instead of reserves template data dissemination, we estimated different versions of the model in which a dummy variable and interactive terms associated with SDDS subscription for each country were

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<sup>15</sup> The fiscal stance and current account balance were not instrumented since they enter the estimating equation with lags.

<sup>16</sup> In this estimation, the AR(1) term to correct first order residual correlation is common to all countries, because when using data up to 1999Q4, the model could not be estimated using both cross section effects and country specific AR(1) terms.

included. The results, presented in Table A.3, show that the effects found are specific to the dissemination of Reserves Template data and that SDDS subscription does not show significant effects on nominal exchange rate volatility.

Using different options for the calculation of the variance-covariance matrix, does not change our conclusions about the significance of the variables in the model. Table A.4 shows the coefficients estimates and their standard errors and levels of significance calculated using different estimates of the variance-covariance matrix.

To test if the Reserves Template dummy variable might be capturing the easing of international liquidity conditions that coincided with the period of heaviest subscription to the reserves template (2000-01), regressions including differing measures of the slope of the U.S. yield curve, a proxy for international liquidity conditions, were estimated. The estimates attached to the U.S. yield curve were found to be positive, but not statistically significant, while those involving the Reserves Template dummy variable remained unchanged in sign, size and significance (Table A.5). We conclude that the Reserves Template dummy variables are not capturing the influence of easing international liquidity conditions.

Table A.1. Model Selection

	Model 1			Model 2			Model 3		
	Coefficient	Standard error		Coefficient	Standard error		Coefficient	Standard error	
Constant	-4.648	0.254	***	-4.836	0.280	***	-5.741	0.328	***
Reserves Template ( <i>RT</i> )	-0.263	0.087	***	-0.055	0.071		-0.193	0.087	**
Debt-to-GDP ratio ( <i>ln DGD</i> )	0.417	0.094	***	0.419	0.089	***	0.376	0.103	***
Reserves Template * Debt-to-GDP ratio ( <i>RT*ln DGD</i> )	-0.212	0.037	***	-0.213	0.037	***	-0.192	0.047	***
Reserves Adequacy ( <i>ln RA</i> )	-0.167	0.042	***	-0.149	0.042	***	-0.136	0.054	**
Reserves Template * Reserves Adequacy ( <i>RT*ln RA</i> )	-0.092	0.030	***	-0.084	0.030	***	-0.111	0.038	***
Change in Fiscal Balance-to-GDP ratio ( $\Delta GBAL$ )	-0.215	0.918		-0.849	0.900		-1.482	0.522	***
GDP growth ( <i>DGD</i> )	-3.413	0.607	***	-3.878	0.564	***	-1.770	0.589	***
Inflation ( <i>INF</i> )	6.023	0.710	***	5.615	0.700	***	2.397	0.635	***
Volatility of money ( <i>ln VOLM</i> )	0.139	0.040	***	0.158	0.040	***	0.121	0.044	***
Current Account Balance-to-GDP ratio ( <i>CAB</i> )	-1.362	0.369	***	-1.338	0.368	***	-0.576	0.276	**
Openness ( <i>ln OPEN</i> )	-0.011	0.118		0.033	0.115		-0.135	0.127	
Fixed Exchange Rate Regime ( <i>FIX</i> )	-1.033	0.059	***	-1.006	0.060	***	-0.305	0.068	***
Intermediate Exchange Rate Regime ( <i>INT</i> )	-0.361	0.054	***	-0.391	0.054	***	-0.143	0.056	**
Trend				0.008	0.002	***	0.013	0.003	***
Adjusted R <sup>2</sup>		0.596			0.579			0.808	
Sample	1990Q4 - 2005Q3			1990Q4 - 2005Q3			1991Q1 - 2005Q3		
Pooled observations	2033			2033			1977		
Durbin-Watson statistic	0.835			0.825			2.096		
Mean of dependent variable ( <i>ln</i> )	-5.639			-5.639			-5.627		
Mean of dependent variable (natural units)	0.0036			0.0036			0.0036		

Source: Authors calculations. Notes: \*, \*\* and \*\*\* indicate significance at 10, 5 and 1 percent levels, respectively. Estimates for fixed effects, AR(1) terms and dummy variables for crises not reported for brevity.

Table A.2. Instrumental Variables Estimations

	Model A			Model B		
	Coefficient	Standard error		Coefficient	Standard error	
Constant	-5.050	0.336	***	-4.991	0.336	***
Reserves Template ( <i>RT</i> )	-0.222	0.117	*	-0.196	0.118	*
Debt-to-GDP ratio ( <i>ln DGD</i> )	0.585	0.176	***	0.560	0.172	***
Reserves Template * Debt-to-GDP ratio ( <i>RT*ln DGD</i> )	-0.309	0.078	***	-0.300	0.077	***
Reserves Adequacy ( <i>ln RA</i> )	-0.059	0.081		-0.016	0.081	
Reserves Template * Reserves Adequacy ( <i>RT*ln RA</i> )	-0.169	0.063	***	-0.157	0.063	**
Change in Fiscal Balance-to-GDP ratio ( <i>DGBAL</i> )	-1.644	0.552	***	-1.631	0.556	***
GDP growth ( <i>DGD</i> )	-1.791	0.642	***	-4.545	1.532	***
Inflation ( <i>INF</i> )	1.985	0.702	***	1.903	0.709	***
Volatility of money ( <i>ln VOLM</i> )	0.154	0.071	**	0.119	0.073	
Current Account Balance-to-GDP ratio ( <i>CAB</i> )	-0.579	0.295	**	-0.528	0.289	*
Fixed Exchange Rate Regime ( <i>FIX</i> )	-0.360	0.072	***	-0.381	0.073	***
Intermediate Exchange Rate Regime ( <i>INT</i> )	-0.154	0.059	***	-0.202	0.062	***
Trend	0.008	0.003	**	0.006	0.003	*
Adjusted R <sup>2</sup>		0.802			0.799	
Sample	1991Q1 2005Q3			1991Q1 2005Q3		
Pooled observations	2017			2017		
Durbin-Watson statistic	2.036			2.037		
Mean of dependent variable ( <i>ln</i> )	-5.632			-5.632		
Mean of dependent variable (natural units)	0.0036			0.0036		

Source: Authors calculations. Notes: \*, \*\* and \*\*\* indicate significance at 10, 5 and 1 percent levels, respectively. Estimates for fixed effects, AR(1) terms and dummy variables for crises not reported for brevity.

Table A.3. Investigating the effects of SDDS Subscription

	48 countries (including a SDDS dummy)			48 countries (including SDDS dummies)			48 countries (including only SDDS dummies)		
	Standard			Standard			Standard		
	Coefficient	error		Coefficient	error		Coefficient	error	
Constant	-5.750	0.329	***	-5.778	0.336	***	-5.709	0.337	***
Reserves Template ( <i>RT</i> )	-0.192	0.087	**	-0.214	0.092	**	---	---	
Debt-to-GDP ratio ( <i>ln DGD</i> )	0.375	0.103	***	0.398	0.106	***	0.324	0.108	***
Reserves Template * Debt-to-GDP ratio ( <i>RT*ln DGD</i> )	-0.192	0.047	***	-0.192	0.050	***	---	---	
Reserves Adequacy ( <i>ln RA</i> )	-0.139	0.054	**	-0.142	0.054	***	-0.161	0.057	***
Reserves Template * Reserves Adequacy ( <i>RT*ln RA</i> )	-0.111	0.038	***	-0.123	0.040	***	---	---	
Change in Fiscal Balance-to-GDP ratio ( $\Delta GBAL$ )	-1.492	0.523	***	-1.490	0.522	***	-1.480	0.524	***
GDP growth ( $\Delta GDP$ )	-1.778	0.590	***	-1.759	0.591	***	-1.811	0.593	***
Inflation ( <i>INF</i> )	2.399	0.636	***	2.413	0.636	***	2.436	0.636	***
Volatility of money ( <i>ln VOLM</i> )	0.120	0.044	***	0.119	0.044	***	0.122	0.044	***
Current Account Balance-to-GDP ratio ( <i>CAB</i> )	-0.583	0.276	**	-0.568	0.275	**	-0.585	0.273	**
Openness ( <i>ln OPEN</i> )	-0.137	0.127		-0.141	0.128		-0.109	0.138	
Fixed Exchange Rate Regime ( <i>FIX</i> )	-0.308	0.069	***	-0.300	0.069	***	-0.293	0.069	***
Intermediate Exchange Rate Regime ( <i>INT</i> )	-0.145	0.056	***	-0.143	0.057	**	-0.133	0.057	**
Trend	0.013	0.003	***	0.014	0.003	***	0.012	0.003	***
SDDS subscription ( <i>SDDS</i> )	-0.048	0.074		0.015	0.107		0.003	0.110	
SDDS Subscription * Debt-to-GDP ratio ( <i>SDDS*ln DGD</i> )				-0.002	0.054		-0.006	0.065	
SDDS Subscription * Reserves Adequacy ( <i>SDDS*ln RA</i> )				0.040	0.043		0.039	0.048	
Adjusted R <sup>2</sup>		0.808			0.808			0.807	
Sample	1991Q1 - 2005Q3			1991Q1 - 2005Q3			1991Q1 - 2005Q3		
Pooled observations	1977			1977			1977		
Durbin-Watson statistic	2.096			2.095			2.105		
Mean of dependent variable ( <i>ln</i> )	-5.627			-5.627			-5.627		
Mean of dependent variable (natural units)	0.0036			0.0036			0.0036		

Source: Authors calculations. Notes: \*, \*\* and \*\*\* indicate significance at 10, 5 and 1 percent levels, respectively. Estimates for fixed effects, AR(1) terms and dummy variables for crises not reported for brevity.

Table A.4. Alternative Standard Error Estimates

		White cross-section standard errors		White period standard errors		White diagonal standard errors	
	Coefficient						
Constant	-5.741	0.000	***	0.000	***	0.000	***
Reserve Template ( <i>RT</i> )	-0.193	0.033	**	0.061	*	0.017	**
Debt-to-GDP ratio ( <i>ln DGD</i> )	0.376	0.006	***	0.001	***	0.001	***
Reserves Template * Debt-to-GDP ratio ( <i>RT*ln DGD</i> )	-0.192	0.000	***	0.000	***	0.000	***
Reserves Adequacy ( <i>ln RA</i> )	-0.136	0.032	**	0.041	**	0.032	**
Reserves Template * Reserves Adequacy ( <i>RT*ln RA</i> )	-0.111	0.000	***	0.008	***	0.001	***
Change in Fiscal Balance-to-GDP ratio ( $\Delta GBAL$ )	-1.482	0.001	***	0.025	**	0.011	**
GDP growth ( $\Delta GDP$ )	-1.770	0.016	**	0.005	***	0.005	***
Inflation ( <i>INF</i> )	2.397	0.013	**	0.011	**	0.008	***
Volatility of money ( <i>ln VOLM</i> )	0.121	0.004	***	0.006	***	0.004	***
Current Account Balance-to-GDP ratio ( <i>CAB</i> )	-0.576	0.107		0.086	*	0.068	*
Openness ( <i>ln OPEN</i> )	-0.135	0.385		0.390		0.344	
Fixed Exchange Rate Regime ( <i>FIX</i> )	-0.305	0.000	***	0.002	***	0.000	***
Intermediate Exchange Rate Regime ( <i>INT</i> )	-0.143	0.001	***	0.027	**	0.016	**
Trend	0.013	0.000	***	0.001	***	0.000	***

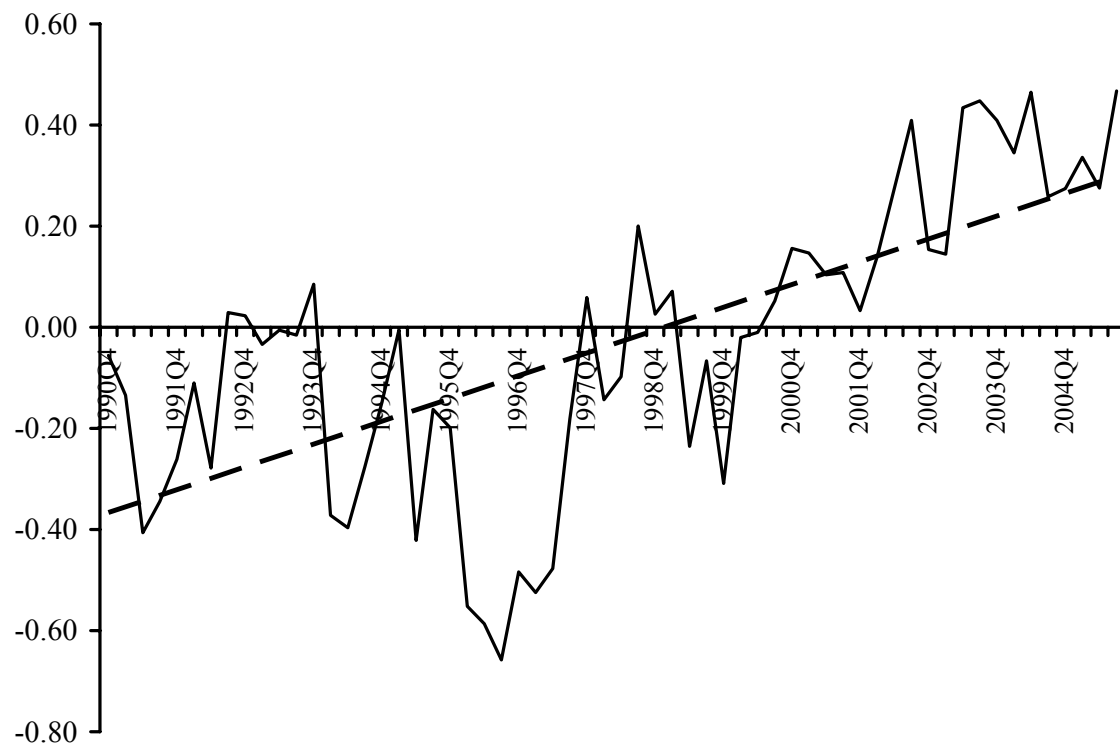
Source: Authors calculations. Notes: \*, \*\* and \*\*\* indicate significance at 10, 5 and 1 percent levels, respectively. Estimates for fixed effects, AR(1) terms and dummy variables for crises not reported for brevity.

Table A.5. Investigating the Effects of Liquidity Conditions

	48 countries including U.S. interest rates slope (A)			48 countries including U.S. interest rates slope (B)			48 countries including U.S. interest rates slope (C)		
	Standard			Standard			Standard		
	Coefficient	error		Coefficient	error		Coefficient	error	
Constant	-5.669	0.331	***	-5.726	0.330	***	-5.674	0.332	***
Reserves Template ( <i>RT</i> )	-0.204	0.088	**	-0.194	0.087	**	-0.201	0.088	**
Debt-to-GDP ratio ( <i>ln DGD</i> )	0.362	0.103	***	0.373	0.103	***	0.365	0.103	***
Reserves Template * Debt-to-GDP ratio ( <i>RT*ln DGD</i> )	-0.196	0.047	***	-0.193	0.047	***	-0.196	0.047	***
Reserves Adequacy ( <i>ln RA</i> )	-0.137	0.054	**	-0.136	0.054	**	-0.137	0.054	**
Reserves Template * Reserves Adequacy ( <i>RT*ln RA</i> )	-0.112	0.039	***	-0.111	0.039	***	-0.112	0.039	***
Change in Fiscal Balance-to-GDP ratio ( <i>ΔGBAL</i> )	-1.492	0.523	***	-1.488	0.523	***	-1.495	0.523	***
GDP growth ( <i>ΔGDP</i> )	-1.787	0.589	***	-1.785	0.592	***	-1.802	0.590	***
Inflation ( <i>INF</i> )	2.412	0.634	***	2.395	0.636	***	2.402	0.635	***
Volatility of money ( <i>ln VOLM</i> )	0.125	0.044	***	0.121	0.044	***	0.124	0.044	***
Current Account Balance-to-GDP ratio ( <i>CAB</i> )	-0.588	0.274	**	-0.580	0.276	**	-0.583	0.274	**
Openness ( <i>ln OPEN</i> )	-0.114	0.128		-0.131	0.128		-0.118	0.128	
Fixed Exchange Rate Regime (FIX)	-0.309	0.068	***	-0.306	0.068	***	-0.309	0.068	***
Intermediate Exchange Rate Regime ( <i>INT</i> )	-0.148	0.056	***	-0.144	0.056	**	-0.148	0.056	***
Trend	0.011	0.003	***	0.012	0.003	***	0.011	0.003	***
U.S. interest rates slope A ( <i>ln USTB10Y/USTBILL3M</i> )	0.074	0.051		---	---		---	---	
U.S. interest rates slope B ( <i>ln USTB3Y/FEDFUNDS</i> )	---	---		0.024	0.064		---	---	
U.S. interest rates slope C ( <i>ln USTB10Y/FEDFUNDS</i> )	---	---		---	---		0.063	0.049	
Adjusted R <sup>2</sup>	0.808			0.808			0.808		
Sample	1991Q1 - 2005Q3			1991Q1 - 2005Q3			1991Q1 - 2005Q3		
Pooled observations	1977			1977			1977		
Durbin-Watson statistic	2.094			2.095			2.094		
Mean of dependent variable (ln)	-5.627			-5.627			-5.627		
Mean of dependent variable (natural units)	0.0036			0.0036			0.0036		

Source: Authors calculations. Notes: \*, \*\* and \*\*\* indicate significance at 10, 5 and 1 percent levels, respectively. Estimates for fixed effects, AR(1) terms and dummy variables for crises not reported for brevity.

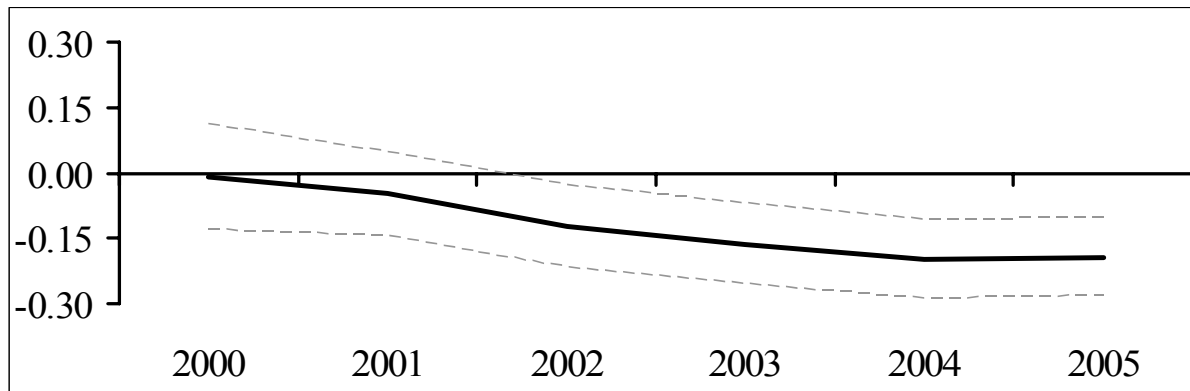
Figure A.1. Estimated Period Effects and Linear Trend



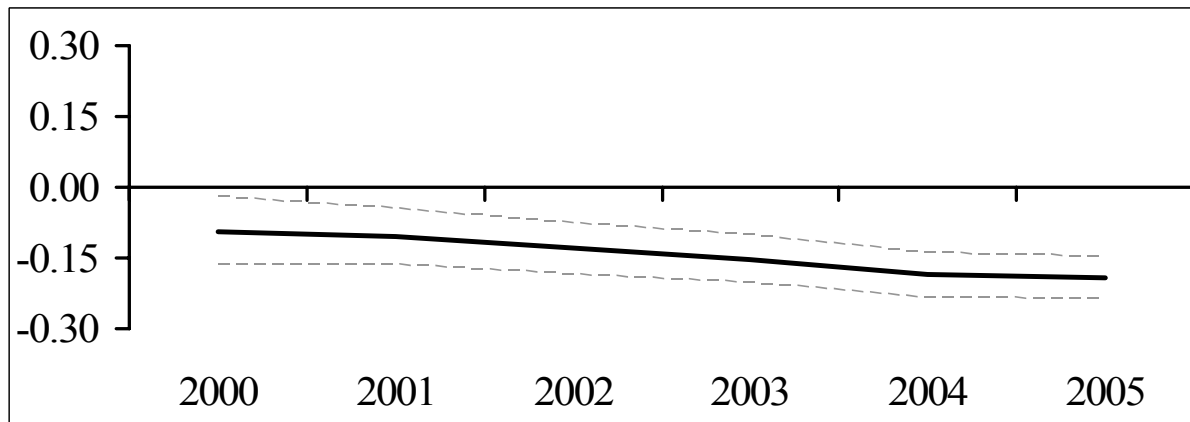
Source: Authors' calculations.

Figure A.2. Recursive Coefficient Estimates

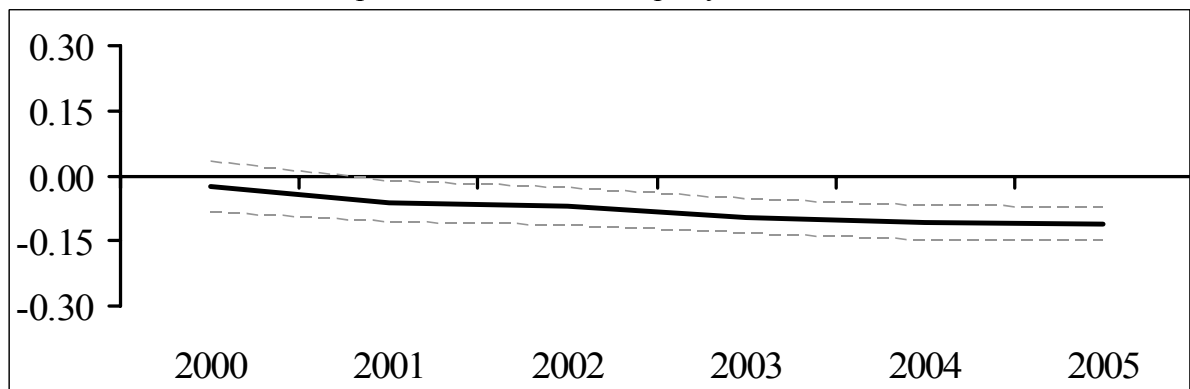
Reserves Template



Interaction - Reserves Template and Indebtedness



Interaction - Reserves Template and Reserve Adequacy



Source: Authors' calculations.

Note: Dotted lines denote one standard error bands.

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