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Estimating Exchange Market Pressure and Intervention Activity

Emanuel-Werner Kohlscheen*

Abstract

Using the index proposed by Weymark (1995) for small open economies, the paper computes exchange market pressure and intervention indexes for Chile in the period from 1990 to 1998. This statistics can be used to assess timing and scale of currency crises, as they include exchange rate and reserves variations in one single indicator. The index is suited for intermediate exchange rate policies, since it gives due consideration to the possibility of accommodating exchange market pressures through changes in domestic credit. The monetarist model developed suggests low effectiveness of controls in affecting the exchange rate level, when the interest rate-elasticity of money demand is low. Substantial appreciative pressure on the Chilean peso is found over the period, with exception of isolated quarters following the introduction of the reserve requirement and following the outset of the Asian crisis.

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Estimating Exchange Market Pressure and Intervention Activity[0]

(Preliminar version, comments are welcome.)

1. Introduction

Following the collapse of the Bretton Woods system of fixed but adjustable exchange rates, monetary authorities of various nations opted for managed floating rate systems, using international reserves or exchange rate variations to accommodate exchange market pressures. Several Latin American countries chose to adopt exchange rate bands within which their currencies were allowed to fluctuate. Such was the case of Chile, which introduced an exchange rate band in 1984. The band was gradually enlarged and altered to account for changes in trading partners and productivity differentials. This process continued until September 1999, when the Central Bank decided to let the currency float freely, though the reference level used to set the center of the band is still published.

In a world in which managed floating and quasi-fixed exchange rate regimes predominate, several indexes were proposed to measure the degree of monetary authority intervention in the exchange rate market. Historically, exchange market pressure indexes were defined to address the question of monetary policy independence (the debate on the insulation of the domestic economy from external shocks provided by floating exchange rate regimes). These indexes produce cardinal measurements of the magnitude of the pressures to which a currency is submitted and can be helpful in understanding the causes of external imbalances.

A seminal paper on this subject was authored by Girton & Roper (1977) proposing an index to estimate the proportion of exchange rate pressures mitigated by exchange

[0] I am indebted to João Ricardo Faria, Fábia Carvalho and to an anonymous referee for their highly valuable comments on an earlier draft of this paper. Any remaining deficiencies are my sole responsibility.

market interventions. However, they did not consider the possibility of accomodating these pressures through changes in domestic credits. Frenkel & Aizenman (1982) and, more recently, Weymark (1995) designed indexes capable of shedding some light upon the degree of exchange market intervention and the factors that drive monetary authorities to intervene.[1]

Following the monetary approach to the balance of payments, Weymark (1995) develops a model-dependent *exchange market pressure (EMP) index,* used as the denominator of an *intervention index* - defined as the proportion of exchange market pressure absorbed by monetary authority intervention. The rationale underlying the monetary approach to the balance of payments is that net excess supply of goods and securities by residents (expressed in the current and capital accounts) will be reflected in a net excess demand for money. Thus, expectations and asset substitution are aspects considered critical in determining the point of equilibrium. The exchange rate is thus regarded as a price that clears the supply and the demand for monies and other financial assets. It should be mentioned that one important flaw in this type of model is that it does not incorporate intertemporal governmental or individual budget constraints.

Following Weymark's methodology, this paper computes the exchange market intervention index for the Chilean economy in the 90s, incorporating the Chilean reserve requirement on capital inflows. The next section provides a short description of this reserve requirement on capital inflows. Section III briefly presents the analytical model, while estimation procedures are described in Section IV.

2. Reserve Requirements on Capital Inflows: the Chilean Experience

In the early 90s, Chile and many other Latin American countries had to cope with a surge in capital inflows capable of generating outcomes that conflicted sharply with Central Bank objectives: high growth in monetary aggregates and real appreciation of the currency. A relatively lax US monetary policy coupled with a stringent monetary policy in Chile produced capital inflows equivalent to more than 10% of GDP. About

[1] Frenkel & Aizenman (1982) showed that the desirability of exchange rate flexibility is directly proportional to the variance of monetary shocks (money demand and supply, foreign prices and deviations from purchasing power parity), to the propensity to save out of transitory income and inversely proportional to the share of non-tradable goods in the economy.

half this volume corresponded to short-term credits. Monetary authorities responded by imposing a one-year non-interest-bearing reserve requirement on selective inflows. Initially (June 1991), the reserve requirement was set at 20% of inflows, increasing to 30% in May 1992. This reserve requirement was gradually widened to cover virtually all non-FDI and non-trade credit flows, closing the loopholes in what was described by one Central Bank official as a “cat-and-mouse game” between market participants and monetary authorities. The effectiveness of reserve requirements in avoiding apreciation is not yet a settled issue. However, studies as Montiel & Reinhart (1999) suggest that they did change the composition of capital inflows. One reason to the failure to avoid appreciation could be that reduction of yields due to implicit taxes are perceived as minor when compared to the expectations of currency appreciation.

If, on the one hand, the reserve requirement was aimed at avoiding appreciation of the currency resulting from rigidities in the prices of non-tradable goods and labor, on the other it represented an additional cost. In practical terms, this reserve requirement functioned as an implicit tax on foreign capital, so that commercial banks incorporated the cost of this non-interest-bearing deposit into their lending rate, charging their clients more for their US$ issuances. This means that the condition of uncovered interest parity in Chile must be adapted so that reserve requirements will not alter the interest rate *i*, earned by foreign investors, assuming that the cost of the reserve requirement is borne by locals (see equation 3 of Section III).

In the wake of the drop in capital flows to emerging markets that followed the Asian crisis, BCCh reduced its reserve requirement to 10% in June 1998, eliminating it completely three months later.

Chile has sterilized foreign inflows since 1990, when real interest increased to 9.7%. It is arguable that sterilization may prolong the interest rate differential and thus postpone achievement of equilibrium. However, if capital inflows are not reined in, the result will be deterioration of the Central Bank balance sheet, since that institution accumulates liabilities for which it has to pay higher yields than it is able to earn under normal conditions on its foreign assets (at least, this is clearly the case in most Latin American economies).

Comentário: Modifiquei o tempo do verbo por causa da palavra “since” que dá o sentido de 1990 até agora. É isso mesmo que quer dizer?

3. The Small Open Economy Model

This section briefly summarizes Section II of Weymark (1995), incorporating into the UIP equation the additional cost of external financing generated by the reserve requirement on inflows.

Exchange market pressure is defined for a small open economy model (assumed to be the case of Chile in the period under study). Equation (1) is the money demand expression in the log-linear form, with exogenous output, where clearing of the money market is assumed (see notations at the end of this paper).

$$m_t = p_t + \beta_1 \cdot y_t - \beta_2 \cdot i_t + v_t \qquad (1)$$

The price level is dependent on the external price level and the nominal level of the exchange rate.[2]

$$p_t = c + \alpha_1 \cdot p_t^* + \alpha_2 \cdot e_t \qquad (2)$$

We assume that financial assets are perfect substitutes. The existence of a reserve requirement ε_t for each unit of capital inflow increases the cost of external financing, so that the uncovered interest parity condition is changed to incorporate this additional cost. For the sake of simplicity, we will assume that all deposits have the same maturity as the reserve requirement period. This means that the external financing cost is increased from i* to i*/(1-ε_t). Thus, the difference { (ε_t.i*)/(1-ε_t) } is the cost of the reserve requirement.

$$i_t = i_t^* + \frac{\varepsilon_t \cdot i_t^*}{(1-\varepsilon_t)} + E[e_{t+1} \mid \Omega_t] - e_t \qquad (3)$$

[2] One could classify goods into tradables and non-tradables so that only the price of tradable goods would be directly affected by the exchange rate. Since this separation is somewhat arbitrary we have used the simpler model.

Equation (4) states that changes in the money supply can occur due to changes in domestic credits or changes in the level of international reserves while equation (5) expresses the response function to changes in the exchange rate.

$$m_t^s = m_{t-1}^s + \Delta d_t + \Delta r_t \qquad (4)$$

$$\Delta r_t = -\rho_t \cdot \Delta e_t \qquad (5)$$

ρ_t is a policy choice that determines the extent to which exchange market pressure is absorbed by monetary authority interventions. In a free floating exchange rate regime, ρ_t would be zero, so that there is no smoothing of the exchange rate level e_t at all, while in a fixed regime ρ_t would be infinite.

Substituting (2) and (3) in (1) and taking the first differences we have

$$\Delta m_t = \alpha_1 \cdot \Delta p_t^* + (\alpha_2 + \beta_2) \cdot \Delta e_t + \beta_1 \cdot \Delta y_t - \beta_2 \cdot (\Delta i_t^* + \frac{\varepsilon \cdot \Delta i_t^*}{(1-\varepsilon)} + \Delta E[e_{t+1} \mid \Omega_t) + \Delta v_t \qquad (6)$$

Now, substituting (4) and (5) in (6), and assuming that the money market clears yields

$$\Delta e_t = (\frac{-1}{\rho_t + \alpha_2 + \beta_2}) \cdot \left\{ \alpha_1 \cdot \Delta p_t^* + \beta_1 \cdot \Delta y_t - \beta_2 \cdot (\Delta i_t^* + \frac{\varepsilon \cdot \Delta i_t^*}{(1-\varepsilon)} + \Delta E[e_{t+1} \mid \Omega_t]) + \Delta v_t - \Delta d_t \right\} \qquad (7)$$

It can be shown that this equation applies to sterilized as well as unsterilized interventions. Note that this expression implies that the lower the interest rate elasticity of money demand, the lower will be the effectiveness of interest rate differentials (and thus reserve requirements on capital inflows) in impacting the exchange rate level.

The terms inside the brackets represent the excess demand for currency that originates exchange market pressure. EMP is defined as the exchange rate that would prevail after elimination of excess demand in the absence of exchange market intervention. To measure EMP in Section III, we set ρ_t at zero, while expectations are formed based on the actual exchange rate policy.

Comentário: "braces" ou "brackets"?

Comentário: Acho que "generates" seria melhor.

What equation (7) states is that excess demand for money could be generated by external (prices or international interest rates), domestic (income, money velocity or changes in reserve requirements on capital inflows) or expectational shocks.

When the government intervenes directly in the exchange rate market by buying or selling foreign exchange, the general formula for exchange market pressure in period t is given by:

$$EMP_t = \Delta e_t - \frac{\Delta r}{(\alpha_2 + \beta_2)} \qquad (8)$$

While the first term on the right side measures actual exchange rate variation, the second term captures the share of exchange rate variation absorbed by direct monetary authority intervention.

Girton & Roper's index represents the specific case in which the denominator of the second term equals unity. The estimation of elasticities of equations (1) and (2) is needed to transform changes in reserves in exchange rate equivalent units.

4. Data and Estimation – Chile in the 90es

To compute the elasticities of equations (1) and (2), two-stage least squares were used, as explanatory variables and residuals may be contemporary correlated. All variables were taken in logs, using monthly data. Since unit roots tests could not reject the hypothesis of the existence of a unit root, except for the nominal interest rates, we took the first differences of the series for the estimation. Nominal interest rates were taken in levels. Lagged variables were used as instruments, except for output, which is exogenous to M2.

M2 figures were obtained from BCCh. The same applies to the real interest rate (the real rate for 90 day PRBCs)[3]. Nominal interest rates were calculated with the ex post variation of the *Unidad de Fomento* published by BCCh. The twelve-month moving average of the IMACEC economic activity index was employed as the activity level indicator. This index encompasses practically the entire Chilean GDP. The three-month US Dollar Libor was used as the external interest rate.

Comentário: Não é "movable average"?

Price indexes, average exchange rates, as well as domestic credits and foreign reserve data were obtained from IMF's IFS CD-ROM. Changes in domestic credits and foreign reserves were computed accounting for changes in the money multiplier (see notes in appendix). The index of external inflation – for equation (2) - was constructed by weighting the consumer price variations of the US (45%), Germany (30%) and Japan (25%) (The weights were those used by the Central Bank to set the center-point of the exchange rate band).

Estimation of equation (1) led to the following results, after correction for an MA(2,4) error process (t-values in parentheses):

$$\Delta m2_t = \underset{(4.0691)}{0.7213} \cdot \Delta p_t + \underset{(7.8021)}{1.6514} \cdot \Delta y_t + \underset{(2.4673)}{0.000613} \cdot i_t$$

R^2=0.0715 F=6.3495 DW=1.8140 Q(30)=28.55

First differences of the residuals were taken as a proxy for money velocity shocks. The very low positive interest rate elasticity may be somewhat surprising but can be explained by the positive impact of interest rates on indexed deposits, as we are using M2.

[3] Between 1985 and May 1995, Banco Central de Chile's main monetary policy instrument was the real interest rate of 90 day PRBCs that is calculated on the basis of the change of the UF - *Unidad de Fomento*, an account unit that is adjusted according to inflation in the previous month. This choice is attributed mainly to the observed volatility of money demand and the high degree of indexation in the Chilean economy. Over the medium-term, this rate equals ex post the real interest rate. As of May 1995, the Central Bank started using the interbank overnight lending rate as its intermediate target (tasa reajustable interbancaria).

For equation (2), an MA(1) error process was found significant.

$$\Delta p_t = 0.0041 + 1.9722 \cdot \Delta p_t^* + 0.2447 \cdot \Delta e_t$$

(3.1943) (5.3918) (2.0581)

R^2=0.4199 F=20.7149 DW=1.9128 Q(30)=32.35

With elasticities on hand, exchange market pressure was estimated according to equations (7) and (8). Table I shows the quarterly evolution of the EMP index, comparing it with Girton & Roper's index. Negative values for the EMP index indicate net appreciation pressure, while positive values mean that the currency is under depreciative pressure. The table shows that, despite imposition of reserve requirements on capital inflows, the Chilean peso was submitted to continued appreciative pressure during the 90s, except for 1991:II (when the reserve requirement was introduced), 1992:I and the period following the Asian crisis.

The table also shows the index of intervention activity, obtained according to the formula

$$w_t = \frac{-\dfrac{\Delta r_t}{(\alpha_2 + \beta_2)}}{\Delta e_t - \dfrac{\Delta r_t}{(\alpha_2 + \beta_2)}} \qquad (9)$$

The intervention activity index measures the share of exchange market pressure absorbed by direct Central Bank intervention.

From this definition, it follows that the intervention index, w_t, would be zero in a free float and one in a fixed exchange rate regime. An average of 0.196 was found between 1990 and 1998. The intervention index was in the [0,1] range in 28 out of 35 quarters, suggesting that monetary authorities acted to smooth the path of the exchange rate during most part of the decade.[4] Despite the volatility of the index, a downward trend

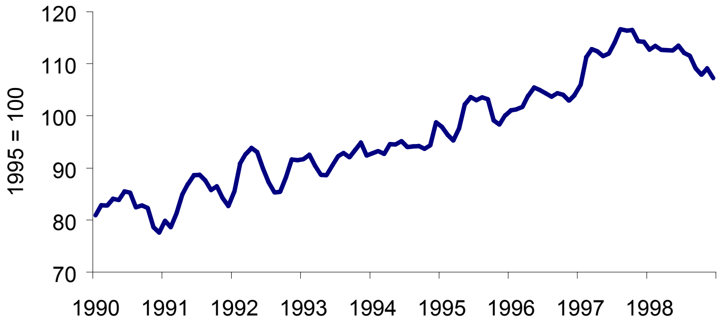
[4] Negative values of wt indicate that monetary authorities actively depreciated the currency, while values above one indicate that strong resistance against depreciation led to appreciation (or that EMPt was in the vicinity of zero).

was visible before the outset of the Asian crisis in 1997. The average between 1990 and 1991 was 0.424 compared to 0.172 between 1992-1997. This may be due to the widening of the band from +/-5% to +/-10% in 1992 and to +/-12.5% in 1997.

Table I – Exchange Market Pressure and Intervention Activity

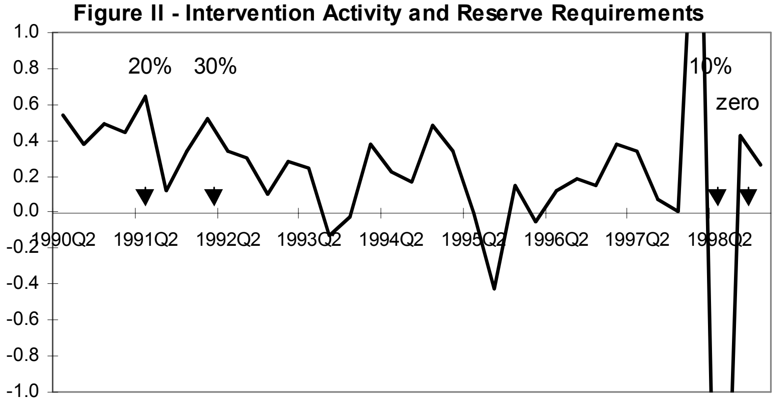
	Exchange Market Pressure		Intervention		Exchange Market Pressure		Intervention
	Weymark	*Girton&Roper*	ω_t		*Weymark*	*Girton*&Roper	ω_t
				1994:III	-0.378	-0.330	0.167
1990:II	-0.152	-0.090	0.544	1994:IV	-0.827	-0.524	0.485
1990:III	-0.570	-0.407	0.378	1995:I	-0.562	-0.417	0.341
1990:IV	-0.776	-0.489	0.490	1995:II	-0.346	-0.348	-0.006
1991:I	-0.952	-0.631	0.446	1995:III	-0.357	-0.471	-0.423
1991:II	0.334	0.170	0.649	1995:IV	-0.700	-0.622	0.146
1991:III	-1.013	-0.925	0.116	1996:I	-0.513	-0.535	-0.056
1991:IV	-0.773	-0.572	0.344	1996:II	-0.391	-0.355	0.122
1992:I	0.411	0.250	0.518	1996:III	-0.245	-0.211	0.186
1992:II	-1.297	-0.962	0.342	1996:IV	-0.623	-0.554	0.147
1992:III	-1.484	-1.151	0.297	1997:I	-0.465	-0.331	0.380
1992:IV	-0.713	-0.659	0.100	1997:II	-0.433	-0.322	0.340
1993:I	-1.218	-0.958	0.283	1997:III	-0.376	-0.355	0.074
1993:II	-0.600	-0.488	0.246	1997:IV	-0.491	-0.488	0.007
1993:III	-0.287	-0.315	-0.128	1998:I	0.024	-0.018	2.337
1993:IV	-0.535	-0.544	-0.022	1998:II	-0.054	-0.188	-3.282
1994:I	-0.870	-0.624	0.374	1998:III	0.227	0.154	0.426
1994:II	-0.227	-0.189	0.221	1998:IV	-0.221	-0.176	0.265

Figure I - Real Effective Exchange Rate
(based on relative unit labor costs)



Source: IFS/IMF

Figure II - Intervention Activity and Reserve Requirements



5. Conclusion

The monetarist model developed suggests little room for interest rates disincentives in affecting exchange rate levels, when the interest rate elasticity of money demand is low (β_2), as relative supply of money has rather low sensitiveness to interest rates. This might be the case in a highly indexed economy where wealth effects of interest rate hikes are sizeable. The results comes in line with findings of Montiel & Reinhart (1999), that reserve requirements on inflows do not diminished capital inflows, in spite of changing it's composition.

In spite of the well-known difficulties in explaining exchange rate movements on the basis of fundamentals (especially in the short-run), Weymark's exchange market pressure index provides a cardinal measurement of the pressures to which a currency is submitted, allowing for a better understanding of the driving forces underlying excess money demand or supply.

Between 1990 and 1998, exchange market pressure in Chile was negative except for four quarters (91:II, 92:I, 98:I and 98:III), indicating substantial appreciative pressure on the Chilean peso during the period. The monetary authority intervention activity index shows that the Central Bank acted to smooth the path of the exchange rate in 28 out of 35 quarters studied. Evidence also points to a declining intervention activity level until 1997.

Future research might do well to analyze the results of lesser rigidity in the assumptions built into the model.

Notes

ε_t – reserve requirement on capital inflows

$\Delta d_t = (h_t.D_t - h_{t-1}.D_{t-1})/B_{t-1}$ where h_t is the money multiplier, D_t is the stock of domestic credit in billions of Chilean pesos (obtained from IMF's IFS statistics) and B_{t-1} is the monetary base composed of domestic credits and foreign reserves

$\Delta r_t = (h_t.R_t.E_t - h_{t-1}.R_{t-1}.E_{t-1})/B_{t-1}$ where R_t is the stock of foreign reserves in billions of US dollars (IFS) and E_t is the exchange rate expressed in Chilean pesos per US dollar.

e_t – log of nominal exchange rate in Chilean pesos per US dollar (period average)

$E[e_{t+1}|\Omega_t]$ – expectation of the nominal exchange rate level at $t+1$ in period t with the information set available at t

i_t – log of nominal domestic interest rates

i_t^* – log of world interest rates (3 month US dollar LIBOR)

m_t – log of money stock (M2) in billion of Chilean pesos

p_t – log of the consumer price index published by IFS

p_t^* - log of the price index of relevant external inflation (weighted average of consumer price variations in US (0.45), Germany (0.30) and Japan (0.25))

rer – real exchange rate (IFS)

v_t – log of money velocity shocks

y_t – log of IMACEC index (monthly indicator of economic activity level)

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