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What Determines Capital Inflows?
An Empirical analysis for Chile

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ABSTRACT

This paper presents an empirical investigation of the determinants of short- and long-term net private capital inflows to Chile between 1985 and 1994. It is shown that the factors determining each type of flow are quite different in nature. Long-term flows tend to respond to structural (domestic) variables of the economy and are not sensitive to short-term arbitrage conditions or to policy measures aimed at affecting the interest rate gap. Short-term flows react strongly to arbitrage conditions, a combination of internal and external factors, and to policy variables, but are not sensitive to structural factors.

In order to capture adequately the dynamic properties of these inflows, different regimes are taken into account. In particular, full sample stable specifications are strongly rejected in most cases, while threshold processes are preferred to Markov switching-regime models. The effects of selective capital controls on short-term inflows are derived by splitting short-term inflows into two series: one that is subject to these controls and one that is not. Significant differences are found between the two series.

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1. Introduction

Latin America has experienced a sharp rise in net private capital inflows in the late 1980s and, particularly, the early 1990s. Although the relevant factors may well vary between countries and types of capital, innovations in both internal and external factors clearly lie behind this trend. Our aim in this paper is to identify the main factors that explain the level and composition of capital inflows to Chile in the last decade.

A significant increase in net private capital inflows has been observed in Latin American countries that have each developed very different combinations of macroeconomic policy, have advanced different economic reform programs, and have experienced diverse political realities. These differences have led several analysts to ascribe a central role to external factors in explaining this trend (Calvo et al, 1993).

The emphasis on external factors, however, has been disputed by others who have argued that the sharp increase in private capital flows into several economies of the region has been the result, to a large extent, of a positive reaction of both local and foreign investors to the implementation of successful stabilization and economic reform programs. Reforms have included, among other measures, some combination of trade and financial liberalization, public sector reform, privatization of state-owned enterprises, and widespread deregulation. Additionally, a sound macroeconomic policy mix --the argument continues-- has sharply changed foreign investors' expectations and risk assessment of domestic financial securities. External investors have perceived local securities as being more attractive and less risky, and therefore have become willing to hold a larger share of these securities in their portfolios.

We believe that both lines of argument form part of a more complex story. In our view, the trend results from a combination of external and internal factors that varies according to the country and the type of financial flows. Stressing one factor or another requires specifying the type of capital to which each factor applies. In this paper we observe that, in the Chilean experience, there is a distinct separation of private capital flows into short and long term flows and we demonstrate how each type responds to a different set of variables. This is a key issue. A clear understanding of the factors that lie behind each type of flow is crucial to the design of policies intended to attract certain types of capital and discourage others.

Developing countries face a complicated dilemma in this regard. On the one hand, these countries want to stimulate the net inflow of long term private capital that is needed to supplement the local savings effort with foreign savings, which would help finance their accumulation of productive capital. On the other hand, they face the challenge of managing massive flows of short term speculative private capital, which may lead to excess volatility in key economic variables such as domestic interest rates and the real exchange rate. This induced volatility may have a depressive impact on physical investment (Tobin, 1978; Tornell, 1990; Larraín and Vergara, 1993), on resource allocation (Krugman, 1987), on exports (Caballero and Corbo, 1990), and thus on economic growth and welfare.

This dilemma can be minimized to the extent that the main factors explaining the composition of private capital inflows (short term relative to medium and long term flows) differ. In particular, this would be the case if a country that were subject to a massive inflow of short term private capital could implement policy measures that effectively reduced this form of capital inflow without significantly affecting the inflow of long term private capital.[1]

From a theoretical point of view, the evolution of medium and long term capital flows should be related to structural factors of the economy relative to the world economy. These factors include the difference between the value of the marginal productivity of capital at home and abroad, the difference in the tax structure on capital, the degree of risk aversion of investors, capital account controls, and any other form of domestic regulatory considerations affecting foreign credit and investment that may increase the degree of irreversibility of the decision to bring capital into a particular country.[2] However, short term speculative private capital flows should be related to arbitrage conditions resulting from the differences in the kind of short term macroeconomic policies upheld domestically as compared to the rest of the world and the non-diversifiable country risk associated to investing in a particular country.

This paper provides and analyzes econometric evidence about the main factors that have engendered the sharp increase in net private capital inflows to Chile in recent years. Section 2 documents the increase in capital inflows to Chile since the mid 1980s, briefly describes magnitudes and composition, discusses the main internal and external factors that might help to

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[1] Arguing that there may be some policy measures that could change the composition of private capital inflows does not necessarily provide a social welfare justification for their implementation.

explain this trend, and describes how Chile has reacted to this increase in net capital inflows.[3] Section 3 provides a brief description of the econometric technique used to characterize the behavior of the series. Section 4 presents the results of the econometric analysis on the factors that appear to give rise to the behavior of both short and long term capital flows between 1985 and 1994. A short conclusion follows.

2. The Return of Private Capital to Chile Since the Late 1980s

2.1 Factors behind the return of capital inflows

Private capital began to return to Chile in the late 1980s. Total net capital inflows rose from an average of almost US$1 billion in 1985-89 to approximately US$3 billion in the first half of the 1990s. Capital returned to Chile in many forms, including foreign investment, short term credits, long term loans, and repatriation of capital held by Chileans abroad.

The growth of capital inflows to Chile since the late 1980s has resulted from the combination of several external and internal factors. External factors include, but are not restricted to, low world interest rates, most notably in the U.S., poor economic performance in the industrialized nations, and a significant increase in the world supply of capital. The latter increase results in part from factors that have contributed to the rapid growth and globalization of world capital markets, widespread trade and capital account liberalization and innovations in financial instruments and techniques, implying that financial markets are becoming *de facto* more integrated despite the lack of deregulation.

These external factors have certainly helped to explain the increase in transnational private capital flows to Latin America, and to Chile in particular, since the late 1980s (Calvo, et al, 1993).[4] Even countries that have experienced significant macroeconomic and political instability, such as Brazil, Peru and Venezuela, have been able to attract capital inflows. Nevertheless,

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[2] On the effects of irreversibility on capital inflows see Laban and Larrain (1997).

[3] A more complete description on this issue can be found in Labán and Larraín (1996).

[4] According to Calvo et at (1992), external factors account for a majority of the recent inflow of private capital to several Latin American economies that are each pursuing different combinations of macroeconomic policies and whose economies have performed differently.

external factors do not explain the variations in the magnitude, composition and conditions of inflows between the countries of the region. Clearly, common external factors do not completely account for these disparities.

The amount of capital flowing into Latin America also responds to the prospects for a brighter economic future for the region in the 1990s and beyond. These expectations are based on the structural reforms carried out in several countries in the region, most notably in Chile, Mexico, Argentina, and Peru. The fact that Chile's reforms were accomplished well before the rest of the region, and were thus firmly established by the late 1980s, explains the fact that capital flowed into Chile before it returned to other countries in Latin America. It also helps to explain why the flows into Chile have been larger, in proportion to the size of its economy, than those of other Latin American nations.

Additional domestic economic factors that have contributed to the return of private capital include the sharp reduction in Chile's external debt burden since 1986, the solid macroeconomic performance recorded since the mid-1980s, particularly in terms of output and trade expansion, and the reduction and elimination of a number of capital and exchange controls.

At the political level, the legitimization of free-market policies, the renewed commitment to sound macroeconomic management after the return of democratic governance in 1990, and the central role the country has given to consensus in shaping its economic policy and reforms during political transition are also important. The approval of both a tax reform and a labor reform, and the implementation of contractionary monetary policy in 1990, were strong signals in this direction (Labán and Larraín, 1995).

Finally, a successful export promotion policy, together with skillful management of foreign debt, sharply cut Chile's external debt burden. The stock of total external debt fell from US$19.5 billion in 1986 to US$ 18.2 billion in 1992 (in nominal dollars), and the debt to GDP ratio declined from 115.9% to 42.6%.[5] Furthermore, lower global interest rates and a very strong expansion of exports reduced the ratio of foreign interest service to exports from 36.5% in 1986 to approximately 3.4% in 1995. Between 1985 and 1994, Chile reduced its existing foreign debt by US$ 8.6 billion through several debt conversion programs. In September 1990, Chile reached an agreement to restructure almost all of its remaining commercial bank debt. The much improved

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[5] This ratio averaged 81% during the 1980s.

external solvency situation of the country has been integrated into the secondary market for Chilean debt, where its discount has declined sharply, from 34% in June 1990 to around 5% in 1993.

The renewed confidence of the international financial community in Chile's economic and political prospects translated into a reduction of the risk premium that foreigners require to invest in Chilean securities. Thus, in 1991, Chile was removed from the list of non-performing economies, for which U.S. banks are required to make loss provisions on any additional lending. Chile was also granted a triple-B rating by Standard & Poor in 1992, the best risk rating of any Latin American country and the only one with an investment grade. This rating was improved to a BBB+ in December 1993 and to A- in mid-1995.

The combination of these factors has led to a dramatic increase in both short and long term private capital inflows (see section 2.1 below). Intending to preclude the induced volatility that short term speculative inflows may have on the relative prices, in June 1991 the Central Bank of Chile introduced an unremunerated reserve requirement of 20% on certain types of short term capital inflows. Subsequently, this requirement has been increased to 30% (in the second quarter of 1993), as has its coverage.[6]

2.2. Short and Long Term Inflows to Chile: 1985-94

Table 1 presents the series that will be used in the next section for evaluating the relative importance of the factors mentioned above in the determination of the level and composition of net capital inflows to Chile. Since the Chilean authorities have introduced selective capital controls to short term-inflows, we divide the inflows between those that were and those were not subject to controls.[7]

Several interesting features of the time series are worth noting. In particular, long term private capital inflows have increased substantially in the second period, while their volatility has increased only slightly given that an upward sloping trend became evident after 1990. In fact, until the beginning of 1991, long term net outflows were promptly reverted to long term net inflows. It

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[6] See Valdés and Soto (1994) for a detailed description of reserve requirements in Chile.

[7] The Appendix provides a detailed description of the construction of the variables used.

is also interesting to observe that the composition of total capital inflows has changed in favor of long term inflows.

Table 1: Basic Capital Flows and Macroeconomic Statistics for Chile : 1985-1994

Statistic	LTC	STC	STC-T	STC-N	GGDP	I/GDP	D/GDP	GAP	GAP1
86:1-94:4									
Mean	62.40	289.34	94.07	195.27	7.25	22.44	65.00	8.10	10.24
Std.Dev.	285.76	293.74	293.97	218.66	3.35	3.36	24.68	6.56	6.58
86:1-91:1									
Mean	-39.40	215.48	87.33	128.15	7.01	20.73	80.68	9.13	9.13
Std.Dev.	199.93	166.13	132.94	116.82	3.45	2.76	20.94	6.78	6.78
91:2-94:4									
Mean	204.91	392.76	103.51	289.25	7.58	24.84	43.04	6.67	11.78
Std.Dev.	331.26	395.78	436.71	289.51	3.30	2.60	3.15	6.17	6.18

Notes: LTC = Long Term Net Private Capital Inflows (millions of US$). STC = Short Term Net Private Capital Inflows (Millions of US$). STC-T = Short Term Net Capital Inflows subject to selective controls beginning in 1991:2 (millions of US$). STC-NT = Short Term Net Capital Inflows not subject to selective controls (millions of US$). GGDP = Rate of growth of GDP (over same quarter of previous year, in percentage). I/GDP = Investment Rate (in percentage). D/GDP = Total External Debt over GDP (in percentage). GAP = Annualized Quarterly Interest Rate differential between the domestic and international rate corrected by actual devaluation, the stamp tax, and selective taxes. GAP1=Annualized quarterly interest rate differential without selective taxes. Std.Dev. = Standard Deviation. See the Appendix for details.

Total short term inflows have almost doubled, but at the expense of more than doubling their volatility. A more interesting comparison arises when separating the short term capital flows between those that are subject to the reserve requirement from those that are independent of such control. The average volume of flows subject to controls has increased by only 12% while their volatility has increased almost four times. On the other hand, the level and volatility of those short term inflows not subject to controls have almost tripled. As a matter of fact, the share of capital flows subject to controls in total short term inflows has decreased substantially, from about 40% until the beginning of 1991 to 26% (on average) in the second period.

The time series behavior of both long term and short term capital inflows is consistent with our expectations. In the case of long term capital inflows, we can see two completely different "regimes". During the first "regime" (1984-1989), net long term capital inflows were on average negative and close to zero despite the strong positive performance observed in the main domestic economic variables (strong output growth; systematic increases in the investment rate and exports; and declines in inflation, unemployment, the current account deficit and the external

debt to output ratio) since 1983. Conversely, in the second "regime" (1990-1994), long term capital inflows have been significantly positive with a strong upward slope, which is consistent with the positive evolution of domestic structural economic variables.

A rationale for explaining this change in the behavior of long term flows can be found in the positive way in which the international community has perceived Chile's successful transition to democracy and the renewed commitment of the country to sound macroeconomic policies after 1990.

On the other hand, the fact that short term capital inflows not subject to a reserve requirement increased on average much more than those subject to capital controls, implying a significant change in the composition of short term capital inflows, may be understood as a response to the introduction of reserve requirements in Chile.

In looking at the fundamentals, we observe that, while the investment rate has been steadily increasing and the rate of growth of the economy has remained basically stable, the debt-output ratio has suffered a dramatic decrease. The interest rate differential increased slightly in the second period. Of course, this differential is even wider if we do not include the several policy measures introduced by the Chilean authorities to prevent a larger gap in favor of the domestic interest rate (the extension of the stamp tax to foreign credit, the implementation of and subsequent modifications in the reserve requirement, and the changes in the exchange rate policy).

Among other results, this brief look at the evidence suggests that it may be misleading to analyze the determinants of long and short term inflows with a unique stable representation for the whole sample period. In particular, it is important to analyze the determinants of short term inflows considering the important differences that are found among those that are and those are not subject to controls.

In order to account for these differences, it is necessary to utilize an econometric technique that may be able to endogenously determine whether the realizations of a given series correspond to the same stochastic process or if they come from different regimes. It is also important to articulate the nature of these regimes as precisely as possible. The following section briefly describes the estimation techniques used in the paper.

3. The Estimation Technique

The striking differences between the series in different periods points to the importance of determining whether their changing behavior over time is attributable to extreme realizations of a unique and stable stochastic process or to changes in the way the series react to their fundamentals. In the first case, modeling the process would require a careful consideration of the distributional assumptions employed; in the latter, one would need to describe the characteristics of the transition from one regime to the other.

In order to select the econometric technique to be used in the next section, it is important to identify the characteristics of the data-generating processes of the variables we will use in our analysis.

Traditional Dickey-Fuller type tests do not reject the null hypothesis of unit root for long term capital inflows, short term total private capital inflows, and (marginally) for short term inflows subject and not subject to taxes. However, as Zivot and Andrews (1992) show, tests of this type lack power when the series are characterized by stationary processes with structural breaks. Tests of this type suggest a structural break for all series.[8] It must be recalled that all of these tests rely on univariate specifications; thus it is still possible to obtain a stable representation for the series or at least to rule out some of the breaks once additional information is included.

It is important, therefore, to use an econometric technique that allows the data to discriminate between the presence of one or more regimes and, if possible, to determine their sources. As a special case, it is still possible to obtain a unique stable relationship between the differently defined private capital inflows and their determinants. In this case, the technique should be flexible enough to allow consistent estimation with a full sample and constant parameters.

Traditional techniques in these cases tend to use diverse specifications for different periods. In doing so, however, it is implicitly assumed that the econometrician has full knowledge of the precise moment and nature of the break. This methodology is not advisable for several

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[8] This is evident particularly in the case of long term inflows. Sequential F tests for change in trend were performed and breaks were detected in 1990 and by the end of 1991 at conventional significance levels. In the case

reasons: the econometrician may not know the precise moment at which the regime switch takes place, nor may know whether the nature of the change is temporary or permanent; even if the econometrician knows the nature of the change in regime and the date at which it occurs, the sample size available makes it very difficult to compute reasonable estimates for each period.

Labán and Larraín (1994) and Valdés and Soto (1996) have estimated simple models to analyze the determinants of short and long term inflows to the Chilean economy. In particular, Labán and Larraín (1994) conclude that the factors explaining the behavior of short term private capital inflows to Chile since the mid-1980s are quite different from those relevant to the evolution of medium and long term inflows. Their results also show that short term inflows respond basically to interest rate arbitrage opportunities --a combination of internal and external factors-- and to the decline in country risk, proxied in their paper by the reduction in the foreign debt to GDP ratio. However, they also conclude that the sharp increase in medium and long term private capital inflows since the late 1980s appears to have been mainly a result of favorable domestic political and economic changes. Of these changes, the most significant are the reduction of the debt overhang, the better prospects of future economic growth (captured by a higher ratio of investment to GDP) and the return to democracy. These have been translated, following their argument, into a reduction of the premium that foreign investors require to invest in Chilean long term securities. Their results also show that medium and long term capital have not been sensitive to the interest rate differential or to the introduction and successive modifications of the reserve requirements for foreign credits in effect in Chile since mid-1991.

In the present paper we improve the structure of the model and the definition of variables used by Labán and Larraín (1994), in an attempt to overcome certain shortcomings apparent in the earlier paper. In particular, the econometric technique utilized is too simple and the definition of medium and long term capital inflows considered only some public sector flows. Due to limitations on data availability, they used Chapter XIV flows as a proxy for total short term private capital inflows; these were precisely one of the sources of short term capital inflows targeted by the selective capital controls introduced.[9] They also did not isolate the impact of

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of short term flows, there is no perceivable modification in their level or the trend, while higher-order moments (particularly the variance) changed at the beginning of 1991.

[9] The fact that these flows were negatively affected by the introduction and modifications of the reserve requirements does not necessarily imply that all short term private capital inflows reacted in the same way. Thus it

these controls and of other policy measures implemented, given that these were introduced in the definition of the interest rate gap, in this way requiring a unique parameter to account for all of its components.

Valdés and Soto (1996) try to measure the impact that selective capital controls may have had on the behavior of short term capital inflows. They conclude that the introduction of selective controls to capital inflows did not have a statistically significant impact on total short term inflows. In fact, they found a positive sign associated with the coefficient of the implicit tax on short term inflows. Their data, however, are subject to the same problems as the data set used by Labán and Larraín (1994), since some of the series they consider include capital flows related to both the private and public sectors and they do not differentiate between inflows that are and are not subject to controls. Other important econometric problems are evident in their specification. In particular, the saturation ratio of their short term inflows equation is very high (in excess of 33%), considering that they have only 33 observations. The small sample size in conjunction with high collinearity may be partially responsible for their results.[10]

A more serious problem evident in the specifications used in both papers is that they do not consider that the dynamic properties of some capital inflows may be subject to different regimes. In that case several problems may arise, among which are: i) full sample estimation, not allowing for these changes, may lead to unreliable results and unstable parameters; and ii) the way in which a set of variables (such as selective taxes) affects capital inflows is non-trivial and may vary between regimes.

Given the arguments discussed above, Chumacero, Labán and Larraín (1996) estimated Hamilton's (1994) Markov Switching Regimes Models in order to assess whether there is statistical evidence that favors the introduction of two different regimes while modeling the determinants of short and long term private capital inflows. They show that in most cases a unique stable representation for both short and long term inflows is strongly rejected by the data and they proceed to estimate the characteristics of the series when switching regimes are allowed. One problem that Chumacero et. al. encountered is that the implicit tax series constructed by

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may well be the case, that after the introduction of the "selective" capital controls there is a substitution effect from those short term capital inflows that are subject to controls to those that are not subject to controls. Therefore, these controls may have an ambiguous impact on overall short term capital flows.

[10] The conditioning number of their equation exceeds 14, thus signaling an important problem of collinearity.

Valdés and Soto (1996) is highly collinear with the interest rate differential. Therefore, their numerically intensive Markov Switching Regimes Model was badly conditioned.

This paper uses several of the findings of Chumacero, et. al. (1996), but uses a different estimation technique that is able to endogenously determine whether there are different regimes in the sample period and, if so, what the nature of each regime is. A brief description of the estimation technique, referred to as a threshold process, follows.

The technique consists of the estimation of a special case of non linear models in which a particular variable may adopt a certain law of motion depending on whether or not an observation has passed a certain threshold. More formally, a two-regime threshold process takes the form:

$$y_t = x_{1,t}{}' \boldsymbol{a} I(q_t \leq \boldsymbol{g}) + x_{2,t}{}' \boldsymbol{b} I(q_t > \boldsymbol{g}) + \boldsymbol{e}_t \tag{1}$$

where $I(\cdot)$ denotes the indicator function, q_t is a known function of the data, and $\boldsymbol{g}$ is the threshold parameter. Thus the parameters $\boldsymbol{a}$ is the vector of slope parameters when $q_t \leq \boldsymbol{g}$, and $\boldsymbol{b}$ is the vector of slope parameters when $q_t > \boldsymbol{g}$. **(1)** can be expressed more compactly as:

$$y_t = x_t(\boldsymbol{g})' \boldsymbol{q} + \boldsymbol{e}_t \tag{2}$$

where $\boldsymbol{q} = (\boldsymbol{a}', \boldsymbol{b}')'$ and $x_t(\boldsymbol{g}) = \begin{cases} x_{1,t} & \text{if } q_t \leq \boldsymbol{g} \\ x_{2,t} & \text{if } q_t > \boldsymbol{g} \end{cases}$.

Thus the problem faced in the estimation of **(2)** is not only to obtain estimates of the vector of slope parameters but also of the threshold parameter. Under the additional assumption that $\boldsymbol{e}_t$ is normal, least squares estimation is equivalent to maximum likelihood. Thus for a given value of $\boldsymbol{g}$, the LS estimate of $\boldsymbol{q}$, denoted by $\hat{\boldsymbol{q}}$ is

$$\hat{\boldsymbol{q}}(\boldsymbol{g}) = \left(\sum_{t=1}^{n} x_t(\boldsymbol{g}) x_t(\boldsymbol{g})' \right)^{-1} \left(\sum_{t=1}^{n} x_t(\boldsymbol{g}) y_t \right) \tag{3}$$

with residuals $\hat{\boldsymbol{e}}_t(\boldsymbol{g}) = y_t - x_t(\boldsymbol{g})' \hat{\boldsymbol{q}}(\boldsymbol{g})$ and residual variance.

$$\boldsymbol{s}_n^2(\boldsymbol{g}) = \frac{1}{n} \sum_{t=1}^{n} \hat{\boldsymbol{e}}_t(\boldsymbol{g})^2 \tag{4}$$

Thus, the estimate of $\boldsymbol{g}$ is the value that minimizes: $\hat{\boldsymbol{g}} = \arg\min \hat{\boldsymbol{s}}_n^2(\boldsymbol{g})$, which can be found by direct search. Remember that the estimate of $\boldsymbol{g}$ depends ultimately on the choice of q_t that is observed by the econometrician.

Hansen (1996) presents a detailed explanation of the technique and derives the asymptotic distribution of the estimates. An advantage of this specification is that conventional likelihood ratio tests can be applied to test the null hypothesis of a unique stable representation for the series against the alternative of a threshold process. This type of specification can be viewed as a special case of the Markov Switching Regime Models where the threshold variable replaces the transition matrix. From a computational standpoint, a threshold process presents several attractive advantages given that it is not as numerically intensive as the Markov switching model.

The following section reports the results of the estimation of this technique for both long and short term inflows.

4. The Econometric Results

In order to apply the technique described in the previous section we followed these steps:

- Run a full sample parsimonious regression for each series in order to determine the variables that are to be included in the threshold process.
- For a given choice of the threshold variable we estimate the model and find the p-value associated with the null of a unique stable representation.
- If a unique stable representation is rejected in favor of a threshold process, choose the threshold variable that minimizes the sum of squares of the residuals.
- Reduce the threshold model to a parsimonious representation.

4.1. Long Term Inflows

Table 2 presents the full sample equation for long term capitals. Consistent with the results of Labán and Larraín (1994) and Chumacero et. al. (1996), only structural variables such as the investment rate and external debt-output ratio are significant, while short term arbitrage conditions are not. As expected, important positive auto-correlation is present in the data. Even though the long-term effect of the reduction of the debt-output ratio is not statistically different from zero, an uncomfortable result from full sample estimation is associated with the sign of the contemporaneous debt-output ratio. Traditional tests suggest well behaved residuals but there is

marginal evidence of parameter instability, particularly associated with the coefficient of the investment rate and departures from normality.

Table 2: Determinants of Long Term Capital Inflows (Full Sample)

Variable	Parameter	Standard Error
Constant	-1256.905	349.677
LTC(-2)	0.568	0.175
I/GDP(-2)	53.151	11.650
D/GDP	13.854	5.629
D/GDP(-2)	-10.833	5.166
R^2=0.649 SSR=1004274.8 DW=1.854 Q=0.913 JB=0.065 F=13.094		

Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. SSR=Sum of Squares of the Residuals. Q=P-value of the Ljung and Box Chi² test for white noise (3 lags). JB=P-value of the Jarque and Bera test for normality. F=F statistic. Standard errors of parameters are HAC.

In order to asses the existence of a threshold process we considered different choices of the threshold variable q_t recalling at this point that the only constraint is that it belongs to the information set of the econometrician. Table 3 reports both the Sum of Squares of the Residuals and bootstrap-calculated asymptotic p-value for the test of the null hypothesis of linearity against the alternative of the particular threshold model. The usage of bootstrapped p-values is recommendable in cases such as ours in which there is a reduced sample size. Although other variables not present in the equation reported in Table 2 were also included as possible candidates for the threshold variables, their results are not as good in terms of sum of squared residuals as the ones reported in Table 3.

According to the results, there is strong evidence against a unique, stable, and linear representation for long term private capital inflows. These results are consistent with Chumacero et. al. (1996), who also find evidence of switching regimes in the series. From Tables 2 and 3 we verify that the threshold model is able to halve the sum of squares of the residuals of the original model. Of course, the cost is a reduction in degrees of freedom. The preferred model suggests the threshold variable to be the contemporaneous debt-output ratio. Given that this variable has shown a smoothly decreasing trajectory, the threshold model endogenously determines to split the sample in two periods.

Table 3: Alternative Threshold Models for Long Term Capital Inflows

q_t	SSR	P-value
LTC(-2)	599565	0.332
I/GDP(-2)	591671	0.071
D/GDP	531958	0.046
D/GDP(-2)	573789	0.145

Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. SSR=Sum of Squares of the Residuals. P-value=Bootstrap-calculated p-value for the null of linearity against the alternative of a threshold representation computed on the basis of 1000 replications.

Table 4 presents the results of a parsimonious representation for long term capital inflows. The value of the parameter associated with the threshold variable is 43.39%. Thus, if the debt-output ratio does not exceed this value, long term inflows are determined by the equation of the first regime. When the variable passes the threshold, regime 2 begins to operate. In our case, this means that a permanent structural change took place between 1990 and 1991 (where the values of the debt-output ratio are enclosed by the 95% confidence interval of the threshold parameter). It is important to notice that apart from the significant increase in the goodness-of-fit of the model, the "wrong" signs of full sample estimation reported in Table 2 are corrected.

Table 4: Threshold Model for Long Term Capital Inflows

Variable	Parameter	Std. Dev.	Variable	Parameter	Std. Dev.
Regime 1:			**Regime 2:**		
Low Debt			**High Debt**		
Constant	6466.92	486.12	Constant	-1358.25	371.98
LTC(-2)	0.81	0.08	LTC(-2)	0.33	0.15
D/GDP	-107.14	8.69	I/GDP(-2)	52.83	12.14
D/GDP(-2)	-41.97	3.82	D/GDP(-2)	-10.31	4.99
R_1^2=0.983 σ_1=55.45 SSR$_1$=18446 N$_1$=11			R_2^2=0.487 σ_2=160.24 SSR$_2$=513512 N$_2$=25		
Joint R²=0.814 Joint SSR=531958 g=43.389 95% Confidence region for g=[41.86, 56.13]					

Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. R_i^2=R² of regression of regime i. s_i=Standard deviation of the residual in regime i. N$_i$=Sample size in regime i. g=Estimated value of the threshold parameter. In this case the threshold variable is D/GDP. Thus, regime 2 corresponds to the periods where D/GDP>43.389.

Among other important differences between regimes, we see that the investment rate is no longer statistically significant for determining long term inflows in the nineties, whereas it performed a crucial role in the eighties. In the nineties, long term inflows are more responsive to reductions in the debt-output ratio and are more persistent than before. This may be due to the

statistical properties of the investment rate after 1991, at which point it has tended to stabilize, thus not providing additional information to foreign investors. The fact that the threshold variable is the debt-output ratio, and given the period in which it permanently switched to the first regime, suggests that there may be other factors that triggered this change and of which this variable is a subset. This period marks the return of democracy to Chile and the opening of the capital account.[11] Another very important feature is that the innovations in long term inflows were three times more volatile in the eighties than in the nineties.

Both in the full sample estimation and in the threshold models, interest rate arbitrage conditions and short term selective capital controls are not statistically relevant in explaining the behavior of long run capital inflows to Chile since 1984.

4.2. Short Term Inflows Subject to Taxes

Table 5 presents the full sample equation for short term capital inflows subject to controls. There we find that structural variables such as the investment rate or the external debt-output ratio are not significant in the determination of this type of inflow. We find, however, that short term arbitrage conditions, as well as the growth rate of the economy, are statistically significant. One interpretation of the latter variable is that, given the way in which the Central Bank of Chile carries out its monetary policy, an increase in the growth rate of the economy may trigger a tight monetary policy and thus an increase in the expected interest rate differential in the future, which would have a positive impact on short term capital inflows subject to reserve requirement. After deciding to bring capital into Chile and complying with the reserve requirement --impacting the cost of arbitrage so that it decreases with the length of time one continues to hold domestic assets-- it is more likely that there will be "good" investment opportunities in Chilean peso-denominated assets.

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[11] Labán and Larraín (1994) find a similar effect that they characterize as a dummy variable; in their interpretation this captured the return to democracy.

Table 5: Determinants of Short Term Capital Inflows Subject to Taxes (Full Sample)

Variable	Parameter	Standard Error
Constant	-447.986	121.803
STC-T(-4)	-0.247	0.129
GAP(-2)	15.219	5.078
GGDP(-2)	52.633	12.313
R²=0.483　　SSR=1562430　　DW=2.176　　Q=0.584　　JB=0.743　　F=7.252		

Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. SSR=Sum of Squares of the Residuals. Q=P-value of the Ljung and Box Chi² test for white noise (3 lags). JB=P-value of the Jarque and Bera test for normality. F=F statistic. Standard errors of parameters are HAC.

The residuals of this model are well behaved but, as in the previous case, there is major parameter instability beginning in 1991, particularly in the coefficients of the interest rate differential and the growth rate of GDP. When the reserve requirement on short term inflows is introduced as an explanatory variable it is not significant at standard levels. This does not mean that the introduction of and successive modifications on the reserve requirements for this type of inflows do not have an effect because these controls are implicitly considered in the interest rate differential. We will return to this point later in this section.

As in the previous case, Table 6 presents the sum of squared residuals and p-values for different threshold variables. According to the results there is strong evidence against a unique, stable, and linear representation for short term private capital inflows subject to taxes. These results are again consistent with Chumacero, et. al. (1996), who also find evidence of switching regimes in the series. From Tables 5 and 6 we verify that the threshold model can reduce SSR substantially. The linear model is only rejected, at standard significance levels, when the threshold variable is the rate of growth of GDP. This implies that short term inflows that are subject to taxes react differently when the economy is experiencing high and low growth rates.

Table 6: Alternative Threshold Models for Short Term Capital Inflows Subject to Taxes

q_t	SSR	P-value
STC-T(-2)	1314148	0.164
GAP	1310832	0.670
GGDP(-2)	1042101	0.028

Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. SSR=Sum of Squares of the Residuals. P-value=Bootstrap-calculated p-value for the null of linearity against the alternative of a threshold representation computed on the basis of 1000 replications.

Table 7 shows the results for short term capital inflows subject to reserve requirement. The value of the parameter associated with the threshold variable is 7.74%. Thus short term inflows are determined by the equation of the first regime when the GDP growth does not exceed this value. When the variable passes the threshold, the second regime begins to operate.

Table 7:Threshold Model for Short Term Capital Inflows Subject to Taxes

Variable	Parameter	Std. Dev.	Variable	Parameter	Std. Dev.
Regime 1 **Low Growth**			**Regime 2** **High Growth**		
Constant	-882.73	228.71	Constant	-710.65	318.00
GAP	27.50	8.20	GAP	16.11	4.15
GGDP(-2)	136.02	30.06	GGDP(-2)	72.17	34.83
$R_1{}^2$=0.63 σ_1=215.7 SSR$_1$=558566 N$_1$=16			$R_2{}^2$=0.49 σ_2=216.1 SSR$_2$=747439 N$_2$=20		
Joint R²=0.579 Joint SSR=1042101 g=7.741 95% Confidence region for g=[5.42, 7.93]					
Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. R²i=R² of regression of regime i. s_i=Standard deviation of the residual in regime i. N$_i$=Sample size in regime i. g=Estimated value of the threshold parameter. In this case the threshold variable is GGDP(-2). Thus, regime 2 corresponds to the periods where GGDP(-2)>7.741.					

As we can see from Table 7, short run capital inflows subject to taxes are explained only by the two period lagged GDP growth rate and by the adjusted interest rate gap that takes into account the introduction and successive modifications of the reserve requirement, the extension to foreign credits of the stamp tax, and the successive modifications of the exchange rate policy (GAP). An increase in the reserve requirement will reduce these short term inflows but only through its impact on the interest gap variable. Structural variables do not play any role in explaining the evolution of these short term capital inflows.

An important question that can be addressed with this specification concerns the effect that the introduction of selective capital controls had on the inflows that it targeted. A brief description of the methodology used to answer this question follows.

Denoting by a_i (for i=1, 2), the coefficients associated with the interest rate differential (GAP), the impact effect that a change in the reserve requirement has on short term inflows can be derived as:

$$\frac{\P STC - T_t}{\P TAX_t} = \sum_{i=1}^{2} a_i \frac{\P GAP_t}{\P TAX_t} I_{i,t} \tag{5}$$

where $I_{i,t}$ denotes the indicator function for the threshold variable in period t, and according to our definition of GAP:

$$\frac{\partial GAP_t}{\partial TAX_t} = -(1 - T_t)i_t \tag{6}$$

where T is the stamp tax, TAX is the tax equivalent of the reserve requirement on selective inflows, and i is the nominal domestic interest rate. This impact effect is clearly non constant and depends not only on the value of the stamp tax or the domestic interest rate, but also on the overall performance of the economy. What is clear is that the impact effect of a 1% increase in reserve requirements would be greater upon reducing this type of inflows when the economy is in the low growth path, rather than when it is in the high growth path. As a matter of fact, for the same levels of the interest rate and the stamp tax, this impact effect would be 1.7 times greater in the low-growth path scenario (ratio of the coefficients associated with GAP on Table 7). This is probably an upper bound, given that it is more likely for the domestic interest rate to be higher in the high growth scenario.

Given all the features described above, it is not surprising to find that the composition of short term inflows has changed in favor of those flows that are not subject to controls.

4.3. Short Term Inflows Not Subject to Taxes

Table 8 presents the full sample equation for short term capital inflows not subject to controls. Again we find that structural variables such as the investment rate, the external debt-output ratio, or the growth rate of the economy are not significant in the determination of this type of short term inflows. We find, however, that short term arbitrage conditions and the reserve requirements are extremely important for this type of short term inflows. It is important to mention that the relevant interest rate differential here is GAP1 (that which does not consider the reserve requirements) given that these inflows are not subject to taxes. The residuals of the model are well behaved, and there is no evidence of significant parameter instability (although normality is rejected marginally). As in the previous cases, Table 9 presents the sum of squared residuals and p-values for different threshold variables.

According to these results there is no evidence against a unique, stable, and linear representation for short term private capital inflows not subject to taxes. The results are again

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consistent with Chumacero, et. al. (1996) who find evidence of a unique absorbing regime. Thus the results of Table 8 show that a linear and stable relation exists. Notice that in this specification there is a differentiated effected between the interest rate differential (that excludes the implicit tax rate to short term inflows) and the tax rate taken by itself. The coefficient associated with the first lag of the tax rate is positive and statistically significant, implying a substitution effect from short term inflows that are subject to taxes towards short term inflows that are not subject to taxes - an effect reported in Chumacero et. al. (1996) and in Valdés and Soto (1996). Notice however, that this short-run effect is completely offset in the third quarter (this effect was also captured in Chumacero et. al. (1996), but not in Valdés and Soto (1996)).

Table 8: Determinants of Short Term Capital Inflows Not Subject to Taxes (Full Sample)

Variable	Parameter	Standard Error
Constant	162.600	31.550
STC-NT(-1)	-0.487	0.103
STC-NT(-2)	-0.210	0.102
STC-NT(-4)	0.302	0.080
GAP1	5.311	2.764
TAX(-1)	42.615	3.761
TAX(-3)	-41.128	3.211
R^2=0.770 SSR=385274.4 DW=1.723 Q=0.123 JB=0.064 F=13.374		

Notes: See Table 1 for the definitions of the variables. Sample: 1986:2-1994:4. SSR=Sum of Squares of the Residuals. Q=P-value of the Ljung and Box Chi² test for white noise (3 lags). JB=P-value of the Jarque and Bera test for normality. F=F statistic. Standard errors of parameters are HAC.

Table 9: Alternative Threshold Models for Short Term Capital Inflows

q_t	SSR	P-value
STC-NT(-1)	341650	0.216
GAP1	360647	0.784
T	343097	0.249

Notes: See Table 1 for the definitions of the variables. Sample: 1986:1-1994:4. SSR=Sum of Squares of the Residuals. P-value=Bootstrap-calculated p-value for the null of linearity against the alternative of a threshold representation computed on the basis of 1000 replications. d3(x)=x-x(-3).

Given that arbitrage is possible (at least in theory) between short term inflows that are and are not subject to taxes, the relevant arbitrage conditions in this case is captured by the coefficient associated with the contemporaneous gap between the domestic and the international interest rate.

Given that the long run effect of an increase on reserve requirements deters inflows subject to taxes and has no long run effect on inflows that are not subject to taxes, its net effect is a reduction of total short term inflows and a permanent change in their composition. This feature can not be captured with the aggregate series of short term inflows, that lead to the "ineffectiveness" hypothesis advanced by Valdés and Soto (1996).

5. Concluding Remarks

This paper presents a robust econometric methodology to analyze the determinants of short and long term capital inflows to Chile during 1985-1994. Using threshold processes we show that in most cases the determinants of these flows are characterized by different regimes.

Long term inflows react to long run fundamentals such as the investment rate and the external debt-output ratio and are not sensitive to short run arbitrage conditions. We demonstrate that there has been a permanent structural break in the period 1990-91 that coincides with economic factors such as the drastic reduction in the external debt-output ratio and political aspects such as the return to democracy, among other important factors. Since that period, long term inflows have been more persistent, more volatile and not sensitive to the investment ratio.

We also show that in order to capture the dynamic properties of short term inflows, it is necessary to divide them between those that are and those that are not subject to selective controls.

Short term capital inflows that are subject to taxes have different determinants depending on the business cycle. In particular, they react more strongly to arbitrage conditions in low-growth scenarios. We also show that the effect of selective taxes on this series is not constant. Given their distortionary nature they have a strong (and asymmetric) influence on deterring the entrance of inflows subject to taxes. There is no doubt that this fact helps to explain why their share in total short term inflows has been dramatically reduced since the introduction of reserve requirements in Chile.

On the other hand, a unique stable representation for short term inflows that are not subject to taxes is found in the data. It is also shown that changing the tax rate has no long-term effect on this type of inflows.

In short, the introduction of reserve requirements on short term capital inflows has had two main effects on these inflows. In the short-term, there is a clear substitution effect away from capital inflows that are subject to taxes and into those that are not subject to taxes. In the long run, the latter effect disappears and the deterrent effect on inflows that are subject to taxes dominates. This analysis does not address the potential efficiency losses of reserve requirements, but it clearly suggests that the case for the ineffectiveness of capital controls may have been overstated.

Appendix: The Data

The definitions of the variables used in the model are:

- LTC = Quarterly Net Medium and Long Term Private Capital Inflows, include net direct private investment (including secondary ADR), and medium and long term foreign loans to the Chilean private banking and non banking sector.

- STC = Quarterly Net Total Short Term Private Capital Inflows, include short term loans to the Chilean private banking and non banking sector (Chapter XIV), other net private sector short term assets, changes in the stock of foreign currency deposits in the Chilean banking system, and errors and omissions.

- STC-T = Quarterly Net Short Term Private Capital Inflows subject to selective capital controls are short term loans to the Chilean private banking and non banking sector (Chapter XIV), and (beginning in 1991:4) the changes in the stock of foreign currency deposits in the Chilean banking system.

- STC-NT = Quarterly Net Short Term Private Capital Inflows not subject to capital controls include other net private sector short term assets, changes in the stock of foreign currency deposits in the Chilean banking system (until 1991 :3), and errors and omissions.

- GAP = Annualized Quarterly Interest Rate Differential between domestic and the "relevant" international interest rate. The domestic rate is the 90-day borrowing market interest rate (i). The international "relevant" interest rate is the 90-day Dollar LIBOR, until the second quarter of 1992; after that date, and considering the change in the exchange rate regime, a weighted average of the 90-day nominal interest rates of the US, Japan and Germany in US dollars (i^*) was used. The weighting factors correspond to those in the currency basket that determine the central level of the exchange rate band since that date. This gap also includes the stamp tax that was extended to foreign credits since the second quarter of 1991 (T) and the tax equivalent of the reserve requirement on selective short term capital inflows (TAX). Finally, the observed exchange rate depreciation was utilized (e). Formally:
$$GAP = (1-T)(1+i(1-t)) - (1+e)(1+i^*).*$$ For the case of short term inflows not subject to taxes the relevant interest rate differential is given by: $GAP1 = (1-T)(1+i) - (1+e)(1+i^*)$.

*Note: In the GAP equation, t signifies TAX.

The source for all data is the Central Bank of Chile.

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