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CAPITAL CONTROLS, EXCHANGE RATE MANAGEMENT AND MONETARY POLICY IN A SMALL OPEN ECONOMY: A STYLIZED MODEL OF THE CHILEAN CASE, 1978-1980

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Abstract

The paper addresses in an intertemporal optimizing framework the high real interest rate and the current account deficit observed in Chile when the economy was disinflated by means of the nominal exchange rate. The particular manner the capital account was controlled (a temporary flow constraint to capital inflows) along with a passive monetary policy (the Monetary Approach to the Balance of Payments) resulted in a tight monetary policy as the balance of payments could not provide the desired money balances fast enough. When the capital account was liberalized, the observed plunge in the (medium-run) real interest rate and the sharp increase in capital inflows are consistent with the tight money hypothesis. Unlike previous literature, the high real interest rate is theoretically consistent with a current account deficit during the transition when the flow constraint to capital inflows is loose enough and the utility function satisfies some conditions. All real effects, nevertheless, can be avoided if the monetary authority provides the desired money balances through expansionary open-market operations.

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1. Introduction

The stabilization policies carried out in the late seventies in the Southern Cone of Latin America have spawned a great deal of modelling in the optimizing representative-consumer framework. While the three countries (Argentina, Chile and Uruguay) show similar stylized facts as a result of the exchange-rate-based stabilization programs (high real interest rate, current account deficit, real exchange rate appreciation, etc.), the differences among these experiences have not been sufficiently emphasized. The two most important differences are the degree of capital mobility and the government budget deficit.

Argentina and Uruguay had a relatively open capital account and a sizable budget deficit (specially Argentina) at the beginning of the stabilization policy. This combination invites to apply the balance-of-payments crisis literature[1]. The model, however, is inappropriate for the Chilean case. Both the budget deficit was balanced and capital controls were important in the latter case.

Models with no capital mobility do explain a high real interest rate during the transition[2]. The current account implication, however, is counterfactual: the current account must be in surplus in order to expand the money supply under the application of the Monetary Approach to the Balance of Payments[3]. A better modelling of the capital control policy is needed to shed light on the Chilean case.

The capital control policy in Chile can be seen as a gradual liberalization, where a flow constraint to capital inflows (maximum volumen per month) was part of the capital control package. In addition, the capital control policy can be visualized as temporary, as the announcement that the capital account would be fully liberalized later was apparent.

The purpose of this paper is to model this "flow" constraint to capital inflows and see the extent to which the observed high real interest rate and the current account deficit can be compatibilized.

In section 2 a description and analysis of Chilean policies and evidence is provided. In section 3, the basic framework is developed. The first part of the section is strongly based on the models with no capital mobility due to Calvo (1981) and Obstfeld (1986). We extend this literature by introducing the possibility of open-market operations and an announcement of capital account liberalization. Then we formalize how the presence of a flow constraint to capital movements may explain the high real interest and the current account deficit. The model stresses a scope for an active monetary policy –an expansionary open-market operation– in order to avoid all the real effects of disinflation. An example when the model is not saddle-path stable is also provided. The example shows how the structure of the relevant model bounds the government's consistent policy space and the independence of monetary, exchange rate and capital inflows policies. Section 4 summarizes the conclusions.

2. Background and Evidence

This section reviews the evidence and the policies carried out in Chile during the period 1978-1980 regarding exchange rate and capital inflows.

The policies are summarized in Table 1. Apart from a couple of unexpected discrete revaluations of the home currency in 1976 and 1977, it is not until February 1978, when the so-called closed-economy stabilization policy ends and the open-economy stabilization policy starts[4]. From this date, a preannounced exchange rate, below past inflation, was established[5]. In June, 1979, the policy was unexpectedly changed and the

TABLE 1

EXCHANGE RATE AND PRIVATE CAPITAL INFLOWS POLICY

Date	Exchange Rate	Capital Inflows
February 1978	Beginning of preannounced "tablita" below past inflation	Flow constraint to capital inflows (US$ 2 million a month per bank)
		Upper bound, 25% banks' equity
June 1979	Unexpectedly fixed	Upper bound lifted and replaced by a 25% required reserve rate
April 1980		Flow constraint lifted
June 1982	Balance of payments crisis, abandonment of fixed parity	

nominal exchange rate was frozen (to US dollar). The fixed exchange rate lasted until June 1982, when a severe balance-of-payments crisis prompted the abandonment of the fixed parity.

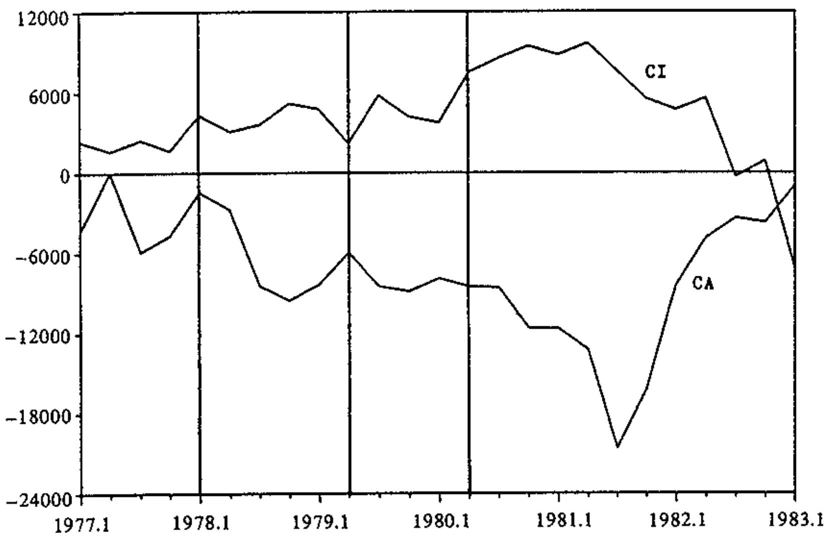
The capital control policy involved multiple methods[6]. It included a quantity upper bound to banks' foreign indebtedness –which were related to the bank's equity–, required reserves on foreign debt and a monthly limit to capital inflows. The most important item of the capital account, which is our concern for the purpose of this analysis, was subject to the three types of constraints[7]. Between September 1977 and June 1979, the banks were subject to an upper bound to foreign debt of 25% of the banks' equity and a maximum of US$ 2 million a month could be sold to the central bank to be lent to the public[8]. In June 1979 (the same month the exchange rate was fixed) the 25% upper bound was eliminated and substituted by a 25% required reserve constraint. The monthly limit, however, was in place until April 1980, that is, for more than two years during the period of exchange-rate-based disinflation policy.

The main concern of this paper is to model the effects of this monthly limit which imposes a flow constraint to the private sector's desire for accumulate foreign debt.

The stylized facts are depicted in Figure 1 and Figure 2. Figure 1 shows the path of private capital inflows (Artículo 14) and the current account deficit. Figure 2 shows the evolution of the indexed medium-run real interest rate (90 to 365 days) and the short-run bank loan and deposit real interest rates (30 days). In both cases the first vertical line marks the beginning of the exchange-rate-based stabilization policy (February 1978), the second vertical line is the date the exchange rate was fixed and the upper bound limit was lifted (June, 1979) and the third vertical line indicates the liberalization of the flow constraint (April 1980). Let us first consider Figure 1. Due to the flow constraint, the capital inflows stay at some flow level until April 1980, when the flow constraint is lifted. Thereafter the flow level jumps upwards. Around June 1979, however, the flow level decreases as the upper bound limit became increasingly binding. When the upper bound is lifted in June 1979, there is a sharp jump upward to recover the controlled flow level (think of many banks resuming their US$ 2 million monthly limits at the same time). The current account stays in deficit throughout the period. The evolution of the capital inflows series suggest that they were extremely sensitive to the capital controls policy. They respond sharply to the two key dates of the capital account liberalization.

FIGURE 1

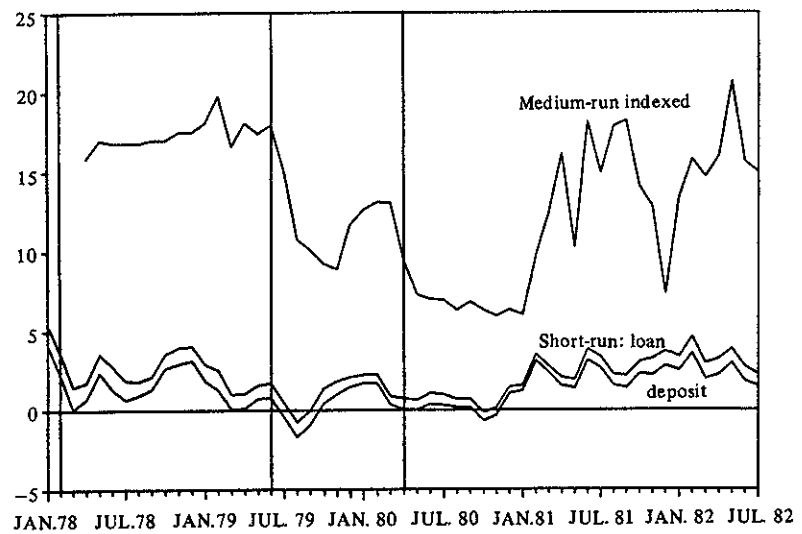
PRIVATE CAPITAL INFLOWS AND CURRENT ACCOUNT (MILL. PESOS 1977)



Source: Corbo and Matte (1984)

FIGURE 2

REAL INTEREST RATES: MEDIUM-RUN (% PER YEAR) AND SHORT-RUN (% PER MONTH)



Source: Monthly Bouletin, Central Bank, various numbers.

Now consider the interest rate paths in Figure 2[9]. The short-run interest rate moves in a very erratic way. The short-run interest rate is partially insulated from foreign bonds arbitrage due to the term structure of the interest rate. The minimum maturity allowed for foreign debt is 2 years. Due to this reason, the interest rate for indexed deposits at longer maturity is also included. In what follows the latter series is referred. The interest rate keeps at a high level until June 1979. The abrupt plunge in the real interest rate at this date could be explained by two reasons. The first one is foreign bonds arbitrage. As pointed out above (Figure 1), the liberalization of the 25% upper bound to the banks' capability to contract foreign debt did yield sudden capital inflows. By June 1979, many banks had probably already hit the 25% limit. Eliminating this limit provokes instantaneous capital inflows. The second explanation for the plunge in the ex-ante real interest rate at June 1979 is related to the greater uncertainty provoked by the unexpected change in the rules when the exchange rate was fixed. The negative ex-post short-run real interest rate at this date (Figure 2) is a proof of the difficulties agents were facing in predicting the inflation rate. Under this higher conditional expected variance of inflation, a risk averse agent would switch his/her portfolio toward indexed deposits, temporary driving down this interest rate. Under the latter explanation, the interest rate starts rising again once the new rule become clear and credible. Under the former explanation, the posterior increase in the real ex-ante interest rate is the result of a too-tight flow constraint to capital inflows relative to the flow demand for money[10]. In any case, the events in June 1979 are not modelled in this paper.

The second plunge of the interest rate in April 1980 is fully consistent with a portfolio adjustment after the flow constraint was eliminated. After April 1980, the interest rate keeps at a low level --arbitraged by foreign bond-- until February 1981[11]. Again, the (medium-run) real interest rate seems quite sensible to the capital control policy.

In next section the flow constraint to capital inflows is formally modelled. Both the upper bound constraint and the period after February 1981 will be hereafter ignored.

3. The Model

The purpose of this section is to derive the effect of fixing the exchange rate under different assumptions After characterizing the individual optimization problem, the main body of the paper (section 3.2) uses endogenous transfers from the government to close the model. We describe the results due to Calvo (1981) and Obstfeld (1986) (no capital mobility), and extend those results in two directions: the implications of an announcement of capital account liberalization and the dynamic response to stabilization under a flow constraint to capital inflows. In both cases we emphasize the use of open-market operations as a complement to the stabilization policy. A digression with the implications of a globally unstable dynamic system and alternatives way to close the model (section 3.2) are also provided.

The representative consumer maximizes a Sidrauski-type utility function subject to the life-time budget constraint. No population growth is assumed. The utility function is

$$\int_0^{\infty} u(c_t, m_t) e^{-\theta t} dt \qquad (1)$$

where c_t and m_t are the planned path of the consumption good and the real money balances respectively. Total financial wealth w_t is held in 3 financial assets: money balances m_t, domestic bonds b_t, and foreign bonds f_t. Foreign and domestic bonds are perfect substitutes. Individuals are endowed with a fixed stream of consumption good y. All magnitudes are expressed in per capital terms.

Under fixed exchange rate and one tradable good, the nominal exchange rate and level of prices are identical and denominated by ρ. No discrete devaluation will be considered, although the setting does allow us to do so.

The financial assets and flow budget constraints may be expressed respectively as[12]

$$w_t = m_t + b_t + f_t \tag{2}$$

$$\dot{w}_t = y + i_t b_t + \tau_t + \theta f_t - c_t \tag{3}$$

where besides the variables already defined, i_t is the nominal (and real) domestic interest rate, the international real interest rate is equal to time preference θ and τ_t is a stream of transfers from the government. The dot over the variable stands for the derivative with respect to time.

Now assume that private capital inflow are subject to a "flow" constraint for the interval $[0, t_1)$ of the form

$$\dot{f}_t \geqslant -\delta \tag{4}$$

where δ is a positive upper bound to capital inflows. The model analyzes the effects of an anticipated opening of the capital account, and therefore an optimal swap of assets may occur at that date. Defining t_j as any swap date, then asset swaps must satisfy the constraint

$$\Delta f_{tj} + \Delta b_{tj} + \Delta m_{tj} = 0 \tag{5}$$

where Δ stands for discrete changes in asset levels (swap) at the date t_j.

Defining A(t) as the set of all such swap dates which belong to the interval [0, t], the relation between flows and stocks of foreign bonds is given at every moment by

$$f_t = f_0 + \int_0^t \dot{f}_x dx + \sum_{t_j \in A(t)} \Delta f_{tj} \tag{6}$$

Using (2), (5), and granted the corresponding transversality condition, the budget constraint (3) may be integrated and expressed as[13]

$$m_0 + b_0 + \int_0^\infty (y + \tau_t + \theta f_t - \dot{f}_t - c_t - i_t m_t)\, e^{(-\int_0^t i_v d_v)}$$
$$- \sum_{t_j\, in A(\infty)} \Delta f_{tj}\, e^{(-\int_0^{t_j} i_v d_v)} \geqslant 0 \tag{7}$$

The individual's budget constraint may be expressed in multiple forms. The form (7) was chosen to allow the derivation of the appropriate first order condition. Given constraint (4), which is assumed to exist at the individual level, the individual must choose the

path of $\dot{f}_t$. Alternatively, as we will discuss later, we could have included a "shadow price" that clears the stock for foreign bonds market instead of assuming individuals observing the flow (quantity) constraint directly.

Expression (7) states that the present value of individual's stream of "total" consumption $(c_t + i_t m_t)$ and the stream of net accumulation of foreign bonds $(\Delta f_t + \dot{f}_t - \theta f_t)$ must be less (equal in equilibrium) than the present value of the stream of total income $(y + \tau_t)$, plus initial wealth in domestic assets.

The representative individual maximizes (1) subject to (4), (6) and (7) with respect to the sequence $\{c_t, m_t, f_t, \dot{f}_t, \Delta f_{tj}\}$ for the entire future. The optimization problem is detailed in Appendix A. The first order condition can be expressed, for all $t \in [0,\infty)$, as

$$\frac{u_m(c_t,m_t)}{u_c(c_t,m_t)} = i_t \tag{8}$$

$$u_{cc}\dot{c}_t + u_{cm}\dot{m}_t = u_c(\theta - i_t) \tag{9}$$

$$\beta_t = 1 - \theta \int_t^\infty e^{(-\int_t^x i_v dv)} dx \tag{10}$$

and for all $t \in [0, t_1)$

$$\beta_t(\dot{f}_t + \delta) = 0 \tag{11}$$

where subscript of utility function stands for partial derivative and β_t is shadow price for constraint (4) (see Appendix A).

Equation (9) gives the motion for consumption and money balances. Substituting (8) in (9) yields

$$u_{cc}\dot{c}_t + u_{cm}\dot{m}_t = \theta u_c(c_t,m_t) - u_m(c_t,m_t) \tag{12}$$

which is the standard differential equation in m_t and c_t in Sidrauski-type optimizing models.

Equation (10) deserves some additional attention. Recall that i_t has the lower bound θ. If i_t is equal to θ for the entire future, the second term in the right-hand side of (10) is 1. This implies β_t, the shadow price of (4), is zero and therefore constraint (4) is not binding when the path of domestic and foreign interest rate are equal. In this case there is no need for portfolio adjustment. If the domestic interest rate is greater than the foreign interest rate at some interval in the future, from (10) β_t is positive (4 is binding) and from (11) $\dot{f}_t = -\delta$. Note that from the individual point of view i_t does not need to be higher today for (4) to be binding today. Individuals know that, in equilibrium, i_t can be higher tomorrow only if foreign credit is rationed in the future. Foreseeing that, individuals want to borrow more (instantaneously) today in order to face that future rationing, which implies that (4) is also binding today. In short, individuals are credit rationed today whenever they will be credit rationed in the future.

Unlike Obstfeld (1986), there is no observed asset price that clears the foreign bonds market[14]. This is a model of credit rationing and therefore every individual observes the quantity "flow" ration δ. Alternatively, however, there is an interpretation in terms of assets prices which, if observed, would clear the foreign bonds market. Define this "shadow price", q_t, as $q_t = 1 - \beta_t$. Substituting this expression in (10) and differentiating, it is straightforward to check that the standard asset arbitrage condition $\dot{q}_t/q_t + \theta/q_t = i_t$ holds at all times. The variable q_t is a utility-based "price" of one additional unit of the foreign asset and β_t can be interpreted as the "dislike" of waiting in front of the bank (queue) to get the corresponding credit ration. The "price", however, is not in the budget constraint (3) as it is not an actual financial cost.

In order to close the model it is necessary to introduce the behavior of the government.

3.1 Government Behavior 1: Closing the Model by Endogenous Transfers

In this part, the model is closed by the convenient mechanism used by Calvo (1981) and Obstfeld (1986). The government is assumed to transfer (tax), endogenously, any consolidate budget surplus (deficit) at every moment in time. The implications of this assumption will be discussed in section 3.2. The government consumes a fixed per capita amount g and must pay interest for a fixed per-capita national debt b_0. The only source of funds (besides endogenous "taxes" when τ_t is negative) is the interest rate yielded by foreign reserves. The flow budget constraint of the consolidated government budget is then

$$\tau_t = \theta\tau_t - g - i_t b_0 \tag{13}$$

where τ_t is the stock of foreign exchange reserves which yield the international interest rate θ.

From the Central Bank balance sheet, stock of real balance is given by

$$m_t = \tau_t + \frac{DC}{p} \tag{14}$$

where DC/p is a fixed number representing past domestic credit and/or adjustments for any past discrete devaluation[15].

Solving (14) for τ_t, substituting in (13) and then eliminating transfers from (3), the motion of aggregate financial assets may be expressed as

$$\dot{w}_t = y - g - c_t + \theta[m_t + f_t] - \theta\frac{DC}{p} \tag{15}$$

or, using (2) and the assumption $b_t = b_0$

$$\dot{w}_t = y - g - c_t + \theta w_t - \theta \quad b_0 + \frac{DC}{p} \tag{16}$$

which says that the motion of financial wealth only depends on consumption and wealth itself.

Solving (2) for m_t, solving time-differential of (2) for $\dot{m}_t$ and substituting both equations in (11) (recall $\dot{b}_t = 0$) can be obtained

$$\dot{c}_t = \frac{1}{u_{cc}}[\theta u_c(c_t, w_t - b_0 - f_t) - u_m(c_t, w_t - b_0 - f_t)]$$
$$- \frac{u_{cm}}{u_{cc}}(c_t, w_t - b_0 - f_t)(\dot{w}_t - \dot{f}_t) \tag{17}$$

Finally substituting (16) into (17)

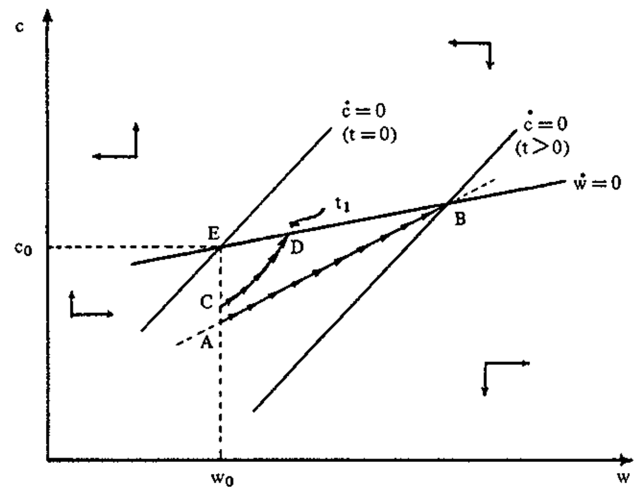
$$\dot{c}_t = \frac{1}{u_{cc}}[\theta u_c(c_t, w_t - b_0 - f_t) - u_m(c_t, w_t - b_0 - f_t)]$$
$$- \frac{u_{cm}}{u_{cc}}(c_t, w_t - b_0 - f_t)[y - g - c_t + \theta w_t - \theta(b_0 - \frac{DC}{p}) - \dot{f}_t] \tag{18}$$

For a given path or policy on capital inflows, (16) and (18) completely describe the dynamic system in consumption and financial wealth.

Before analyzing different cases, it is important to understand the meaning of equation (16). This function can be drawn in space $\{w, c\}$ for $\dot{w}_t = 0$. It is upward sloping where the slope is the international interest rate θ (see Figure 3). This relation does not depend upon the interest rate, which represents transfers between the consolidated public sector and the private sector. In fact this relation represents the unique long-run relation between financial wealth and consumption. It is upward sloping because a higher steady-state level of consumption can be obtained from the yield of a higher stock of net claims on the rest of the world (a higher national income). Given that the government does not accumulate net assets, private financial assets and net claims on rest of the world for the country as a whole are linearly related. To see this, define the net foreign asset position or net claims on rest of the world for the country as a whole as

FIGURE 3

NO CAPITAL MOBILITY (SADDLE-PATH STABILITY)



$$n_f a_t \equiv f_t + \tau_t \tag{19}$$

Substituting back (14) in (15) and using (19) and after some manipulation, the following relations between financial wealth and net foreign assets can be derived

$$nfa_t = y - g - c_t + \theta nfa_t = \dot{w}_t \tag{20}$$

$$nfa_t = w_t - b_0 - \frac{DC}{p} \tag{21}$$

Expressions (20) and (21) show that there is a unique linear relation between the financial wealth held by individuals and the net foreign assets of the country as a whole. The motion of both variables is identical. Using (20) and (21) the system could well be expressed in $\{c, nf\alpha\}$ space.

Note also that locus $\dot{w}_t = 0$ is not affected by open market operations (just the composition of b and DC/p changes), but is is affected by changes in total domestic "outside" assets (b + DC/p). If domestic "outside" assests increase, the schedule shifts downward due to a crowding-out of net foreign assets. This implies a lower long-run consumption (national income) for the same aggregate financial wealth.

Now let us study the dynamics of the model for two types of capital controls policy: the polar case of no capital mobility, and the case of a flow constraint to capital movements[16]. In both cases an anticipated opening of capital account is explored.

Dynamics under no Capital Mobility

Assume, without loss of generality, that domestic residents are not allowed to hold foreign bonds. Therefore $f_t = \dot{f}_t = 0$[17]. The system (16) and (18) may have multiple steady state equilibira, some of them saddle-path stable and some globally unstable, although we rule them out[18]. The unique steady state would be saddle-path stable if for all positive $\{c, m\}$,

$$\frac{u_{mm}}{\theta u_{cc}} > \theta \tag{22}$$

is satisfied and the system would be globally unstable if inequality sign in (22) is reversed[19]. Linear version of the system when it is saddle-path stable are depicted in Figure 3. The globally unstable case is depicted in Figure 5.

In all cases the analysis will rely on local arguments and goes as follows. Before period t = 0, the economy is assumed to be in a steady state with a positive rate of devaluation. Consumption and real money balances must satisfy

$$\frac{u_m(c_0, m_0)}{u_c(c_0, m_0)} = \theta + \pi \tag{23}$$

where π is the rate of devaluation (and inflation) before period zero and therefore $\theta + \pi$ is the initial steady state nominal interest rate. In the final steady state the ratio must be equal to the final nominal (and real) interest rate θ. Consider first the saddle-path stable model in Figure 3. Assume that the devaluation rate before fixing the exchange rate implies a steady state depicted by point E in Figure 3. Fixing the exchange rate implies a higher level of money balances for the same level of consumption, which shifts the locus $\dot{c}_t = 0$ to the right[20]. In order to reach the higher level of money balances, the economy must jump to the saddle-path, generating a current account surplus and increasing foreign reserves (point A, Figure 3). This is the same conclusion obtained by Calvo (1981) and for the same reason. The only way to increase monetary balances is by increasing the stock of foreign reserves. The difference with Calvo (1981) and the early literature on Monetary Approach to the Balance of Payments, as pointed out by Obstfeld (1986), is that foreign reserves yield the international interest rate, allowing residents a higher steady-state national income and consumption level. However, unlike this latter model, the balance of payments is not the only way to increase money balances. In this three-asset model, the government can provide, instantaneously, the higher level of money balances by an (instantaneous) expansionary open market operation. Note that near the steady state, and using the open-market operations condition d(DC/p) = –db, it can be verified that[21]

$$\frac{dc}{db} = \frac{u_{mm} - \theta u_{cm}}{-\theta u_{cc}} < 0 \tag{24}$$

Increasing DC/p and decreasing b in same magnitude move the locus $\dot{c}_t = 0$ to the left without affecting $\dot{w}_t = 0$. Hence, there exist a volumen of open market operations which would leave the economy at the same point E and a higher level of money balances. This disinflation policy is clearly pareto improving[22].

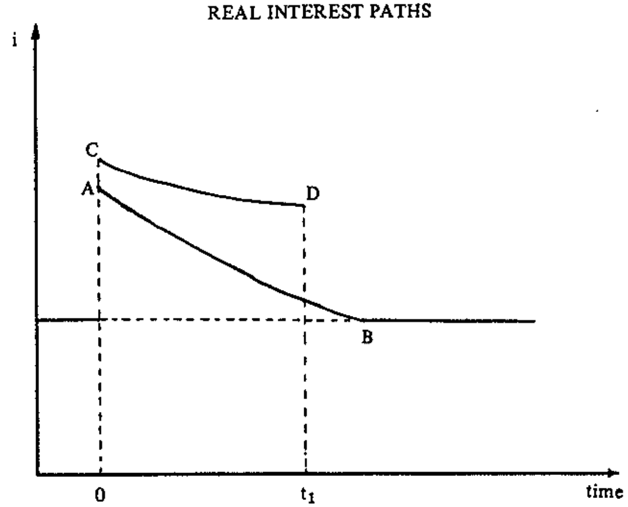
The path of the real interest rate implied by fixing the exchange rate (path AB in Figure 3) is depicted by path AB in Figure 4. The real interest rate must jump upward to clear the domestic money market. This can be verified easily from (9) when u_{cm} is negative. In point A (Figure 3), consumption and money balances are increasing, therefore, the left-hand side in (9) is negative. When u_{cm} is positive, however, we need to guarantee that the positive second term in the left-hand side of (9) does not offset the negative term. This happens to be the case when the system is saddle-path stable and the sub-utility function u(•) is strictly concave in both arguments. The discussion above is an implicit implication from both Calvo (1981) and Obstfeld (1986) and it is is summarized in the following proposition. The proof is relegated to Appendix B.

Proposition 1 (Calvo-Obstfeld) If there is no capital mobility, the system is saddle-path stable and the function $u(c_t, m_t)$ is strictly concave, then a balance of payment or current account surplus (deficit) is associated with a real domestic interest rate higher (lower) than the international interest rate.

Now assume that along with fixing the exchange rate, the monetary authority announces that the capital account will be liberalized at a date t_1. In this case, the same dynamic equations drive the system before that date. If the announcement occurs too early, the economy would reach the point B before that date and the optimum path would be along the saddle path AB. The announcement has no effect. If that is not the case, the economy would follow a path like CD in Figure 3, such that the point D is reached just at date t_1. This is the smoothest consumption path available to the individuals. At point D (date t_1) a swap ($\Delta m_t = -\Delta f_t$) takes place, whose magnitude moves back the locus $\dot{c}_t = 0$[23]. After the swap, the new locus $\dot{c}_t = 0$ goes through point D. The swap, of course, plunges the real interest rate to its long-run value θ (path CD in Figure 4). The

FIGURE 4

REAL INTEREST PATHS



anticipated opening of the capital account implies a smaller current account surplus during the transition (Figure 3). The effect of the announcement on the real interest rate is less obvious and it is summarized in the following proposition for the case of homothetic utility function.

Proposition 2 If u(•) is homothetic, an announcement of a full opening of the capital account for period t_1 implies a higher real interest rate "on impact" (at period 0^+) compared with no announcement. The closer t_1 to period 0, the bigger the impact of the announcement on the real interest rate.

An informal proof-by-picture follows. When the utility function is homothetic, for a given inflation rate the real interest rate depends directly on the ratio consumption-real money balances (equation 8). Because real money balances is a predetermined variable at period 0, the real interest rate is higher on impact the higher is consumptin on impact. With the help of Figure 3, the first part of proposition 2 follows. The second part of the proposition follows the fact that the shorter the period of capital controls the shorter the jump EC in Figure 3. Q.E.D.

The interest path CD in Figure 4 and the swap at the liberalization date are consistent with the plunge in real interest rate in Figure 2 and with the break in capital inflows trend in Figure 1 (both in April 1980). The current account effect, however, goes in the opposite direction. The purpose of the remaining of this section will be to compatibilize the high real interest rate and the current account deficit. Before that a theoretical digression is provided regarding the saddle-path stability condition.

Digression: A Solution to the Globally Unstable System

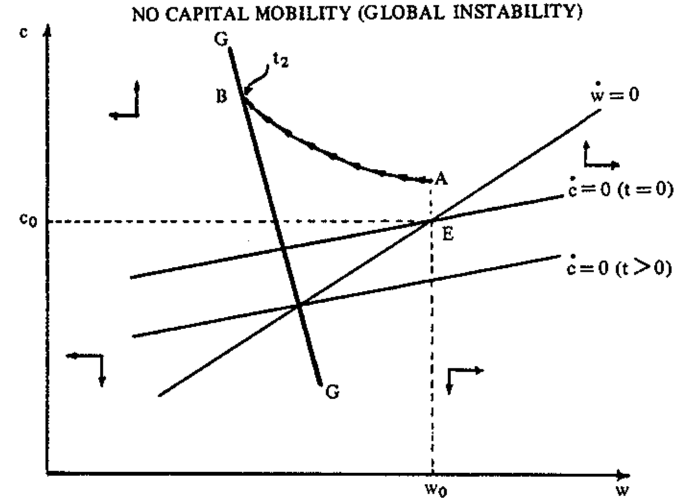
While the saddle-path stability is usually the case studied in the literature, nothing in the model itself can guarantee this assumption. This digression studies the consequences of fixing the exchange rate when the system exhibits global instability. This is the case

when inequality sign in (22) is reversed, an therefore the slope of the locus $\dot{w}_t = 0$ is bigger than the slope of the locus $\dot{c}_t = 0$. The exercise is depicted in Figure 5. Again, fixing the exchange rate moves locus $\dot{c}_t = 0$ to the right. Because w_t cannot jump, the system would be on a non-converging path. In this case, therefore, the policy is not long-run consistent unless the corresponding open market operation mentioned above is carried out. This complementary policy would move the locus $\dot{c}_t = 0$ back to its original position. The unstable system, therefore, imposes an additional constraint to the government's long-run-consistent policy space: the exchange rate policy and open market operation policy cannot be chosen independently. In other words, fixing the exchange rate and leaving the balance of payments alone to prove the desired money balances is inconsistent.

As shown by Drazen (1985) –in the context of Sargent-Wallace's "unpleasant arithmetic" debate–, systems with no saddle-path stability are still useful to study anticipated switches in policy. Suppose for a moment that the government does not carry out the necessary open market operation policy. The path chosen by the agents would depend on their expectations of future policy switches. Suppose individuals believe that at a certain date t_2 the government will have to stabilize the economy by changing the level of expenditure g. The locus GG, in Figure 5, is the locus of intersection of $\dot{c}_t = 0$ and $\dot{w}_t = 0$ (steady state equilibria) when g is varying[24]. The path chosen by individuals must reach the locus GG at date t_2 (path AB in Figure 5). In this example, an increasing and widening current account deficit occurs during the transition. The negative-sloped curve GG was chosen to set conditions about uniqueness. As an informal proof-by-picture about uniqueness consider the following reasoning. The length of the path AB in Figure 5 is a proxy for the "duration" of the transitional path. The negative-sloped GG curve together with the fact that two paths cannot cross each other implies that any initial "jump" shorter (longer) than EA in Figure 5 would reach the locus GG before (after) t_2. Hence, granted that no jump downward satisfies the same condition, the path AB is unique. This finishes the informal proof-by-picture about uniqueness.

FIGURE 5

NO CAPITAL MOBILITY (GLOBAL INSTABILITY)



The example above was not chosen because of its realism. It depends on decreasing the amount of resources the government is spending outside the private market (public goods?). The example, however, provides an extension to the type of reasoning which is the core of the balance-of-payments crisis approach. It is interesting to make a parallel between this case and the usual balance-of-payments crisis analysis. In the latter models, the government's inconsistent policy leads to a flow imbalance in its budget which prompts the crisis[25]. A collapsing exchange rate, therefore, is an alternative that provides the money seigniorage which closes the government's flow gap. In this model, however, the government's budget is balanced by definition. The inconsistent policy package of fixed exchange rate and capital control does not allow individuals to adjust instantaneously to the new portfolio equilibrium. The dynamics of the model prompts individuals to believe in a policy switch in the future.

Díaz-Alejandro (1985) suggests that the case of Chile does not fit into the usual balance-of-payment crisis approach as the government's budget was balanced according to the usual definitions. He mentioned the accumulation of "contingent claims" by the government originated from the belief in a general bailing out. In the example above the government implicitly bails the private sector out by permanently transferring the flow Δg_{t2}.

Dynamics under a Flow Constraint to Capital Inflows

In this part, the assumption of no capital mobility is relaxed and the constraint (4) to capital inflows is included. If constraint (4) is binding from period 0 to t_1, then, integrating (4), the variable f_t is predetermined and equal to

$$f_t = f_0 - \delta t \tag{25}$$

When (4) is binding, substituting (4) and (25) into (18) gives the motion for consumption. That motion is reproduced here, for convenience, as[26]

$$\dot{c}_t = \frac{1}{u_{cc}}[\theta u_c(c_t, w_t - b_0 + \delta t) - u_m(c_t, w_t - b_0 + \delta t)]$$

$$- \frac{u_{cm}}{u_{cc}}(c_t, w_t - b_0 + \delta t)\ [y - g - c_t + \theta w_t - \theta(b_0 - \frac{DC}{p}) + \delta] \tag{26}$$

Equation (26) is the motion of consumption when (4) is binding. At the steady state, however, $\dot{f}_t = 0$ and therefore the motion is recovered setting $\delta = 0$. This characteristic of the system obliges us to consider an additional switch of locus $\dot{c}_t = 0$ which comes up on impact when the system moves from a steady state to a transition path. From (26) this effect on impact can be characterized near the steady state by

$$\frac{dc}{d\delta} = \frac{u_{cm}}{\theta u_{cc}} \begin{cases} > 0 \text{ if } u_{cm} < 0 \\ = 0 \text{ if } u_{cm} = 0 \\ < 0 \text{ if } u_{cm} > 0 \end{cases} \tag{27}$$

On impact, therefore, locus $\dot{c}_t = 0$ switches to the left if $u_{cm} < 0$, to the right if $u_{cm} > 0$ and does not move if $u_{cm} = 0$.

Equation (16) still represents the motion for financial wealth.

Consider first the case of $u_{cm} < 0$ which seemingly is a better candidate to allow a current account deficit during the transition.

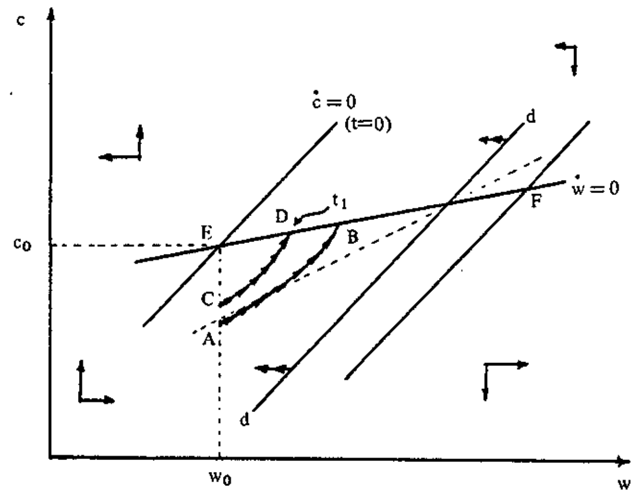
In Figure 6 and Figure 7 the dynamics of the system is analyzed when the exchange rate is fixed under the assumption of saddle-path stability. Consider first Figure 6. Assume again that the initial point is E. Fixing the exchange rate moves again locus $\dot{c}_t = 0$ to the right (say locus goes through F in Figure 6). The effect on impact (equation 27) moves the locus partially to the left and call this "transition" locus dd.

Now assume that the constraint to capital inflows is tight enough (δ is small enough) such that the locus dd is to the right of the original locus before disinflation. The dynamics is analogous to the no capital mobility studied above (Figure 3) and path AB and CD in Figure 6 represent again no announcement of opening and anticipated opening respectively. The only additional complication is due to the fact that the whole system is switching through time to the left. From (26), foreign assets, f_t, keep decreasing at the rate δ. Near the steady state

$$\frac{dc}{df} = \frac{u_{mm} - \theta u_{cm}}{-\theta u_{cc}} < 0 \tag{28}$$

FIGURE 6

TIGHT CONSTRAINT TO CAPITAL INFLOWS, $u_{cm} < 0$

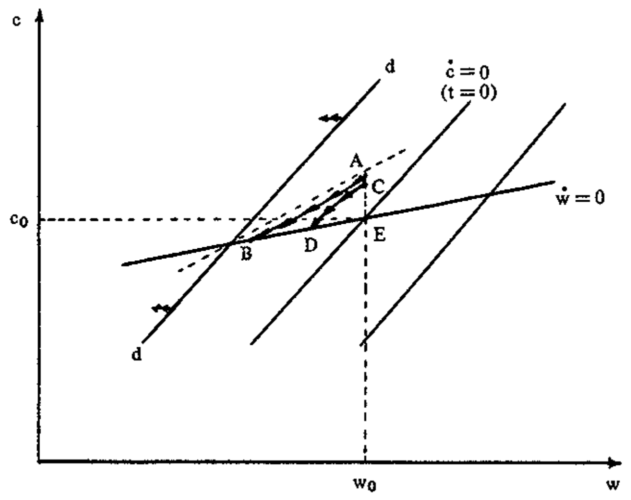


Through time therefore the whole system (saddle-path) is shifting to the left.

The initial jump EA goes slightly beyond the initial saddle-path for the following reason. At the new steady state, $\dot{f}_t = 0$ (4 is not binding at the steady state), therefore setting $\delta = 0$ moves the locus dd to the right. The relevant path (AB or CD) is chosen to

FIGURE 7

LOOSE CONSTRAINT TO CAPITAL INFLOWS, $u_{cm} < 0$



satisfy this condition. No significant gain is obtained with this case as the result is still a current account surplus. Note that the tighter the flow constraint is, the closer this case it to no-capital-mobility case (Figure 3).

Now assume that the flow constraint to capital inflows is loose enough, such that locus dd moves to the left beyond the original point E (Figure 7). By the same token, paths AB and CD correspond to the optimal paths under no announcement and announcement respectively. These case are very good candidates to explain the facts described in section 2. Take for instance the path CD in Figure 7. Here there is a high real interest rate, capital inflows, a current account deficit and accumulation of foreign reserves (increasing real money balances). At the anticipated liberalization date, the interest rate plunges and massive capital inflows are observed[27]. This account fits the Chilean experience.

The rationale is very intuitive. The traditional MABP with one asset requires a current account (balance of payments) surplus in order to increase money balances. When the capital account is allowed to be positive at some controlled level the current account can be in deficit and still the balance of payment of payments be in surplus, expanding money balances. The constraint to capital inflows can be tight enough to allow a differential between domestic and foreign real interest rates during the transition, but loose enough to allow a transition with a current account deficit.

The current account deficit in Figure 7 depends crucially on the structural "parameter" u_{cm} being negative. There is some debate in the literature on the Southern Cone experience regarding this cross derivative. Obstfeld (1985) needs this "parameter" to be negative in order to reproduce some stylized facts from Argentina and Uruguay in a perfectly credible model. Calvo (1986) requires this cross derivative to be positive when the disinflation is assumed temporary (non credible). In general, Feenstra (1986) showed that this cross derivative could be either positive or negative when we interpret the

money-in-the-utility-function as a reduced form of a general liquidity cost function. While the result of this section in theoretically interesting, evidence on the sign of this crucial parameter is necessary to evaluate its empirical relevandy. Our own empirical investigation (Arrau, 1989, ch. 2), although not fully conclusive, suggests that the cross-derivative would be positive for the Chilean economy, which casts doubts on the power of this model to explain the current account deficit in Chile.

3.2 Government Behavior 2: Closing the Model by Anticipated Switch in Policy

In this section I argue that dropping the assumption of endogenous transfers from the government (equation 12) and substituting it for a traditional balance of payments crisis alternative does not help much to understand the Chilean case. The reason, as we will see, is the evolution of the public, sector's assets position during this period.

As in Calvo (1987) or Drazen and Helpman (1987) the government accumulates net assets (liabilities) if the flow consolidated budget constraint is in surplus (deficit). The government flow budget constraint is

$$\dot{a}_t = \theta a_t + \dot{m}_t - i_t b_0 - g \qquad (29)$$

where a_t is the net foreign assets position of the consolidate government. The assumption of fixed domestic debt is kept here. The government is assumed to finance any budget deficit with additional foreign debt, therefore movements in m are solely associated with movements in foreign reserves held by the Central Bank $\dot{m}_t = \dot{r}_t$, obtaining the MABP[28]. The complication of this assumption is that now we have a third differential equation. The model must be solved analytically as we cannot use the phase diagramans.

The classical case is to analyze an initially inconsistent policy, where money seigniorage is needed in the long-run in order to finance g. In (32), therefore, even for $i_t = \theta$, the government is accumulating net debt indefinitely. This, of course, yields expectations about a policy switch in the future, which is the collapse date in the balance-of-payments crisis literature.

This is not a good starting point for the Chilean case as the budget was balanced in 1978 and there was no need for money seigniorage.

An alternative would be to consider the distortions of the capital control period and its effect on the government budget. The need to roll over the national debt at a high real interest rate between February 1978 and April 1980 may require some money seigniorage in 1980 that was not needed in 1978. A way to check this hypothesis is to look at the government's net asset position. The public (direct) foreign debt was reduced from 9.3% of GDP in 1978 to 3.6% in 1981. The national debt was reduced from 20.9% of GDP in 1978 to 9.5% in 1981[29]. This evidence suggests that, if any, there was a consolidate budget surplus rather them deficit[30].

In any case the model to be closed need to consider this policy switch in the future. If government is accumulating assets, the private sector should expect a positive transfer some day in the future. In general, if the government does not transfer the flow of surplus, this would imply an additional pressure to the domestic capital markets (interest rate) in order to smooth consumption during the period of capital controls. This is so because the total private wealth is not affected. The implications about the real interest rate and the swap at liberalization date would still hold.

4. Conclusions

The objective of this paper has been to explore the extent to which the modelling of the actual capital control policy in Chile (a flow constraint to capital movements) can shed light on the high real interest rate and the current account deficit observed when the nominal exchange rate was used for stabilization purposes. The paper studies dynamic transitions under perfect credibility of the policy and under balanced budget policy, which are reasonable assumptions for the period 1978-80 in Chile.

The combination of perfect capital mobility and fiscal deficit, preferred by the balance-of-payment crisis literature, seems appropriate for the case of Argentina and Uruguay but inappropriate for Chile. In the latter case, the fixed exchange rate does appear to be inconsistent with the fiscal situation.

The results can be summarized as follows.

(a) When the economy is disinflated by the use of the exchange rate and the economy is subject to a flow constraint to capital inflows, the results are similar to the no-capital-mobility case (Calvo, 1981; Obstfelf, 1986). The real interest rate jumps upward to balance the money market.

(b) We extend the above result in two directions. First we show that if the economic agents expect a liberalization of the capital account, the impact of the stabilization policy on the real interest rate is higher the closer is the liberalizaton date. Second, all real effects can be avoided if the authority complements the stabilization policy with expansionary open market operations, or what is the same, if the monetary authority targets the real domestic interest rate. If the relevant dynamic system is globally unstable, this complementary monetary policy is necessary for the stabilization policy to be consistent.

(c) Finally, we show that the possibility of a transition path with a high real interest rate and a current account deficit, which is not possible with full capital immobility, could arise under a flow constraint to capital inflows similar to the one applied in Chile. For this to happen, the flow constraint must be loose enough and the utility function's cross-derivative must be negative. While this result is theoretically interesting, its empirical relevance for the Chilean economy seems to be weak as the second condition is doubtful (Arrau, 1989, ch. 2). Optimizing models with one tradable good, certainty, credibility and capital controls are still unable to explain the current account behavior in Chile. Future research should explore the role of durable goods.

Notes

1 The literature was first developed by Krugman (1979) and Flood and Garber (1984) in the context of a rate for growth of money inconsistent with a fixed exchange rate. Applications to the Southern Cone stabilization programs are Calvo (1987) and Drazen and Helpman (1987).

2 Calvo (1981) and Obstfeld (1986).

3 The MABP was officially in application in the three countries. See Ardito-Barletta and others (1983).

4 Edwards and Edwards (1987).

5 The system, which made its debut in the Southern Cone experiments, is known as "tablita" or active crawling peg. Its purpose was to provide a longer horizon regarding the disinflation path.

6 A detailed description is in Ffrench-Davis and Arellano (1981).

7 The item called "Artículo 14" was the major source of foreign debt for the private sector and therefore for the country as a whole. Most of this debt was contracted through the intermediation of banks. See Edwards and Edwards (1987) and Ffrench-Davis and Arellano (1981).

8 The foreign money contracted through the "Artículo 14" could be lent to the private sector in home currency (documented in foreign currency). The banks, therefore, needed to sell the foreign currency to the central bank in order to do so. This swap was subjet to the flow constraint. Strictly speaking, this flow constraint or limit per month was 5% of the banks' equity. From December 1978, it was the biggest of 5% of the banks' equity or US$ 2 million.

9 The short-run rates are plotted on monthly basis and the medium-run rate is plotted on annual basis.

10 A flow demand for money would be the result of rapid income growth and a gradual disinflation.

11 At this date, presumably due to a risk premium over an expected discrete devaluation and a tightening of the credit supply from the international community, the interests rate rises again. The high-expectation-of-devaluation hypothesis after February 1981 is econometrically supported by Le Fort's (1985) research. Some results are reported in Edwards and Edwards (1987), pages 67-69).

12 The models is derived assuming no inflation as the exercise is fixing the exchange rate at period zero.

13 The transversality conditon will be satisfied if domestic interest rate converges to the fixed international interest rate and if the holdings of aggregate financial assets per capita also converge to some fixed number. This will be the case.

14 In Obstfeld (1986) this is the financial exchange rate. Here I assume that residents can not trade foreign currency by law.

15 Obsfeld (1986). The consequence of this assumption is that changes in money balances are solely due to the balance of payment. The Monetary Approach to the Balance of Payment was actually in application (see Ardito-Barletta and others, 1983 .

16 Full capital mobility is trivial. Fixing the exchange rate yields an instantaneous portfolio swap and has no real effect, although a gradual disinflation policy has (Obstfeld, 1985).

17 Obstfeld (1986) allows individuals to hold a fixed amount of foreign currency in order to study a dual exchange rate system.

18 Obstfeld (1986). The multiple steady states would be ruled out assuming $u(\cdot)$ is homothetic.

19 See first part of Appendix B for a proof.

20 Strictly speaking it can be verified that near the steady state, the shift of the locus $\dot{c}_t = 0$ is given by $dc/d\pi = -u_c/\theta u_{cc}$, which is grater than zero.

21 For u_{cm} positive the inequality in (24) is obvious. For u_{cm} negative, combining the saddle-path stability condition (22) and the condition for a strictly concave utility $(u_{mm}u_{cc} > (u_{cm})^2)$, it can be shown that the same is true. To see this use the former to substitute u_{cc} into the latter and take square root.

22 Previous policy change is not clearly pareto improvement due to the initial drop in consumption.

23 Formally the movement is analogous to open market operations. See equation (24).

24 The locus GG is negative-sloped when locus $\dot{c}_t = 0$ shifts upward in less proportion than locus $\dot{w}_t = 0$. That is when for the former one $0 > dc/dg = -u_{cm}/\theta u_{cc} > -1$. This implies that u_{cm} must be negative but close enough to 0.

25 Calvo (1987), Drazen and Helpman (1987).

26 Without loss of generality f_0 in (25) is set to 0.

27 The current account should balance at this date and this is not observed in Figure 2. An hypothesis to explore in the future in the role of durables. When foreign loans are fully available after April 1980, durable imports jump sharply until late 1981. This could explain a huge once and for all current account deficit as observed in Figure 2.

28 Drazen and Helpman (1987).

29 Financial Report of the Treasury, 1981.

30 Fiscal illusion (Auerbach and Kotlikoff, 1987, ch. 8) may arise from looking only the financial assets position of the government. The physical assets position of the government is worsening due to the selling off of public enterprises. The income from these operations is included as current income in the government's accounts.

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Appendix A: Individual Optimization

The problem is stated in a form similar to Drazen and Helpman (1987). It consists in maximizing (1) subject to (4), (6) and (7) with respect to the sequence $\{c_t, m_t, f_t, \dot{f}_t, \Delta f_{tj}\}$. Define A(t) as the set of all swap dates, t_j, which belong to the interval [0,t].

The Lagrangean is

$$L = \int_0^\infty u(c_t,m_t)e^{-\theta t}dt$$
$$+ \mu_0 \left[m_0 + b_0 + \int_0^\infty (y + \tau_t + \theta f_t - \dot{f}_t - c_t - i_t m_t)\, e^{-\int_0^t i_v dv} dt - \sum_{\forall t_j \in A(\infty)} \Delta f_{tj} e^{-\int_0^{t_j} i_v dv}\right] + \int_0^{t_1} \beta_t^* (\dot{f}_t + \delta)\, dt$$
$$+ \int_0^\infty \alpha_t \left(f_0 + \int_0^t \dot{f}_z dx + \sum_{\forall t_j \in A(\infty)} \Delta f_{tj} - f_t\right) dt \qquad (A.1)$$

where μ_0 is the lagrange multiplier of constraint (7), α_t of constraint (6) and β_t^* of constraint (4).

The first order conditions with respect to c_t, m_t, f_t, $\dot{f}_t$ and Δf_{tj} are, respectively, as follows.

For all $t \in [0, \infty)$

$$u_c = \mu_0 e^{(\theta t - \int_0^t i_v dv)} \qquad (A.2)$$

$$u_m = i_t \mu_0 e^{(\theta t - \int_0^t i_v dv)} \qquad (A.3)$$

$$\alpha_t = \mu_0 \theta e^{(-\int_0^t i_v dv)} \qquad (A.4)$$

$$\int_t^\infty \alpha_x dx + \beta_t^* = \mu_0 e^{(-\int_0^t i_v dv)} \qquad (A.5)$$

and for all $t_j \in A(\infty)$

$$\int_{t_j}^\infty \alpha_x dx = \mu_0 e^{(-\int_0^{t_j} i_v dv)} \qquad (A.6)$$

For all $t \in [0, t_1)$, the Kuhn-Tucker condition

$$\beta_t^* (\dot{f}_t + \delta) = 0 \qquad (A.7)$$

must be satisfied.

Equation (8) in the text is obtained by dividing (A.3) by (A.2). Equation (9) in the text is obtained by differentiating (A.2) with respect to time and substituting (A.2) and (A.3) into that result.

Finally equation (10) is obtained as follows. First we define

$$\beta_t = \frac{\beta_t^* e^{\int_0^t i_v dv}}{\mu_0} \qquad (A.8)$$

which can be interpreted as the current-and-dollar-valued lagrange multiplier for constraint (4), or simply, the shadow price of (4). Now substitute (A.4) into (A.5) (eliminating α_t), and after some manipulation using (A.8), expression (10) in the text follows.

Finally comparing (A.5) and (A.6) it can be seen that portfolio adjustment (swap) at liberalization date t_1 must be such that equation (4) is no longer binding ($\beta_t = \beta_t^* = 0$).

Appendix B: Proof of Proposition 1

The proof follows the lines from Obstfeld (1986), pages 17-19. It shows that if the system is saddle-path stable, it is along the saddle-path, the current accounts is in surplus (deficit), there is no capital mobility and the function $u(c_t, m_t)$ is strictly concave, then $i_t > \theta$ ($i_t < \theta$).

The system with no capital mobility can be expressed linearized around the steady state $\{\bar{c}, \bar{m}\}$ as

$$\begin{pmatrix} \dot{m}_t \\ \dot{c}_t \end{pmatrix} = \begin{pmatrix} \theta & -1 \\ -\sqrt{\frac{u_{mm}}{u_{cc}}} & \theta \end{pmatrix} \begin{pmatrix} m_t - \bar{m} \\ c_t - \bar{c} \end{pmatrix} \qquad (B.1)$$

The eigenvalues are $\theta - \sqrt{u_{mm}/u_{cc}}$ and $\theta + \sqrt{u_{mm}/u_{cc}}$. The latter is positive and the former must be negative in order to have a saddle-path stable system. This condition is expressed as (22) in the text. Define this negative eigenvalue as ϵ. The corresponding eigenvector is $(1, \sqrt{u_{mm}/u_{cc}})$. The solution of the system, therefore is

$$m_t - \bar{m} = (m_o - \bar{m})\, e^{\epsilon t} \qquad (B.2)$$

$$c_t - \bar{c} = \sqrt{\frac{u_{mm}}{u_{cc}}}\,(m_o - \bar{m})\, e^{\epsilon t} \qquad (B.3)$$

Combining (B.2) and (B.3) and differentiating, it can be shown that along the (linearized) saddle-path the relation

$$\dot{c}_t = \sqrt{\frac{u_{mm}}{u_{cc}}}\,\dot{m}_t \qquad (B.4)$$

must be satisfied.

Equation (B.4) is a condition for convergency. It says that if the current account is in surplus ($\dot{m}_t > 0$), absorption (consumption) must increase fast enough to catch up the national income (also increasing) and shrink the current account surplus.

Substituting (B.4) in (11) we have

$$\left(u_{cc}\sqrt{\frac{u_{mm}}{u_{cc}}} + u_{cm}\right)\dot{m}_t = u_c(\theta - i_t) \qquad (B.5)$$

or

$$\left(-\sqrt{u_{mm}u_{cc}} + u_{cm}\right)\dot{m}_t = u_c(\theta - i_t) \qquad (B.6)$$

However when $u(\bullet)$ is strictly concave we have $u_{cc}u_{mm} - (u_{cm})^2 > 0$, which implies that the term in parentesis at left-hand side of (B.6) must be negative and $i_t > \theta$. For current account deficit ($\dot{m}_t < 0$), of course, $i_t < \theta$ Q.E.D.

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FACTORES ESTRUCTURALES Y CICLICOS Y LA COMPOSICION DEL DESEMPLEO ABIERTO EN CHILE

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Abstract:

Unexistence of a inverse relationship between unemployment level and the observed wage changes has been empirically detected in the Chilean case. In this regard, the paper points out the need of distinguishing between structural and cyclical components of the total open unemployment. The structural unemployment is determined by the existence of market imperfections, and it is likely not to be an important factor in affecting market wages. Hence, based upon a segmented labor market model –in which the presence of segmentation is due to labor market distortions– empirical estimates of the cyclical and structural components of the total unemployment are obtained. Subsequently, the paper shows that a regression between observed wage changes and the level of cyclical unemployment produces the expected negative correlation. The conclusion point outs that the distinction between unemployment components is paramount to understand the dynamics of the labor market.

1. Introducción

La preocupación profesional por los problemas vinculados al ajuste macroeconómico ha conllevado una creciente atención sobre los mecanismos de respuesta del mercado del trabajo a políticas tradicionales de tipo agregado. Flexibilidad en salarios reales y en el empleo son considerados factores claves para obtener un traslado de trabajadores desde la producción de no transables a la de transables, como se busca por medio de la combina-

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