

Financial liberalization and adjustment: the cases of Chile and New Zealand

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This paper analyzes macrodynamic adjustments during financial liberalization in Chile and New Zealand. During the adjustment to more open capital accounts in the late 1970s or mid-1980s, both countries experienced a real exchange rate appreciation and a collapse of net exports, while domestic interest rates slowly converged to international levels.

This paper develops and estimates a two-sector dynamic model with current and time-varying parameter techniques. The domestic interest rate is relatively more responsive to shocks under imperfect capital mobility, while the real exchange rate becomes more responsive under perfect mobility. Therefore, capital account liberalization does not eliminate, but rather shifts, volatility from the domestic interest rate to the real exchange rate. (JEL E65, F33).

Significant fluctuations of foreign credit flows, domestic interest rates and real exchange rates affected most financially semi-open economies in recent years. Especially affected were those Southern hemisphere countries which rapidly liberalized their capital accounts, overborrowed, and then experienced a foreign credit squeeze.

Chile and New Zealand, far apart geographically, are small primary producers which were long isolated from international financial markets. Both countries followed a similar pattern of adjustment following rapid financial liberalization.

* Financial support by the Instituto Interamericano de Mercados de Capital and the Fulbright Commission of New Zealand is acknowledged. Our thanks go to Hector Hernandez and Brendan O'Donovan for able research assistance, and to John Cuddington, David Giles, Judith Giles, James Hanson, Felipe Morande, the late Bela Balassa, and anonymous referees for valuable comments. Earlier versions of this paper were presented at the VII Latin American Regional Meeting of the Econometric Society, Costa Rica, August 1988, as well as at Canterbury University, Christchurch, Victoria University of Wellington, and the New Zealand Institute of Economic Research.

Initial overborrowing and real exchange rate overappreciation led to a loss of competitiveness and ultimately a balance of payments crisis, followed by protracted stagnation and real exchange rate depreciation.

Domestic interest rates did not converge rapidly to covered world interest rates following liberalization of capital markets. This slow convergence posed severe problems. With interest rates remaining high during the liberalization process, and imports becoming relatively cheap, domestic producers faced a credit squeeze at the worst possible time.

In Chile, the nominal exchange rate was fixed during the period of financial liberalization (1979–82), followed by discreet devaluations, a brief float, and an active crawl in the wake of the 1982–83 financial crisis and recession.¹

Several studies have analyzed interest rate adjustment in Chile. Corbo and Matte (1984) estimated a simple portfolio adjustment model. The offset coefficient for Chile was less than minus one, implying less than perfect capital mobility, despite the liberalization policies. Edwards (1985), on the other hand, defined a 'semi-open' economy as one in which the interest rate depends on both domestic credit conditions as well as on covered foreign interest rates. With standard econometric techniques, he found Chile (as well as Colombia) to be financially semi-open, and not open (in which case only covered foreign interest rates matter). Valdes-Prieto (1992) reviews Chilean capital-account liberalization, concluding that both its timing and intensity were beneficial to the country, in spite of the costs of overborrowing due to inadequate banking supervision before 1983.

The New Zealand experience of liberalization and reform came much later than the Chilean experience. As well as similarities, there are some important differences from the Chilean adjustment. The debt that was accumulated in New Zealand was mostly private debt, and never was assumed by the government, as in Chile, followed by the financial crises in 1982. There was no high inflation problem, comparable to Chile, although a reduction of inflation rates from double-digit levels was a goal of the reforms set in place in 1985. The nominal exchange rate was floated after liberalization, but in 1988, the Reserve Bank changed the emphasis of monetary policy to greater exchange rate stability.²

We develop a two-sector model for current and capital-account interaction during financial liberalization. It yields the dynamic relations between foreign debt accumulation, the real exchange rate and domestic interest rate adjustment (when all three variables are endogenous) under imperfect asset substitutability and imperfect capital mobility. With regard to trade in goods and non-financial services, different degrees of openness are consistent with this general framework. We wish to explain the sharp fluctuations in domestic interest rates, real exchange rates, and capital inflows following financial liberalization. In particular, we wish to show that during the process of financial liberalization, the responsiveness of the domestic interest rate to underlying domestic variables diminishes over time, as it slowly converges to the covered world interest rate, while the real exchange rate becomes increasingly more responsive to domestic variables.^{3,4}

Our starting point is Dornbusch and Fischer (1980). However, rather than following a national/foreign goods dichotomy, we define the real exchange rate as the relative price in a traded/non-traded goods model. In addition to the two assets in the Dornbusch–Fischer model, money and foreign bonds, we also introduce a third asset, domestic bonds, which enables us to model imperfect asset substitutability and imperfect capital mobility. We assume imperfect capital

mobility in response to domestically imposed restrictions on flows or on holdings of foreign capital or debt. Imperfect capital mobility thus allows for short-run deviations of domestic interest rates from their long-run equilibrium levels. Because of additional imperfect asset substitutability, stationary equilibrium interest rates also deviate from values under perfect arbitrage.

Kouri and Porter (1974) have used a portfolio model in which domestic and foreign assets are imperfect substitutes. There are two differences between our portfolio model and theirs. We model explicitly the variables which are behind imperfect substitutability between domestic and foreign bonds and we distinguish between instantaneous and long-run asset market equilibria.

In our dependent-economy specification the current account is determined by the excess of income over absorption. We assume that the nominal exchange rate is controlled by the government and is subject to discreet or continuous changes or even to fixed exchange-rate periods. While this assumption does not fit strictly the New Zealand experience for the first three years following liberalization (1985–88), it does apply to the New Zealand case from 1975–85 and from 1988 to the present. Furthermore, greater real exchange rate volatility under flexible exchange rates with capital mobility is an implication of nominal exchange rate overshooting explored by Dornbusch (1976). While the model can be recast for the case of flexible exchange rates, the propositions we derive for real exchange rate and interest rate behavior are valid for both a fixed and flexible exchange rate regime.

In the next section we present the model, for the benchmark case of perfect capital mobility. In Section II we study the dynamics of the real exchange rate, capital inflows, and domestic interest rates under imperfect capital mobility. In Section III we present the results of an empirical analysis—using time-varying parameter methods—of the real exchange rate, the interest rate, net exports, and foreign reserves for both countries. The Chilean period covers the 1975–82 bust-boom-bust years of financial liberalization and high foreign debt accumulation, while the New Zealand analysis spans 1975 to 1991, with financial liberalization, real exchange rate appreciation, and output stagnation beginning in 1985.

I. General equilibrium under imperfect asset substitutability and perfect capital mobility

Our model specifies asset and goods markets equilibrium conditions, and under capital mobility spells out the dynamics of foreign asset accumulation. From this, we derive dynamic equilibrium conditions for foreign asset accumulation and the real exchange rate. Although inflationary and exchange rate devaluation expectations appear in the model, they do so in order to define real interest rates and arbitrage levels of international interest rates. We make no assumptions about expectations mechanisms, since we do not analyze continued exogenous nominal exchange-rate changes nor changes in long-run inflation rates.

I.A. Asset markets equilibria and wealth

Total private domestic wealth (w) is composed of financial wealth (w_f) and real wealth (w_r). Financial wealth is the sum of three outside assets in private hands:

domestic money (M), domestic government bonds (B) and foreign assets (F), each of them deflated by the domestic price index (Q).

Continuous asset market clearing ensures that real asset demands L , BD and FD equate actual real asset holdings at equilibrium returns. The signs of the partial derivatives of each variable in the equations appear in brackets below the corresponding functions. The three demand functions have the following form:

$$\begin{aligned} \langle 1 \rangle \quad M/Q &= L(i, i^* + \mu LR + \hat{E}^e + \Phi, y, wf) \\ &\quad [-, \quad -, \quad +, +] \\ \langle 2 \rangle \quad B/Q &= BD(i, i^* + \mu LR + \hat{E}^e + \Phi, y, wf) \\ &\quad [+ , \quad -, \quad ?, +] \\ \langle 3 \rangle \quad EF/Q &= FD(i, i^* + \mu LR + \hat{E}^e + \Phi, y, wf) \\ &\quad [-, \quad +, \quad ?, +] \end{aligned}$$

where i and i^* are the nominal domestic and foreign interest rates, respectively, LR is a variable measuring legal restrictions imposed on capital flows, μ is the corresponding non-negative coefficient, E is the nominal exchange rate (units of domestic currency per unit of foreign currency), \hat{E}^e is the expected rate of devaluation, Φ is a risk-premium parameter, and y is current real disposable income.

Legal restrictions can be established by domestic authorities on foreign asset or liability holdings, and/or on flows of foreign assets or liabilities. Restrictions on stock holdings of foreign assets or liabilities affect the LR variable influencing asset demands in equations $\langle 1 \rangle$ to $\langle 3 \rangle$, even in the case of perfect capital mobility. But capital mobility is mainly impaired by restrictions on capital flows, which are introduced in the following section. For the purpose of our analysis the variable LR captures the extent of restrictions on both foreign capital holdings and flows. In our model, financial liberalization means a reduction in the foreign transactions costs of domestic bonds as well as a reduction in domestic transaction costs of foreign bonds.⁵

Domestic and foreign assets also are imperfect substitutes because of a second variable, the risk premium on domestic assets. In Section II we define Φ as a function of the foreign position. The domestic-foreign interest spread thus depends on foreign asset holdings.

Finally, the domestic interest rate could differ in the short run from its long-run (imperfect) arbitrage value, represented by the second argument in the preceding equations, because of imperfect or slow capital mobility. This is the case modeled in Section II. Here we assume the benchmark case of perfect capital mobility with imperfect arbitrage.

Consistent with the above equations, total financial wealth must satisfy the following adding-up constraint:

$$\langle 4 \rangle \quad wf = [M + B + EF]/Q,$$

where Q is the price deflator defined as a weighted average of domestic traded (P_T) and non-traded (P_N) goods prices:

$$\langle 5 \rangle \quad Q = P_T^{(1-\alpha)} P_N^\alpha,$$

where α is the share of non-traded goods in the price deflator.

Assuming that purchasing-power parity holds continuously, for domestic traded goods prices ($P_T = EP^*$, with internationally-traded goods prices denoted by P^*), and defining the real exchange rate p as the ratio of domestic traded and non-traded goods prices, the effective exchange rate, E/Q , is given by the following function of the real exchange rate:

$$\langle 6 \rangle \quad E/Q = p^\alpha / P^*.$$

Total real wealth of the private sector is the valuation of current and future income streams adjusted by changes in the terms of trade. With the domestic price index Q as the numeraire, real wealth depends on the domestic (*ex ante*) real rate of interest, permanent income (yp) and the terms of trade (tt):

$$\langle 7 \rangle \quad wr = wr(i - \pi^e, yp, tt),$$

$$[-, +, +]$$

where π^e is the expected rate of domestic inflation.

Combining equations $\langle 4 \rangle$ and $\langle 7 \rangle$ and using $\langle 6 \rangle$, we obtain the following function for total wealth:

$$\langle 8 \rangle \quad w = [M + B + EF]/Q + wr(i - \pi^e, yp, tt)$$

$$= w(M, B, p, f, i - \pi^e, yp, tt).$$

$$[+, +, +, +, -, +, +]$$

In this equation, real asset holdings M/Q and B/Q are replaced by a function which separate the influence of nominal holdings and the real exchange rate,⁶ and f represents the value of foreign assets in real domestic-currency units. Hence, $f = EF/Q$.

I.B. Goods markets equilibria in a dependent economy

In a two-sector dependent economy, the real exchange rate (and the absolute non-traded goods price) is determined by the following equilibrium condition for non-traded goods:

$$\langle 9 \rangle \quad y_N(p) = c_N[p, w(f, i - \pi^e, p, yp, tt), i - \pi^e] + j_N(p, i - \pi^e) + g,$$

$$[-] \quad [+, +, +, -, +, +, +, ?] \quad [+, -]$$

where sub-index i ($i = N$ for non-traded goods in equation $\langle 9 \rangle$, T for traded goods in equation $\langle 10 \rangle$ below) denotes the goods sector, y_i is sectoral output supply, c_i is sector consumption demand, j_i is sector investment demand, π^e is traded and non-traded sector expected inflation, and g is public consumption, falling entirely on non-traded goods.

Sector supply and demand equilibrium functions appearing in equation $\langle 9 \rangle$ are consistent with intertemporal optimization, although we do not explicitly derive them from an optimization program.⁷ Non-traded consumption depends positively on the real exchange rate and on private wealth, and ambiguously on the real rate of interest, while investment in non-traded goods depends positively on the real exchange rate and negatively on the real interest.^{8,9}

The trade surplus (or net exports) in quantity terms is determined by the excess

supply of traded goods:

$$\langle 10 \rangle \quad NX = y_T(p) - c_T(p, w(f, i - \pi^e, p, yp, tt), i - \pi^e) - j_T(p, i - \pi^e).$$

[+] [-, +, +, -, +, +, +, ?] [-, -]

Since the real exchange rate comes from the non-traded market clearing condition, we solve equation $\langle 9 \rangle$ for the following real exchange rate equation:

$$\langle 9' \rangle \quad p = p(f, i - \pi^e, yp, g, tt).$$

[-, +, -, -, -]

Collecting terms in equation $\langle 10 \rangle$, we derive the following function for quantum net exports or the trade balance:¹⁰

$$\langle 10' \rangle \quad NX = NX(p, w(f, i - \pi^e, p, yp, tt), i - \pi^e).$$

[+, -, +, -, +, +, +, +]

I.C. Foreign sector equilibrium

Foreign asset accumulation satisfies the following balance of payments identity defined in terms of foreign currency:

$$\langle 11 \rangle \quad \dot{F} = P^*NX(p, w(f, i - \pi^e, p, yp, tt), i - \pi^e) + i^*(F + R) - \dot{R},$$

[+, -, +, -, +, +, + +]

where R measures international reserves in units of foreign currency.

Multiplying equation $\langle 11 \rangle$ by E/Q , we obtain the balance of payments restriction in real domestic currency units. By an appropriate substitution, we transform equation $\langle 11 \rangle$ into an equation describing the accumulation of foreign assets defined in terms of real domestic currency units:

$$\langle 11' \rangle \quad \dot{f} = p^*NX(p, w(f, i - \pi^e, p, yp, tt), i - \pi^e) + (i^* + \hat{E}^e - \pi^e)(f + r) - \dot{r},$$

[+, -, +, -, +, +, + +]

where r measures the stock of international reserves in real domestic currency units and \hat{E}^e is the expected rate of devaluation.

I.D. General equilibrium

Domestic financial markets (for money and government bonds) clear instantaneously. We assume perfect capital mobility, implying an infinite velocity of international capital flows in response to foreign-domestic interest differentials. The interest arbitrage condition holds continuously for given levels of devaluation expectations, legal restrictions and country risk. We call this the imperfect arbitrage condition:

$$\langle 12 \rangle \quad i = i^* + \hat{E}^e + \mu LR + \Phi.$$

The dynamic paths of foreign assets and the real exchange rate appear in Figure 1. The phase diagram is based on equations $\langle 9' \rangle$ and $\langle 11' \rangle$. The NN schedule represents in $(f-p)$ space continuous non-traded goods market clearing equation $\langle 9' \rangle$. Appendix 1 shows that the NN curve is unambiguously downward sloping, because higher foreign assets have a positive wealth effect on consumption

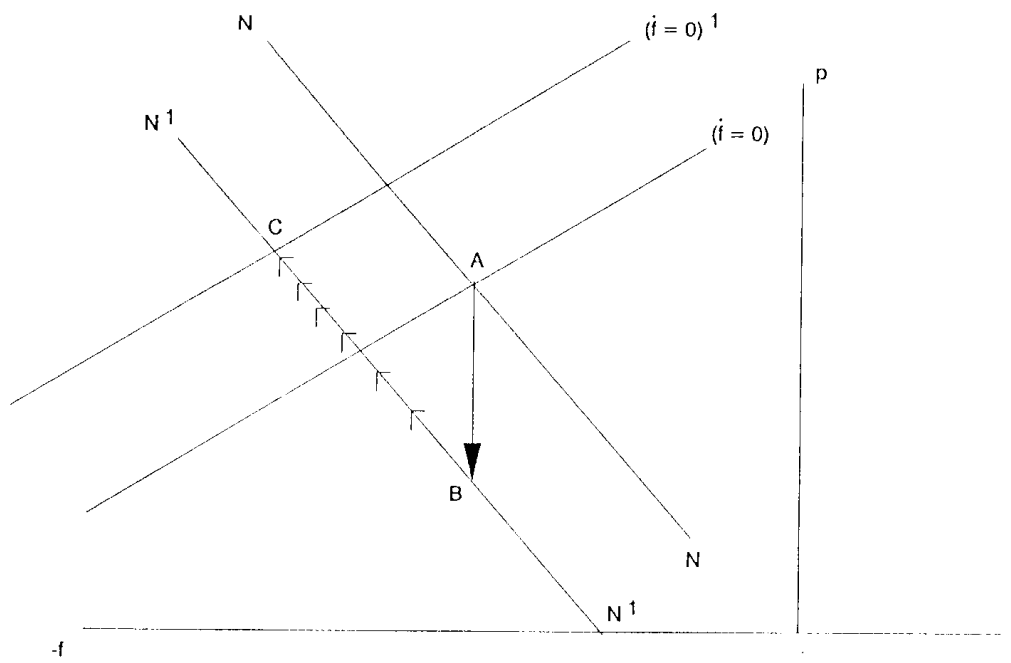


FIGURE 1. Real exchange rate and foreign asset dynamics under perfect capital mobility.

which lowers the equilibrium real exchange rate. Imposing the steady state equilibrium condition on equation $(11')$, we obtain the $(\dot{f} = 0)$ schedule in Figure 1. Its slope is ambiguous and depends on the current account consequences of the wealth effect on consumption relative to the debt-servicing effects when foreign assets increase. Assuming the wealth effect dominates, the $(\dot{f} = 0)$ schedule has a positive slope. We show this in Appendix 1.

Dynamic adjustment takes place along the NN schedule. Steady-state equilibrium is reached when the increase in foreign debt stops: such as at the international dynamic equilibrium position at point A .

An increase in permanent income raises consumption of both traded and non-traded goods, and forces a leftward shift of both the NN and the $(\dot{f} = 0)$ curves in Figure 1. The impact effect of higher spending is an appreciation of the real exchange rate. The effect depends only on the size of the increase in yp and on the elasticity of the excess supply of non-traded goods with respect to real exchange rate. Dynamic adjustment along the N^1N^1 schedule shows simultaneous real exchange rate depreciation and foreign debt accumulation. The final effect on p is ambiguous, depending on the value of final wealth resulting from higher levels of permanent income and of foreign debt, as combined to initial stationary wealth. If initial and final wealth levels coincide, the real exchange rate returns to its initial value.¹¹

II. Capital flows and domestic adjustment under imperfect capital mobility

Under imperfect international capital mobility, domestic interest rates temporarily deviate from their international imperfect arbitrage levels. Domestic interest rates adjust to continuous short-run money and domestic bond market equilibrium

conditions, although incentives for changing the portfolio composition remain as long as the imperfect arbitrage condition given by equation <12> is not met. This occurs because domestic asset holders cannot quickly change their portfolio compositions by buying or selling foreign assets because of domestic legal restrictions imposed on foreign capital flows.

To derive the behavior of interest rates and international reserves under imperfect capital mobility, we focus on the monetary flow equilibrium condition, which equates constant-price flow supply and demand:

$$\langle 13 \rangle \quad (\dot{M}/Q) = \dot{L}.$$

Money supply is increased by accumulating domestic credit and international reserves. Asset holders adjust their monetary balances over time in response to the difference between desired and actual holdings. They do this by exchanging international reserves for foreign assets at a speed β times the gap between desired and effective monetary holdings. Hence flow monetary equilibrium relates reserve accumulation and monetary flow demand as follows:

$$\langle 13' \rangle \quad (E\dot{R}/Q) + (\dot{C}/Q) = \beta[L^D - (M/Q)] + (\dot{C}/Q),$$

where L^D is desired or long-run real money holdings under conditions of imperfect interest arbitrage, β is the speed of adjustment coefficient, and (C/Q) is the stock of real domestic credit on the central bank.

Excess demand of money causes domestic interest rates to increase instantly (and domestic bond prices to fall). Asset holders accumulate cash balances by turning to international credit markets, where they sell foreign assets (or accumulate debt) and change the proceeds at the domestic central bank for domestic currency. Through this sluggish monetary adjustment process, domestic interest rates come down and cash balances increase until stationary monetary equilibrium is reestablished.

The difference between the short-run interest rate and its long-run arbitrage level depends only on the partial derivative of the money demand with respect to the domestic interest rate.

The speed with which asset holders accumulate money balances depends on the legal restrictions which regulate the flows or acquisitions of foreign assets or liabilities. Hence β is a negative function of the legal restrictions variable LR :

$$\langle 15 \rangle \quad \beta = \beta(LR). \\ [-]$$

The country-risk parameter Φ depends negatively on the stock of foreign assets or liabilities, a frequently used indicator for a country's foreign position for a given GDP level:

$$\langle 16 \rangle \quad \Phi = \Phi(f). \\ [-]$$

This function could be either continuously differentiable or could have a kink at a critical value of the stock of foreign debt.

After substitution and use of desired and actual domestic money stocks L^D and L , we obtain the following equation for the change in international reserves

at constant prices:

$$\begin{aligned} \langle 17 \rangle \quad \dot{r} = & \beta(LR)[L^D(i = i^* + \mu LR + \hat{E}^e + \Phi(f), i^* + \mu LR + \hat{E}^e + \Phi(f), y, wf) \\ & [-] \quad [\quad \quad \quad -, \quad \quad \quad -, \quad \quad \quad +, +] \\ & -L(i, i^* + \mu LR + \hat{E}^e + \Phi(f), y, wf)]. \\ & [-, \quad \quad \quad -, \quad \quad \quad +, +] \end{aligned}$$

We substitute the equilibrium real exchange rate (equation <9'>) and the foreign-reserve accumulation (equation <17>) into equation <11>, to obtain the following equation for foreign asset accumulation under imperfect capital mobility:

$$\begin{aligned} \langle 18 \rangle \quad \dot{f} = & [p(f, i - \pi^e, yp, g, tt)]^z NX(f, i - \pi^e, yp, g, tt) \\ & [-, +, -, -, -] \quad [-, +, -, -, -] \\ & + (i^* + \hat{E}^e - \pi^e)(f + r) \\ & - \beta(LR)[L^D(i = i^* + \mu LR + \hat{E}^e + \Phi(f), i^* + \mu LR + \hat{E}^e + \Phi(f), y, wf(f)) \\ & \quad [\quad \quad \quad -, \quad \quad \quad -, \quad \quad \quad +, +, +] \\ & -L(i, i^* + \mu LR + \hat{E}^e + \Phi(f), y, wf(f))]. \\ & [-, \quad \quad \quad -, \quad \quad \quad +, +, +] \end{aligned}$$

In equation <18> β plays the role of the offset coefficient first presented by Kouri and Porter (1974), which measures the effect of an increase in domestic credit on foreign asset accumulation. But there are two important differences between our framework and the Kouri and Porter model. We specify the variables explaining imperfect substitution (LR and Φ), and we distinguish between instantaneous and long-run equilibria in asset markets. Our offset coefficient depends explicitly on the variable determining imperfect capital mobility (LR), and not on the magnitude of the interest elasticities of asset demands, as in their model.

Substitution of Φ from equation <16> into <18> reinforces the negative effect of f on foreign asset accumulation. We already assumed this when we postulated the dominance of the wealth effect over the interest effect when f increases.

On the other hand, foreign asset accumulation in equation <18> depends ambiguously on the domestic interest rate. A rise in i increases net exports but also induces a higher foreign reserve accumulation as asset holders build up cash balances in response to their excess demand for money. If the latter effect dominates, \dot{f} falls with the interest rate.¹² This is the case reflected by the negatively sloped ($\dot{f} = 0$) schedule in Figure 2, which shows steady-state foreign asset equilibrium under imperfect capital mobility in ($f-i$) space.

What about instantaneous or short-run equilibrium in the domestic money market? From equation <1>, after substitution of Q from equation <6> and p from equation <9>, we obtain the following expression for i in terms of the determinants of stock supply and current (not desired) stock demand:

$$\begin{aligned} \langle 19 \rangle \quad i = & i((M/EP^*), \pi^e, f, yp, g, tt, i^* + \mu LR + \hat{E}^e + \Phi(f), y). \\ & [\quad -, \quad +, +, +, +, +, \quad \quad \quad -, \quad \quad \quad +] \end{aligned}$$

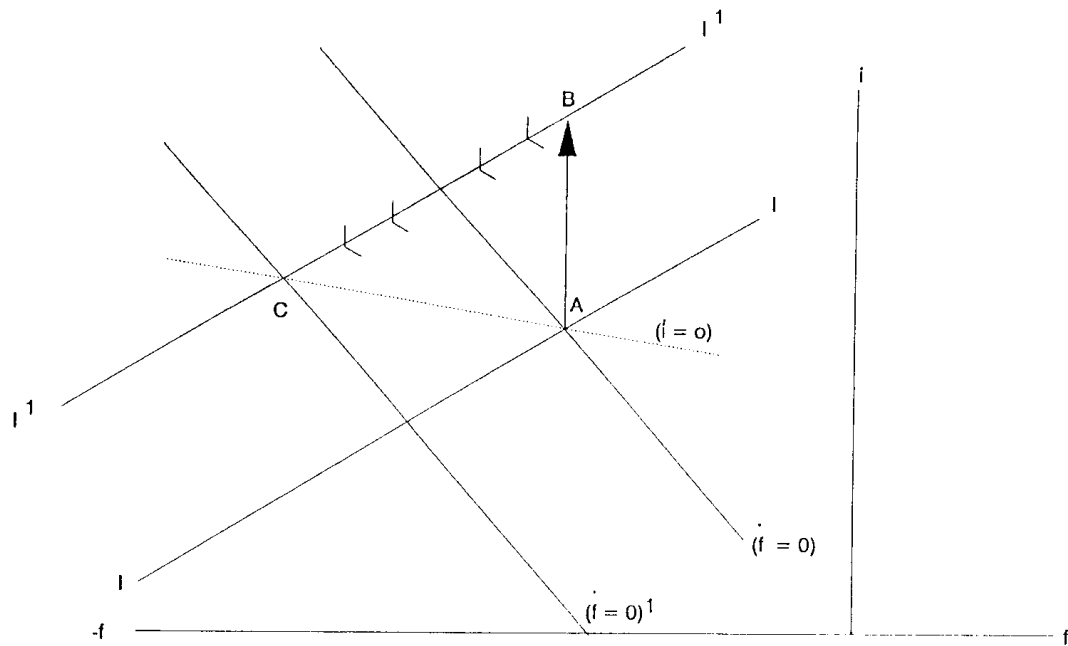


FIGURE 2. Domestic interest rate and foreign asset dynamics under imperfect capital mobility.

The II curve in Figure 2 represents the unambiguously positive relation between i and f in equation <19>. Adjustment takes place on this curve after a disturbance to the dynamic system given by equations <18> and <19>.

Long-term or stationary equilibrium is reestablished when domestic interest rates reach imperfect arbitrage levels determined by stationary values consistent with equation <12>. The adjustment equation for domestic interest rates is derived from the relation between money demand and the interest rate in equation <20>, where ε is the partial derivative of money demand with respect to the interest rate:

$$\langle 20 \rangle \quad \dot{L} = \varepsilon \dot{i} = \beta(LR)[L^D - L].$$

With further substitution, the adjustment of domestic interest rates is given by the following equation:

$$\langle 21 \rangle \quad \dot{i} = [\beta([LR]/\varepsilon)][L^D(i = i^* + \mu LR + \hat{E}^e + \Phi(f), i^* + \mu LR + \hat{E}^e + \Phi(f), y, wf(f)) - L(i, i^* + \mu LR + \hat{E}^e + \Phi(f), y, wf(f))].$$

$[-] \quad [\quad - , \quad - , \quad + , + , +]$
 $[- , \quad - , \quad + , + , +]$

From equation <21> the steady-state condition ($\dot{i} = 0$) is reached when domestic interest rates converge to their parity levels determined by equation <12>. The ($\dot{i} = 0$) curve in Figure 2, negatively sloped since Φ is negatively related to f , thus coincides with the imperfect arbitrage condition. This curve also represents the foreign credit supply schedule which relates higher foreign debt levels to higher credit costs.

An increase in permanent income causes leftward shifts of both the ($i = 0$) and the II curves. The impact effect is a real exchange rate appreciation and an increase in the domestic interest rate, as shown in Figure 2. Then foreign debt is accumulated, the real exchange rate depreciates and the domestic interest rate falls as adjustment continues on the $I^1 I^1$ curve toward the final steady state at point C in Figure 2.

This adjustment process is quite different from the corresponding one under perfect capital mobility. Under perfect capital mobility the domestic interest rate is continuously maintained at its imperfect arbitrage level, while the real exchange rate shows greater variability. Under imperfect capital mobility, the reverse is true. The increase in the domestic interest rate reflects a lower foreign debt accumulation and a lower domestic monetary accumulation than under perfect mobility, during the first phase of dynamic adjustment process. The instantaneous appreciation of the real exchange rate is smaller under imperfect capital mobility because of the partly offsetting effect of the higher interest rate on p .

Although the dynamic transition of f , i , and p is different in the polar cases of perfect and imperfect mobility, the final stationary levels are the same.

III. Model implementation and empirical results: Chile and New Zealand

In this section we discuss simplified relationships implied by the model developed above, which are suitable for dynamic econometric analysis. Then we present the results of estimation with constant parameters and with time-varying parameters separately for each country.

III.A. Relations implied by model

Equations <9> and <9'> imply a relation between the real exchange rate, domestic financial wealth, the real interest rate, and government expenditures:

$$\langle 22 \rangle \quad p_t = p(wr_t, wf_t, ir_t, g_t),$$

$$[-, -, +, -]$$

where ir_t is the real interest rate defined as $i - \pi^e$.¹³ Since real wealth is not observable, it has been omitted from equation <22>, which includes only financial wealth as the domestic wealth argument. The latter variable is defined as the sum of foreign assets and international reserves. Hence, $wf = f + r$.

In order to derive a reduced-form equation for the short-term nominal interest rate, actual holdings of base money are assumed to be a weighted average of desired holdings and *ex ante* monetary base (z). Hence the domestic nominal interest rate relates to the foreign interest rate, ($i^* + \hat{E}^e$), foreign assets, foreign reserves, and monetary base, z :

$$\langle 23 \rangle \quad i_t = i(i^* + \hat{E}_t^e, f_t, r_t, z_t).$$

$$[?, ?, +, -]$$

The first two right-hand variables present an ambiguous sign. For empirical reasons we expect the dominance of the positive effects in each case, as discussed in Appendix 2.

Instead of specifying a relation for foreign assets, we specify two separate

relations, for net exports and foreign reserve accumulation, consistent with the model. The net exports (quantum) function consistent with <10'> is:

$$\langle 24 \rangle \quad NX_t = NX(p_t, wf_t, ir_t). \\ [-, +, -]$$

Finally, foreign reserves demand consistent with equation <17> is given by:

$$\langle 25 \rangle \quad r_t = r(i_t^* + \hat{E}_t^e, f_t, z_t, r_{t-1}). \\ [-, +, -, +]$$

III.B. Stationarity of the data

For dynamic econometric analysis, the variables in equations <22> through <25> must be stationary. For many of the variables, first differences will have to be used, but levels may be appropriate for those that are stationary.

Table 1 contains the results of Phillips–Perron (1988) tests for the stationarity of these variables in levels, for both the Chilean and New Zealand quarterly data. For Chile, only the real interest rate is unambiguously stationary in levels, while for New Zealand both the foreign interest rate and net exports are stationary in levels. All of the other variables are unambiguously stationary in first-differences.¹⁴

III.C. Estimation results, constant parameters

For estimating dynamic relations based on equations <22> through <25>, we followed the general-to-specific approach of David Hendry (1986). Each of the four equations, with variables in first differences, or in levels if appropriate, was estimated with a four-period lag structure. Then 'irrelevant' variables were progressively eliminated. Irrelevant variables are those which were not significant, and whose omission did not affect the significance of the remaining variables.¹⁵

The results for the Chilean data appear in Table 2, and for the New Zealand data in Table 3. In addition to the usual regression estimates, each table has a set of diagnostic tests for evaluating autocorrelation, normality of the disturbance terms, heteroskedasticity, and misspecification, with chi-square statistics.¹⁶

While financial liberalization makes this assumption of constant coefficients hard to defend, these results serve as a benchmark for assessing how much time-varying coefficient values depart from the constant parameter values which represent the average coefficient values for the entire period. The constant coefficients also allow a quick comparison between countries, for assessing the importance of specific variables during the adjustment period.

Table 2 shows that the Chilean real exchange rate is significantly determined by real interest rates and its own lag. Neither wealth nor government spending affect the relative traded/non-traded goods price. For New Zealand the opposite is true: Table 3 shows that both wealth and government spending are significant, with the expected signs.

Nominal interest rates are significantly sensitive to most variables expected *a priori*. For Chile, covered arbitrage interest levels ($i^* + \hat{E}^e$) have a dominant influence on domestic nominal rates, during a period characterized by massive changes in the access to foreign credit markets.

TABLE 1. Phillips-Perron unit root tests of macroeconomic variables.

Variable:	Two unit roots vs. one			One unit root vs. none		
	Z(I3)	Z(I2)	Z(I1)	Z(I3)	Z(I2)	Z(I1)
Chile, 1975-1982						
<i>p</i>	19.65	12.97	18.48	3.89	2.69	1.88
<i>wf</i>	14.50	9.59	10.67	2.18	1.54	0.50
<i>ir</i>	26.51	17.39	27.66	14.02*	9.28*	14.13*
<i>g</i>	16.00	10.67	16.69	4.28	2.86	2.90
<i>i</i>	31.07	20.44	28.51	7.25	5.04	5.22
<i>i</i> * + \hat{E}^e	18.31	12.15	16.54	8.15	5.63	8.26*
<i>f</i>	16.06	10.62	12.26	2.52	1.88	0.23
<i>r</i>	14.15	9.35	14.10	1.36	1.31	1.20
<i>z</i>	8.87	5.88	8.20	1.29	0.92	1.18
<i>nx</i>	13.27	8.77	12.82	2.02	1.41	1.20
New Zealand, 1975-1991						
<i>p</i>	30.12	20.03	28.74	5.87	4.01	0.49
<i>wf</i>	42.38	28.14	42.51	7.41	5.02	2.48
<i>ir</i>	45.75	30.36	46.47	11.02*	7.41*	3.30
<i>g</i>	36.60	24.36	36.04	2.95	1.97	2.66
<i>i</i>	30.15	20.03	30.13	5.22	3.48	4.32
<i>i</i> * + <i>E</i>	58.38	38.74	59.42	32.84*	21.83*	32.22*
<i>f</i>	44.32	29.41	45.05	3.72	2.64	1.29
<i>r</i>	43.25	28.70	43.55	9.18*	6.22*	1.86
<i>z</i>	51.03	33.83	51.20	11.64*	7.78*	5.42
<i>nx</i>	50.27	33.33	51.19	17.93*	11.93*	17.63*

In test model: $y(t) = u + bt + ay(t-1) + e(t)$

$z(I3)$ tests $a = 1, b = 0$

$z(I2)$ tests $a = 1, b = 0, u = 0$

$z(I1)$ tests $a = 1, u = 0$, given $b = 0$,

where y is the respective variable to be tested, t is time, e is the residual, and u, b , and a are coefficients.

* Significant at the one per cent level, in rejection of appropriate unit root hypothesis vs. no unit root.

While foreign assets (the negative of the gross foreign debt) are not significant, the role of foreign reserves is significant. *Ex-ante* domestic money supply z presents the correct sign, negatively associated to domestic nominal interest rates. Table 3 shows that for New Zealand, foreign assets, reserves, and the money supply are also significant, with the same signs as the corresponding variables in the Chilean equation. For the foreign arbitrage interest rates, however, the story is different: higher levels at three and four lags lead to less change in domestic interest rates, implying a ceiling or bound on the domestic interest rates, characteristic of the pre-liberalization period.

With regard to the determination of the excess supply of traded goods or the net exports quantum (NX), for Chile, only two, the real interest rate and real wealth, are significant. Wealth has a negative effect, through its effect on consumption, while the effect of the real interest rate is positive, through its effect on domestic demand. For New Zealand, the story is somewhat different. Apart

TABLE 2. The estimated model. Chile, 1975.3–1982.4.

The real exchange rate:

$$\Delta p = -0.027 + 0.448 \Delta p_{t-1} + 0.673 ir_{t-1} - 0.772 ir_{t-2} + 0.673 ir_{t-3}$$

(1.63) (2.23) (2.94) (3.17) (2.58)

D.W. = 1.96 RSQC = 0.412

Diagnostics:	Stat	Order	P-value
Serial correlation	0.395	4	0.982
Normality	3.37	–	0.184
ARCH	2.39	4	0.663
Heteroskedasticity	3.10	–	0.927
Specification	6.67	2	0.035

The nominal interest rate:

$$\Delta i = -0.0062 + 0.349 \Delta(i^* + \hat{E}^e)_{t-2} - 0.00071 \Delta f_{t-4} + 0.0032 \Delta r_{t-2} - 0.0004 \Delta z_{t-2}$$

(1.21) (2.46) (1.04) (1.75) (2.23)

D.W. = 1.83 RSQC = 0.45

Diagnostics:	Stat	Order	P-value
Serial correlation	1.26	4	0.86
Normality	1.34	–	0.50
ARCH	2.01	4	0.73
Heteroskedasticity	4.22	–	0.83
Specification	1.31	2	0.51

Net exports:

$$\Delta nx = -0.561 + 0.683 \Delta nx_{t-4} - 0.169 \Delta wf_{t-3} + 22.62 ir_{t-4}$$

(0.969) (4.16) (1.90) (5.79)

D.W. = 2.17 RSCQ = 0.645

Diagnostics:	Stat	Order	P-value
Serial correlation	6.23	4	0.182
Normality	1.48	–	0.476
ARCH	3.03	4	0.551
Heteroskedasticity	8.95	–	0.176
Specification	2.88	2	0.236

Foreign reserves:

$$\Delta r = 0.883 - 0.1318 \Delta f_{t-4} - 32.067 \Delta(i^* + \hat{E}^e)_{t-2}$$

(1.66) (1.78) (2.06)

D.W. = 1.11 RSCQ = 0.102

Diagnostics:	Stat	Order	P-value
Serial correlation	5.14	4	0.272
Normality	0.67	–	0.715
ARCH	3.08	4	0.543
Heteroskedasticity	1.27	–	0.865
Specification	7.58	2	0.022

TABLE 3. The estimated model. New Zealand, 1976.3–1991.1.

The real exchange rate:

$$\Delta p = -0.004 + 0.235 \Delta p_{t-1} - 6.014E-06 \Delta w f_{t-2} - 3.74E-07 \Delta g_{t-3}$$

(1.12) (1.97) (1.63) (2.43)

D.W. = 2.00 RSQC = 0.207

Diagnostics:	Stat	Order	P-value
Serial correlation	3.15	4	0.530
Normality	1.35	–	0.508
ARCH	1.54	4	0.818
Heteroskedasticity	4.55	–	0.601
Specification	1.04	2	0.594

The nominal interest rate:

$$\Delta i = -0.419 - 0.0304(i^* + \hat{E}^e)_{t-3} - 0.031(i^* + \hat{E}^e)_{t-4} - 0.0003 \Delta f_{t-1} + 0.0011 \Delta r_{t-1}$$

(1.170) (2.08) (2.27) (2.16) (4.03)

$$-0.0031 \Delta z_{t-4}$$

(1.51)

D.W. = 1.84 RSQC = 0.36

Diagnostics:	Stat	Order	P-value
Serial correlation	4.59	4	0.33
Normality	1.55	–	0.45
ARCH	5.36	4	0.25
Heteroskedasticity	17.8	–	0.05
Specification	7.03	2	0.02

Net exports:

$$nx = -78.7 + 0.716nx_{t-1} - 0.546nx_{t-2} + 0.594nx_{t-3} - 2110 \Delta p_{t-1} - 1735 \Delta p_{t-2}$$

(1.34) (7.24) (5.34) (6.31) (2.76) (1.97)

$$+ 1640 \Delta p_{t-3} - 0.051 \Delta w f_{t-2} + 0.049 \Delta w f_{t-4} - 35.98 \Delta ir_{t-2}$$

(2.10) (2.15) (2.06) (2.99)

D.W. = 2.26 RSCQ = 0.61

Diagnostics:	Stat	Order	P-value
Serial correlation	5.47	4	0.242
Normality	0.96	–	0.617
ARCH	4.97	4	0.290
Heteroskedasticity	14.3	–	0.703
Specification	2.25	2	0.324

Foreign reserves:

$$\Delta r = 276.31 - 17.60(i^* + \hat{E}^e)_{t-1} + 0.154 \Delta f_{t-2}$$

(2.64) (2.81) (2.49)

D.W. = 1.87 RSCQ = 0.128

Diagnostics:	Stat	Order	P-value
Serial correlation	5.70	4	0.222
Normality	3.55	–	0.168
ARCH	18.3	4	0.001
Heteroskedasticity	10.0	–	0.040
Specification	10.3	2	0.005

from its own lagged effects, the real exchange rate initially has a negative effect, but at two and three period lags it has a positive effect. The total effect is positive. Wealth also has opposite effects at two and four lags, but the total effect is negative. Finally, the real interest effect is negative and at a two-period lag, reflecting a different channel than the Chilean case, which was positive at a four-period lag: higher real interest rates depress the current account as capital is drawn into the country.

Tables 2 and 3 show that foreign reserves are significantly determined by the same variables, although at different lag lengths. For Chile, reserves respond negatively to changes in foreign interest, and are negatively related to changes in foreign assets. For New Zealand, higher foreign interest levels lead to reserve losses, but foreign asset accumulation has a positive effect on reserve changes, implying that reserves were insulated from capital movements.

At the five per cent level of significance, practically all of the tests are insignificant, and thus do not allow us to reject the hypothesis of white noise. The exception is the test for specification in the reserve equation for both countries, as well as for ARCH in the New Zealand reserve equation, and specification in the Chilean real exchange rate equation.

The absence of serial correlation in the equations permits the use of Kalman filtering for evaluating the variability of the coefficients over time. The possibility of specification error in the dynamic linear model with constant coefficients, indicated by the tests, indicates that the use of a time-varying coefficient may be a more appropriate specification for the model during the liberalization process.

III.D. Estimation results with Kalman filtering

The Kalman filter follows a two-stage process for estimating the time-varying coefficients. At time t , an optimal predictor for the dependent variable is formed, using all information available up to and including time t . In the second-stage, the forecast error is used to modify the coefficients, and new information is used to generate new predictions at time $t+1$ for time $t+2$. Detailed descriptions of Kalman filtering appear in Anderson and Moore (1979), Pagan (1980), Hansen and Sargent (1991), Harvey (1981) and Chow (1984). Intuitively, the Kalman filter may be described as an 'optimal discounting' of past data to find the best one-period forward predictor.¹⁷

Figures 3a through 3d picture the adjustment of key coefficients in the real exchange rate equation, the interest rate equation, net exports, and the reserves for Chile, during the period of financial liberalization.

We see in Figure 3a that the real exchange rate became progressively more responsive (negatively) to the real interest rate at the lag of two periods, whereas the positive effects of the real interest rates at lags one and three progressively diminished. As the economy became more open, the capital flow effects of real interest rates had progressively stronger negative effects on the Chilean real exchange rate.

Figure 3b shows that the domestic interest rate in Chile became less responsive to domestic credit expansion, while the effects of foreign interest rates at the end of the sample period were stronger than at the beginning, although the coefficient fluctuated in value during the process of liberalization.

In Figure 3c we see that net exports became more responsive (negatively) to

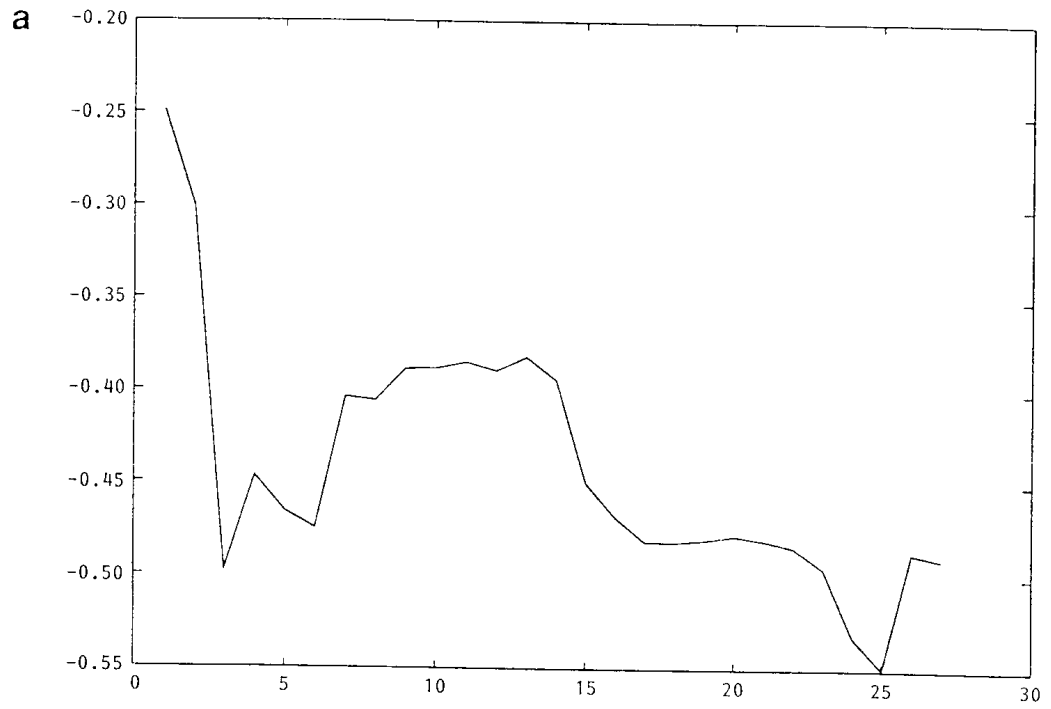


FIGURE 3. Real exchange rate response to IR(-2), Chile 1975-1982.

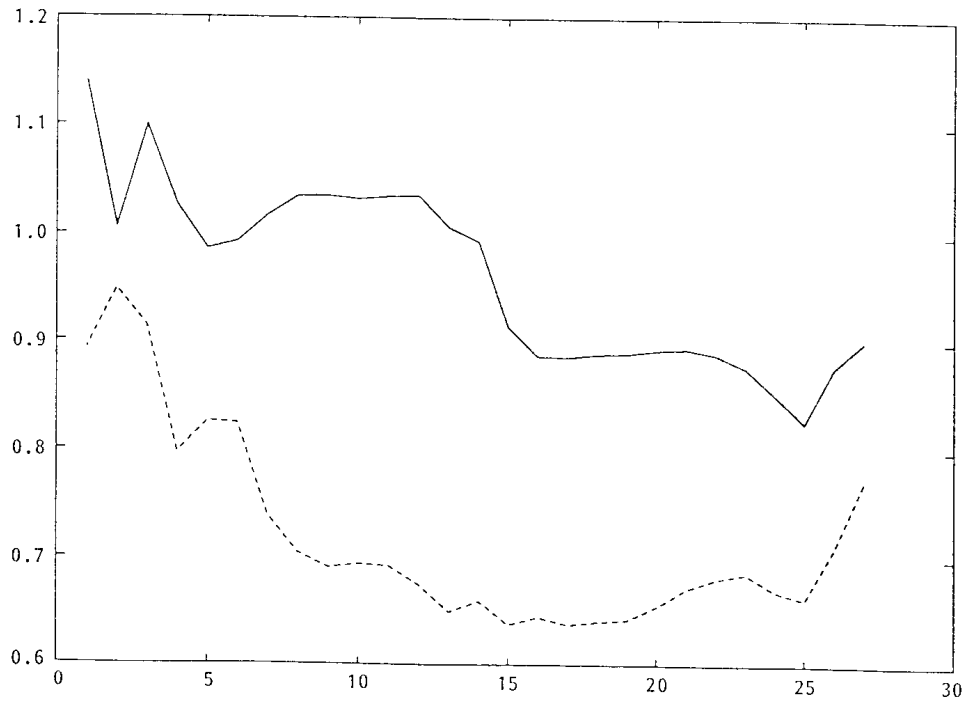


FIGURE 3a. Real exchange rate response to IR(-1) and IR(-3), Chile, 1975-1982.

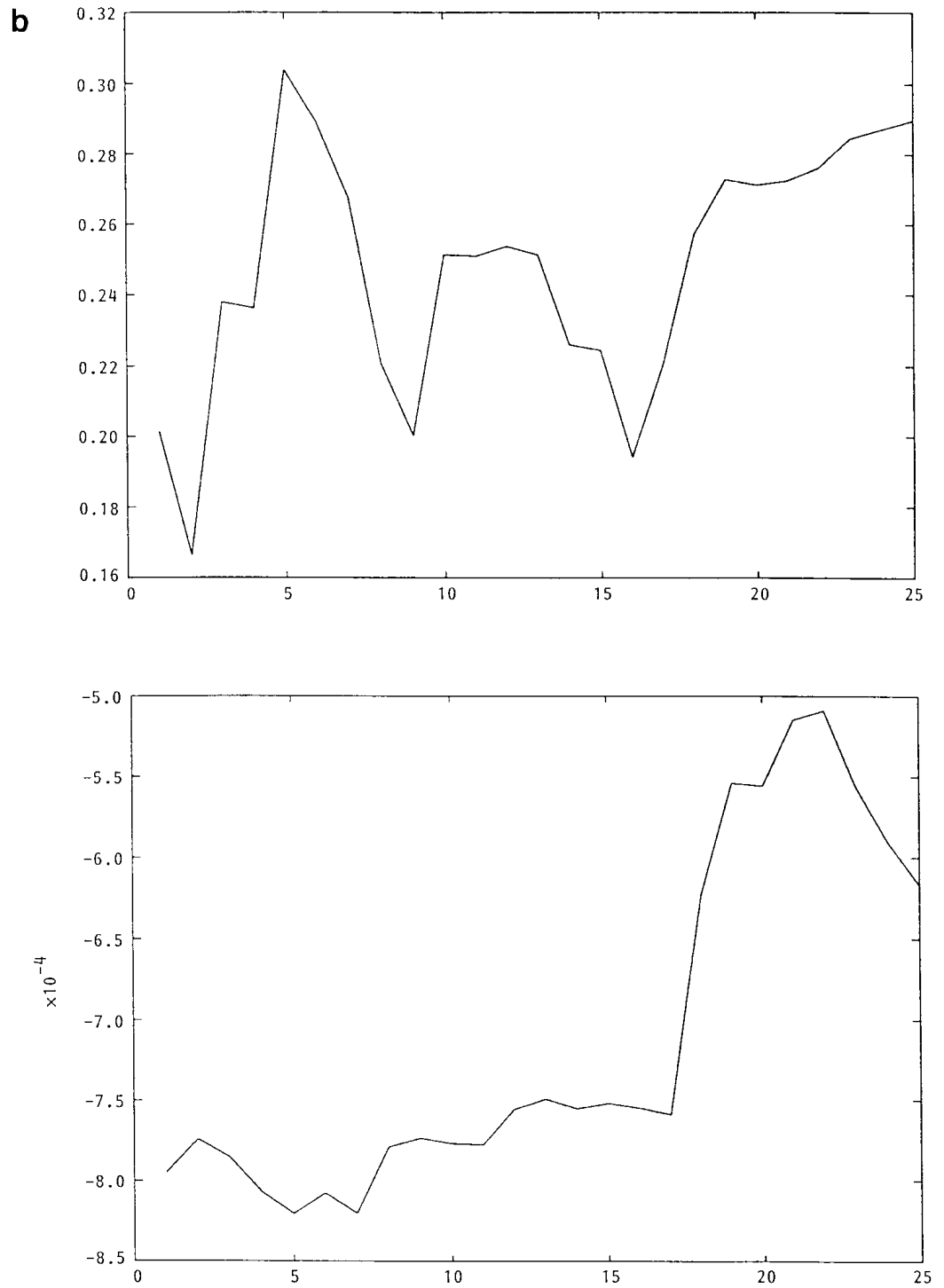


FIGURE 3b. Nominal interest responses, Chile, 1975–1982.

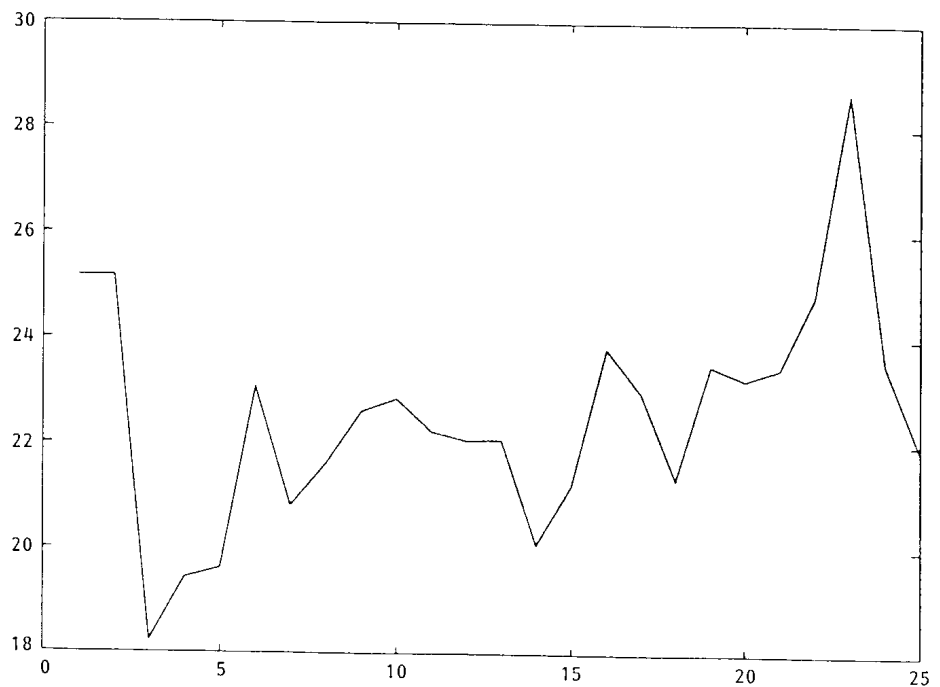
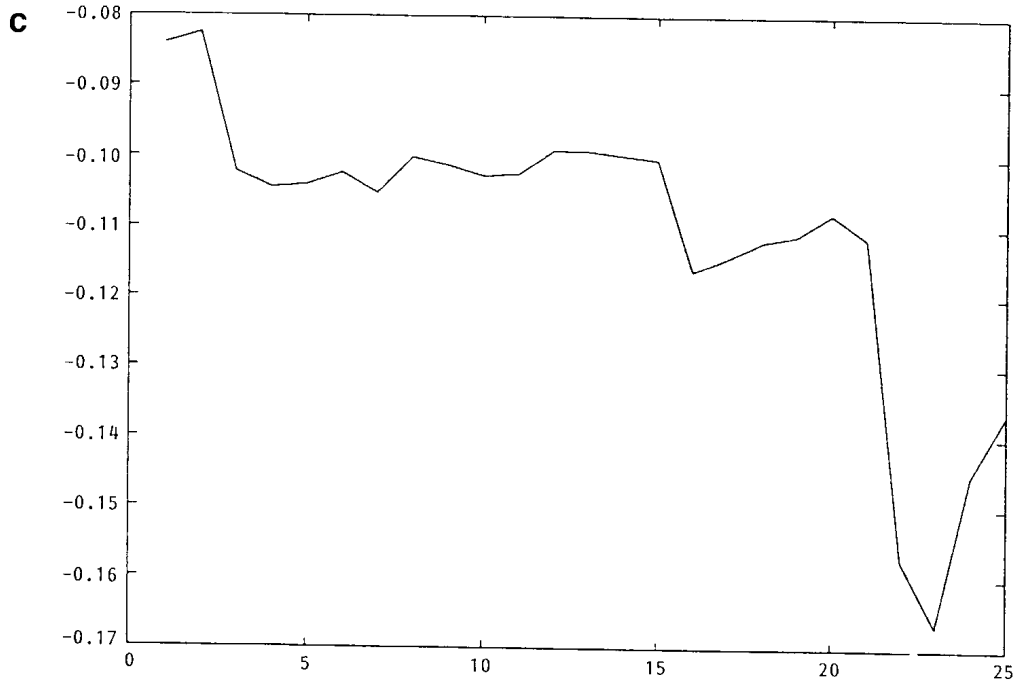


FIGURE 3c. Net export responses, Chile, 1975-1982.

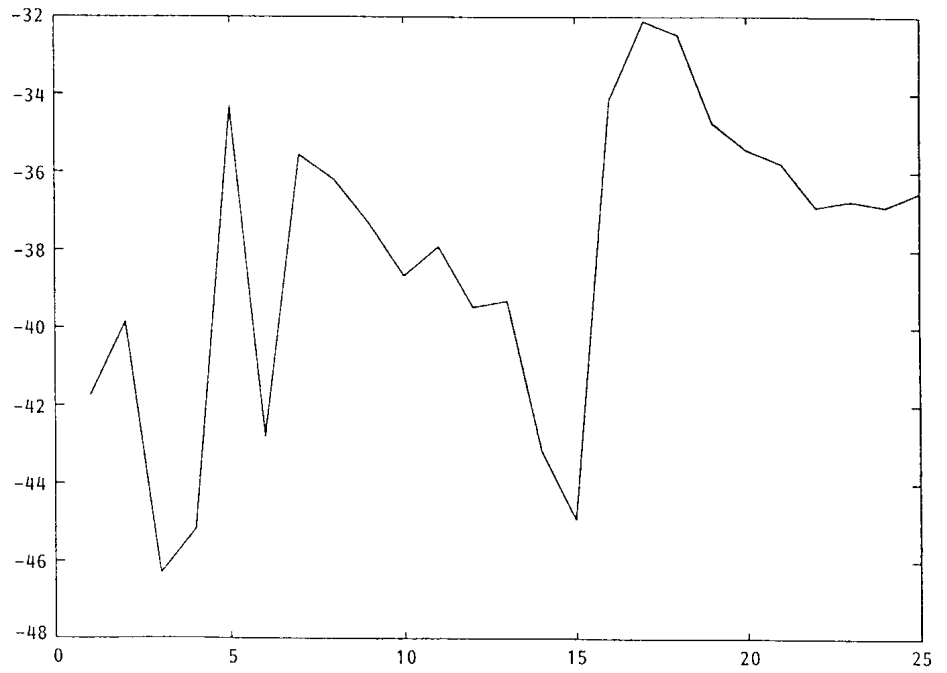
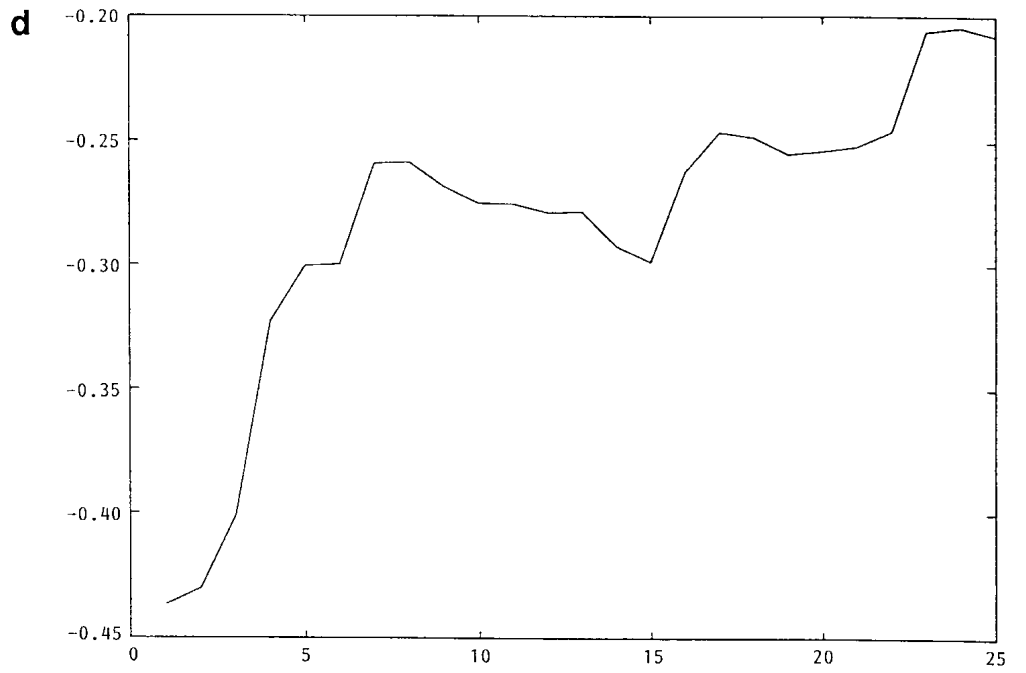


FIGURE 3d. Reserve responses, New Zealand, 1975–1991.

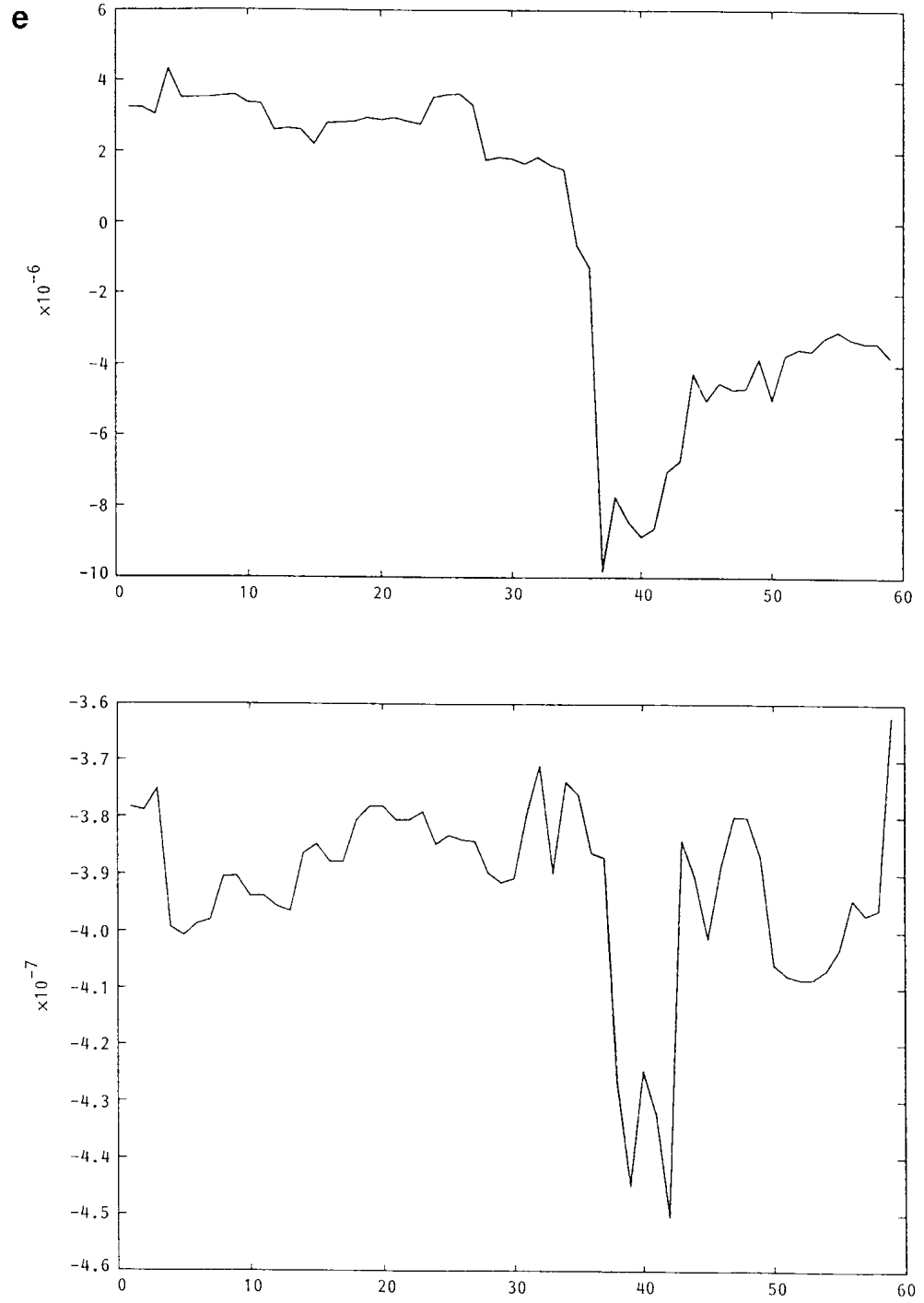


FIGURE 3e. Real exchange rate responses, New Zealand, 1975–1991.

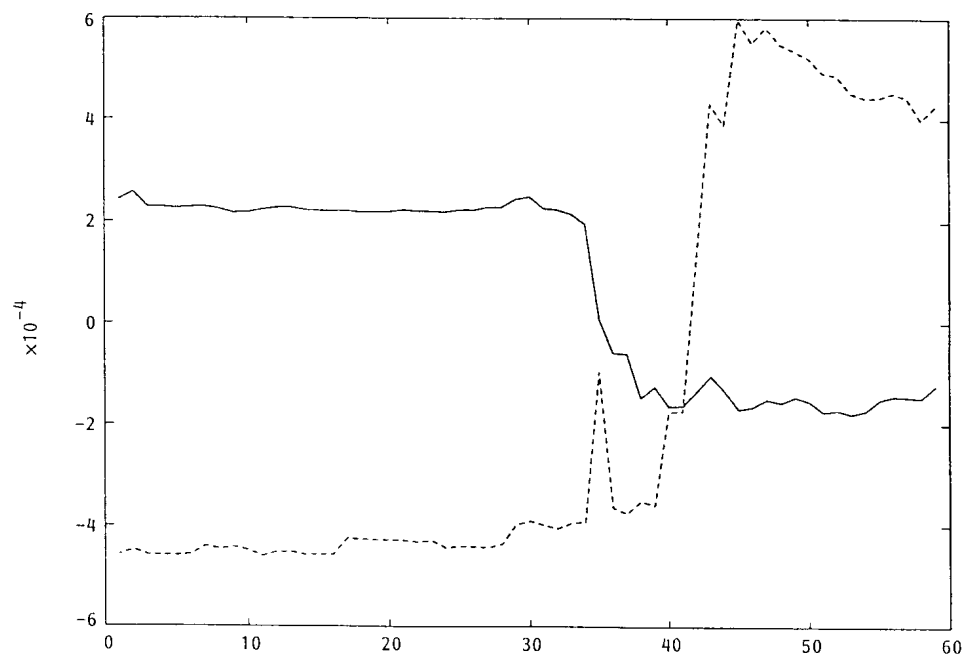
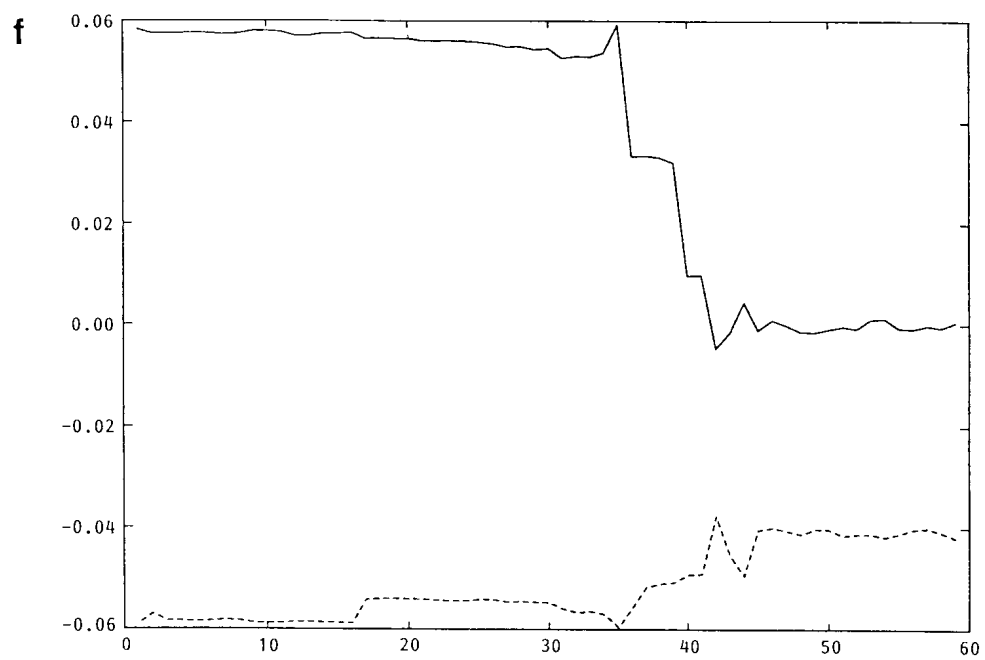


FIGURE 3f. Domestic interest responses, New Zealand, 1975–1991.

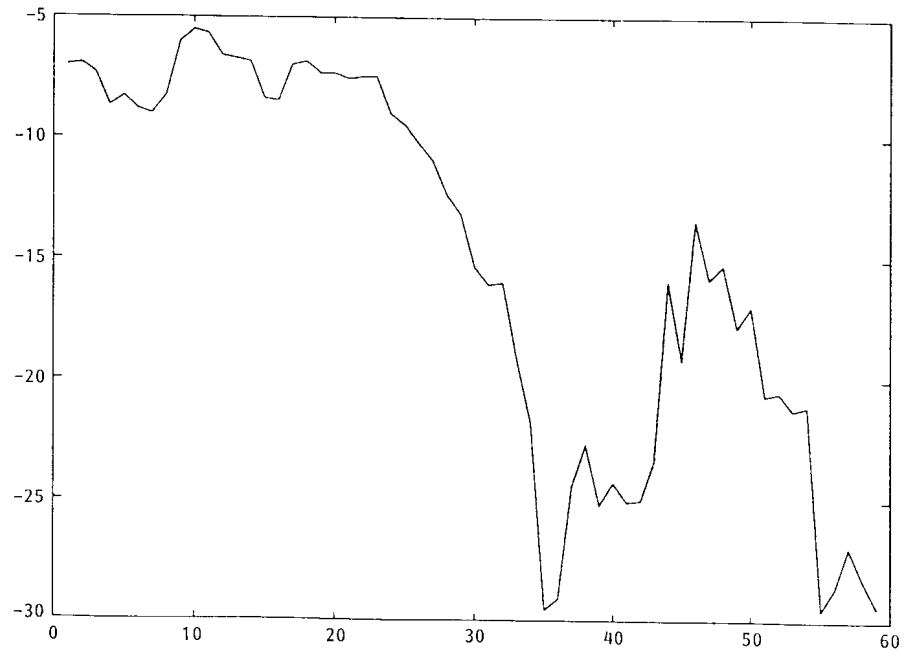
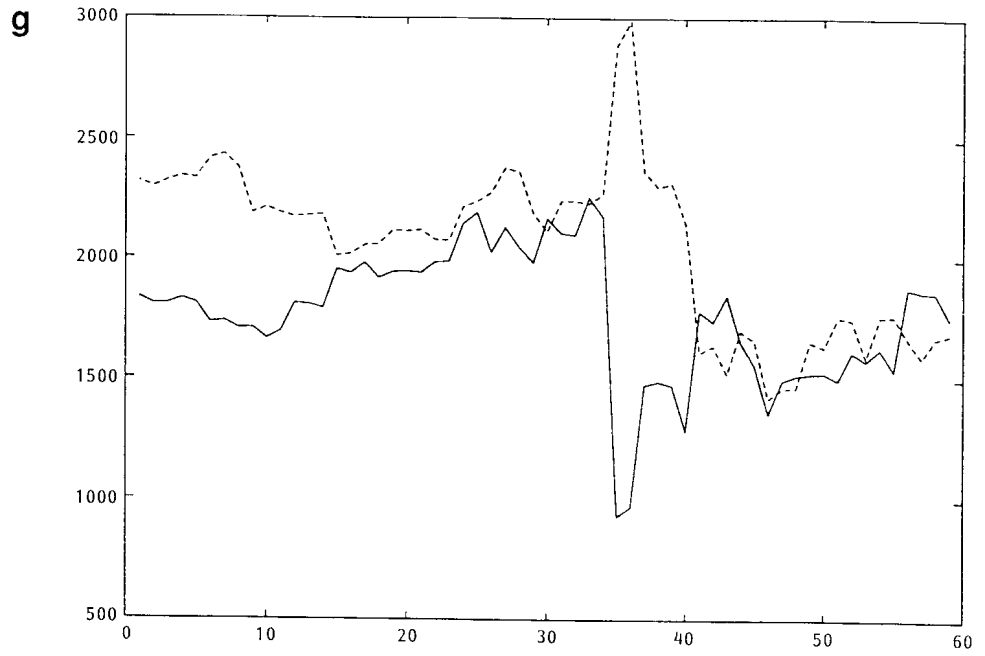


FIGURE 3g. Net export responses, New Zealand, 1975–1991.

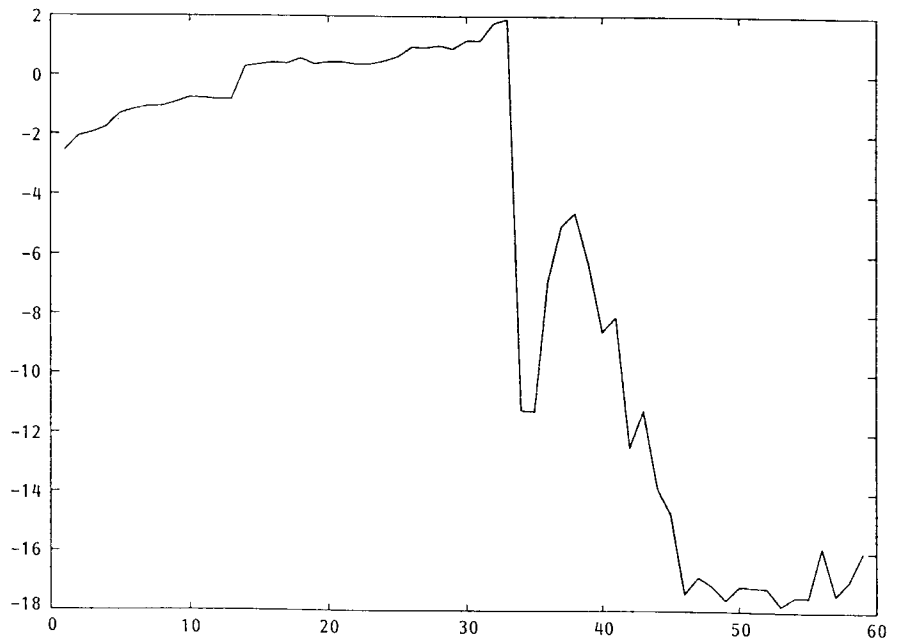
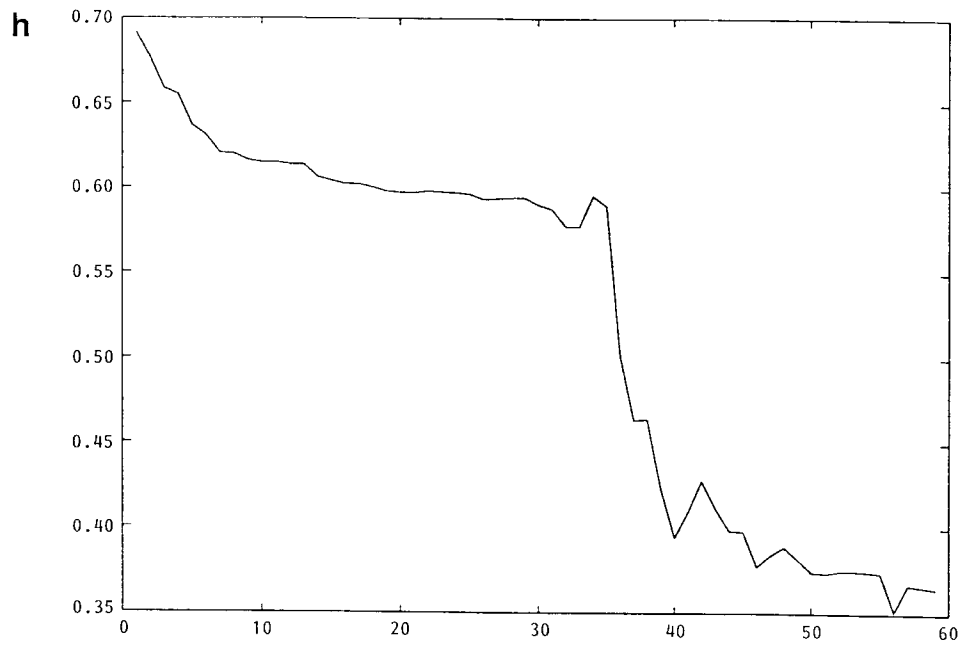


FIGURE 3h. Reserve responses, Chile, 1975–1982.

financial wealth effects, and more positively responsive to real interest rate effects. The behavior of net exports thus became more closely linked to factors in financial markets during the period of liberalization.

In Figure 3d, reserves were less responsive, negatively, at the end of the period to foreign assets (or the foreign debt) and to foreign interest rates, although the response pattern to foreign interest rates showed strong fluctuations, indicating some periods of highly responsive capital movements and reserve losses due to foreign interest rate movements.

The results for New Zealand appear in Figures 3e through 3h. For the response pattern of the real exchange rate, we see that it became progressively more dependent (negatively), on financial wealth and more dependent (negatively) on government spending. Thus domestic monetary and fiscal factors became more significant determinants of the real exchange rate as the economy became more financially open.

Figure 3f pictures the effects of the lagged foreign interest levels and the lagged foreign asset and reserve stocks on the change in domestic interest rates. The upper graph shows that the two lagged level effects diminish in absolute value terms in their effects on the change in domestic interest rates, indicating greater convergence at the end of the period. The lower graph shows sign-switching: at the end of the period foreign asset effects, indicated by the solid curve, became negative, while reserve accumulation effects, represented by the broken curve, became positive.

Figure 3g pictures the movement of coefficients in the net export equation. While the effects of real exchange rate changes had slightly lower positive effects on the net export balance at the end of the period, net export became negatively more responsive to real interest rate changes, by a factor of six. Thus, as the economy became more open financially, interest rates had stronger (negative) effects on the current account through the capital inflow effect, which dominated the positive effects through aggregate consumption and investment. Financial and capital market effects became more important for the current account as liberalization progressed.

Finally, Figure 3h pictures the response of reserves to foreign assets and to foreign interest rates. The results are different from the Chilean response pattern. We see that reserves became less responsive to foreign assets in New Zealand, while foreign interest rates had progressively stronger negative effects. Foreign interest rates became more important, rather than less, as determinants of reserves, as private asset holders responded progressively more to foreign interest rates. Foreign assets or debts, mostly private, had less influence on reserves as foreign interest rates became more important.

IV. Concluding remarks

Tests show that financial liberalization experiences have both important similarities and differences. Financial liberalization can have very different effects, depending on the way it is implemented, on the array of transactions costs on domestic and international assets, and on the public or private status of its existing international debts. While Chile and New Zealand are clear cases of rapid liberalization, the way macroeconomic variables evolved in their responses to domestic and international variables shows a very different adjustment,

reflecting differences in the deep ‘transactions costs’ parameters as well as different risk factors associated with its external debts.

Despite the differences, our results show that domestic interest rates become less volatile when the capital account is opened, while the sensitivity of the real exchange rate to changes in fundamentals increases with financial openness. The results also suggest that financial market factors as well as fiscal policy become more important determinants of the real exchange rate and net exports as financial liberalization progresses. Since both of these variables have important effects on employment and growth during the adjustment process, our analysis of Chile and New Zealand shows that misguided fiscal or financial policy can exact high costs when an economy becomes more financially open.

Appendix 1

To obtain the slopes of the non-traded market equilibrium condition and of the steady-state equilibrium condition implying a stationary level of foreign assets, as represented by schedules NN and ($\dot{f} = 0$) in Figure 1, differentiate equations <9> and <11>. The corresponding slopes are given in equations <A1> and <A2>, where d denotes total differentials and ∂ partial derivatives, and the signs in brackets are those of the partial derivatives:

$$\langle A1 \rangle \quad dp/df = (\partial c_N / \partial w) / [\partial y_n / \partial p - \partial c_N / \partial p - \partial c_N / \partial w \partial w / \partial p - \partial j_N / \partial p] < 0,$$

$$[+] \quad [-] \quad [+] \quad [+] \quad [+] \quad [+]$$

$$\langle A2 \rangle \quad dp/df = [p^z \partial c_T / \partial w - (i + \hat{E}^e - \pi^e)]$$

$$[+] \quad \div [(xp^{z-1}NX) + p^z \partial y_T / \partial p - \partial c_T / \partial p - \partial c_T / \partial w \partial w / \partial p - \partial j_T / \partial p] > 0.$$

$$[+] \quad [-] \quad [+] \quad [+] \quad [-]$$

While equation <A1> has an unambiguous sign, both the numerator and the denominator of equation <A2> can have either sign. However in note 4 we assume that net exports depend unambiguously and positively on the real exchange rate p , implying a positive denominator of <A2>.

In the absence of additional information on parameter values one could expect that the magnitude of the slopes of the excess demand curves for traded and non-traded goods with respect to p are similar, so that the magnitude of the denominator of <A1> is higher than that of <A2>.

The sign of the numerator of <A2> depends on the magnitude of the wealth effect on consumption relative to the interest effect stemming from higher foreign assets. In Figure 1 we assume that the wealth effect dominates, so that the numerator is positive.

Appendix 2

I. Sign-dependencies in equation <23>

We might expect a dominance of the positive effects of $i^* + \hat{E}^e$, LR , and f on domestic interest rate i for the following reasons.

The ambiguous effect of $i^* + \hat{E}^e$ stems from the fact that an increase in the arbitrage interest level reduces desired (*i.e.* long-run) money demand L^D , therefore increasing i_t , but at the same time it reduces (shifts) the short-run or current money demand, reducing i_t . The higher β is, and the lower the magnitude of the cross derivative of the money

demand $[\partial L/\partial (i^* + \hat{E}^e)]$, the higher is the probability that the first effect dominates, as we assume is the case.

The ambiguity of the effect of f on i also stems from two channels. Assuming again the dominance of β on $\partial L/\partial (i^* + \hat{E})$, an increase in f reduces i . But on the other hand there is also a wealth effect of f via higher financial wealth, which increases i . Under dominance of the second channel, the net effect of f on i is positive.

Notes

1. Dornbusch (1985) analyzes overborrowing in Latin America, which led to the 1982 debt crisis. He emphasizes the role of domestic policies. Calvo *et al.* (1992) study the recent resumption of capital flows to Latin America, emphasizing the role of external factors. For a detailed analysis of Chile's 1975–83 bust-boom-bust cycle, see Morande and Schmidt-Hebbel (1988). See Dornbusch and Reynoso (1989) for a more general survey of financial issues, including the role of inflationary finance, in the development process.
2. See Spencer and Carey (1988) and Hunn *et al.* (1989) for details on the financial policy reforms put in place in New Zealand in 1985.
3. In our analysis, we compare dynamic adjustment of the *nominal* interest rate with the *real* exchange rate, rather than the real interest rate with the real exchange rate. We do so because the nominal interest rate is the variable which clears the money market, and the real exchange rate clears the non-traded goods market. Their dynamic behavior reflects the underlying disequilibria in these two markets. The nominal interest rate is consistent with the real interest rate driving intertemporal consumption and investment decisions.
4. A major limitation of this paper is that we do not cover the issue of sequencing of capital and current-account liberalization. For a recent survey, see Hanson (1992).
5. Niehans (1991, 1992) recently analyzed the effects of financial liberalization under a wider-array of transactions costs parameters. He found that the effects of financial liberalization in a variety of cases depends more on the relationships between individual transactions costs than on their general level.
6. Q is replaced by a function depending negatively on the real exchange rate. The positive influence of p on w stems from the fact that an increase in p reduces the general price deflator and therefore increases the value of real money and domestic bond holdings for given M and B .
7. We cite the recent work by Butlin (1985), Brock (1985) and Schmidt-Hebbel (1987), among others, which extend previous work on intertemporal optimization, and derive behavioural functions in the context of a dependent or small open economy.
8. Consumption demands in equations <9> and <10> depend ambiguously on own real interest rates because of the well-known opposite signs of the substitution and wealth effects. Investment demands depend unambiguously and negatively on their own real rates of interest in each sector. We simplify our dynamic analysis by dropping the effect of interest rates on consumption.
9. In addition to the variables we include in <9>, factor prices could determine output supplies while investment could depend either on factor prices or output levels. This opens the possibility of explicitly introducing unemployment and business cycles, through exogenous or sluggish factor prices and accelerator mechanisms.
10. We postulate that net exports depend unambiguously and positively on the real exchange rate. This assumes very realistically that the indirect price effect of a higher real exchange rate on consumption via a wealth rise is more than compensated by the sum of the direct effects of higher p on traded goods production, consumption, and investment.
11. When the debt-servicing effect of a rise in f dominates the wealth effect, *i.e.* when the ($f = 0$) curve is negatively sloped, there is an unambiguous rise in the stationary values of both the foreign debt and the real exchange rate.
12. This dominance depends on the value of the speed of adjustment β , and thus on the intensity of legal restrictions, as shown in equation <18>.
13. Expected inflation π_t^e (the expectation of inflation between periods t and $t + 1$, as of period t) and expected nominal devaluation (defined similarly) are obtained from autoregressive time-series specifications for actual rates of inflation and nominal devaluation.

14. The results of the Phillips–Perron tests appearing in Table 1 are for lag truncations at zero. The same results held up at lag truncations 1 through 4. A copy of a Matlab (1990) program for the Phillips–Perron tests is available from the first author.
15. Unfortunately, the length of observations made it impossible to test for cointegration among the variables, using the Johansen–Juselius (1990) test. Thus, we could not specify an error-correction mechanism in our dynamic analysis.
16. These tests are a part of the Micro TSP Version 7.1 program, and are discussed in Hall *et al.* (1990).
17. A copy of a Matlab program for Kalman filtering, using the program provided with Hansen–Sargent (1991), is available from the first author upon request.

References

- ANDERSON, BRIAN, AND JOHN MOORE, *Optimal Filtering*, Englewood Cliffs: Prentice-Hall, 1979.
- BROCK, PHILLIP L., 'Temporary and Permanent Economic Liberalization,' *Manuscript*, Department of Economics, Chapel Hill, Duke University, 1985.
- BUTLIN, M.W., 'Imported Inputs in an Optimizing Model of a Small Open Economy,' *Journal of International Economics*, February 1985, **18**: 101–122.
- CALVO, GUILLERMO A., LEONARDO LEIDERMAN, AND CARMEN M. REINHART, 'Capital Inflows and Real Exchange Rate Appreciation in Latin America: The Role of External Factors,' *Manuscript*, International Monetary Fund, June 1992.
- CHOW, GREGORY, 'Random and Changing Coefficient Models,' in Z. Griliches and M. Intrilligator, eds., *Handbook of Econometrics 2*: 1213–1245, Amsterdam: North Holland, 1984.
- CORBO, VITTORIO, 'Reforms and Macroeconomic Adjustment in Chile during 1974–1984,' *World Development*, August 1985, **13**: 893–913.
- CORBO, VITTORIO, AND RICARDO MATTE, 'Capital Flows and the Role of Monetary Policy: the Case of Chile,' *Working Paper*, Catholic University of Chile: Department of Economics, 1984.
- DORNBUSCH, RUDIGER, 'Expectations and Exchange Rate Dynamics,' *Journal of Political Economy*, December 1976, **84**, 1161–1176.
- DORNBUSCH, RUDIGER, *Open Economy Macroeconomics*, New York: Basic Books, 1980.
- DORNBUSCH, RUDIGER, 'Overborrowing: Three Case Studies,' in Gordon W. Smith and John T. Cuddington, eds., *International Debt and the Developing Countries*, Washington, D.C.: The World Bank, 1985.
- DORNBUSCH, RUDIGER, AND STANLEY FISCHER, 'Exchange Rates and the Current Account,' *American Economic Review*, December 1980, **70**: 960–971.
- DORNBUSCH, RUDIGER, AND ALEJANDRO REYNOSO, 'Financial Factors in Economic Development,' NBER Working Paper 2889, 1989.
- EDWARDS, SEBASTIAN, 'Money, the Rate of Devaluation, and Interest Rates in a Semi-Open Economy,' *Journal of Money, Credit and Banking*, February 1985, **17**: 59–68.
- EDWARDS, SEBASTIAN, 'Monetarism in Chile, 1973–83: Some Economic Puzzles,' *Economic Development and Cultural Change*, April 1986, **34**: 535–560.
- EDWARDS, SEBASTIAN, AND ALEJANDRA COX EDWARDS, *Monetarism and Liberalization: The Chilean Experiment*, Boston, Ballinger, 1987.
- HALL, ROBERT E., JACK JOHNSTON, AND DAVID M. LILIEN, *Micro-TSP User's Manual*, Irvine, CA: Quantitative Micro Software, 1990.
- HANSEN, LARS PETER, AND THOMAS J. SARGENT, *Linear Recursive Models of Dynamic Economies*, Princeton, NJ: Princeton University Press, 1991.
- HANSON, JAMES A., 'An Open Capital Account: A Brief Survey of the Issues and the Results,' *Manuscript*, World Bank, 1992.
- HARVEY, ANDREW C., *Time Series Models*, London: Philip Allen Publishers, 1981.
- HENDRY, DAVID A., 'Econometric Modeling with Cointegrated Variables: An Overview,' *Oxford Bulletin of Economics and Statistics*, May 1986, **48**: 201–212.
- HUNN, NICOLA, DAVID MAYES, AND NEIL WILLIAMS, *Financial Deregulation and Disinflation in a Small Open Economy*, Wellington: New Zealand Institute of Economic Research, Research Monograph 44, 1989.

- JOHANSEN, SOREN, AND KATARINA JUSELIOUS, 'Maximum Likelihood Estimation and Inference on Cointegration—with Application to the Demand for Money,' *Oxford Bulletin of Economics and Statistics*, May 1990, **51**: 169–210.
- KOURI, PENTII, AND MICHAEL PORTER, 'International Capital Flows and Portfolio Equilibrium,' *Journal of Political Economy*, May/June 1974, **86**: 443–468.
- MATLAB, *Matlab 386*, South Natick, MA: The MathWorks, Inc., 1990.
- MORANDE, FELIPE, AND KLAUS SCHMIDT-HEBBEL, *Del auge a la crisis de 1982: ensayos sobre liberalización financiera y endeudamiento en Chile*, Santiago: IIMC-ILADES Georgetown University, 1988.
- NIEHANS, JURG, 'Capital Mobility with Transactions Costs: A Concept and Applications,' Working Paper No. PB91-03, Center for Pacific Basin Monetary and Economic Studies, Economic Research Department, Federal Reserve Bank of San Francisco, 1991.
- NIEHANS, JURG, 'The International Allocation of Savings with Quadratic Transactions (or Risk) Costs,' *Journal of International Money and Finance*, June 1992, **11**: 222–234.
- PAGAN, ADRIAN, 'Some Identification and Estimation Results for Regression Models with Stochastically Varying Coefficients,' *Journal of Econometrics*, August 1980, **13**: 341–363.
- PHILLIPS, PETER C.B., AND PIERRE PERRON, 'Testing for a Unit Root in Time Series Regressions,' *Biometrika*, June 1988, **75**: 335–346.
- SCHMIDT-HEBBEL, KLAUS, 'A Short-run Macro Model for a Small Open Economy with An Application to Chile, in Foreign Shocks and Macroeconomic Adjustment in Small Open Economies,' *Ph.D. dissertation*, M.I.T., 1987.
- SCHMIDT-HEBBEL, KLAUS, 'Consumo e inversión en Chile: una interpretación "real" del boom', in F. Morandé and K. Schmidt-Hebbel, *Del auge a la crisis de 1982: ensayos sobre liberalización financiera y endeudamiento en Chile*, Santiago: IIMC-ILADES Georgetown University, 1988.
- SPENCER, JOHN, AND DAVID CAREY, 'Financial Policy Reform—the New Zealand Experience, 1984–1987,' Wellington: Reserve Bank of New Zealand, Discussion Paper G88/1, 1988.
- VALDES-PRIETO, SALVADOR, 'Financial Liberalization and the Capital Account: Chile 1974–84,' *Manuscript*, World Bank, 1992.