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Estimating Financial Programming Models During Periods of Extensive Structural Reform: The Case of Chile*

Prepared by Donald J. Mathieson

Approved by George M. von Furstenberg

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I. Introduction

In designing a financial program, a sample of data taken from the prestabilization program period is often used to obtain empirical estimates of the parameters of a variety of behavioral relationships. Implicit in the use of these estimated empirical relationships is the assumption that, at least in the short run, the financial program will affect the performance of a given economic structure but will not fundamentally alter the structure itself. While this assumption may be quite reasonable for many economies, there is the problem of how to estimate these behavioral relationships for countries that are undergoing extensive structural change over an extended period of time as a result of sweeping trade, fiscal, and financial market reforms.

During the 1973-81 period, Chile provides an example of an economy that underwent extensive trade, financial, and fiscal policy changes designed to open the economy to international influences. The trade policies encompassed the replacement of a system of quotas and high tariffs with a uniform 10 per cent tariff and an exchange rate policy which evolved initially from a crawling peg complemented with occasional discrete adjustments, to a preannounced crawl, and finally a fixed exchange rate. In financial markets, the program included the removal of interest rate ceilings, substantial reductions in required reserves in financial institutions, the payment of interest on bank reserves, a sustained reductions in the central bank's issuance of base money and subsidized lending programs, and opening up the financial system to

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increased domestic and international competition. Finally, fiscal reforms have resulted in expenditures and tax changes which created a substantial fiscal surplus.

The objective of this analysis is to empirically estimate the response of inflation, the balance of payments, and financial markets to the opening of the economy and other reform elements within a framework consistent with the usual financial programming structure. The rest of this paper is divided into three sections. First, there is a discussion of the financial programming framework used to describe the linkages between inflation, the balance of payments, interest rates, and financial aggregates. The next section analyzes the empirical results for a sample of data from July 1976 to June 1980. Finally, the last section contrasts these estimates with those obtained recently for Argentina and also examines the reasons for the persistence of high nominal and real interest rates.

II. Basic Model

In order to describe the channels by which the trade, fiscal, and financial reforms influenced the Chilean domestic economy, it is convenient to first describe the determinants of financial system behavior and then turn to the determinants of domestic inflation and the balance of payments. In the financial markets, our model distinguishes between the behavior of banks, financieras, and the nonfinancial sector. The financieras are financial institutions which accept short term deposits and make short term consumer and enterprise loans. The deposits and loans of financieras are viewed to some degree as substitutes for comparable bank assets and liabilities. The nonfinancial sector consists of households and firms. In each sector, wealth holders are assumed to attempt to achieve some desired stock and composition of wealth or net worth but that adjustment costs make it unlikely that actual and desired portfolio holdings are equal at each instant in time.

1. The nonfinancial sector

The nonfinancial sector is taken as holding currency, demand deposits, bank time deposits, financiera time deposits, and real capital as assets and bank, financiera and foreign loans as liabilities. Since we will take the bank loan rate and time deposit rate as representative domestic market interest rates, we can begin with the specification of the nonfinancial sector demand for bank loans and time deposits.

The nonfinancial sector demand for bank loans is assumed to be a positive function of the expected real return on capital, the real cost of foreign borrowing, the cost of borrowing from financieras, and the level of permanent income, and a negative function of the real loan rate. At each instant in time, the nonbank sector will attempt to eliminate any difference between its desired and actual holdings of bank loans. Thus the desired stock of bank loans equals (see Appendix I for a summary of notation):

$$(1)\qquad \ln\left(\frac{B}{P}\right)^{d} = \alpha_1 - \gamma_1[r_B-\pi^e] + \gamma_2[r_F^{\prime}-\pi e] + \gamma_3[r_{FL}- {}^{e}]$$

$$+ \gamma_4 \ln[Y/Y^T] + \ln Y^T$$

where B = bank loans

P = general price level

r_B = domestic bank loan rate (in per cent per month)

π^e = expected rate of inflation (in per cent per month)

$r_F^{\prime}$ = cost of foreign borrowing (in per cent per month)

r_{FL} = cost of financiera loans (in per cent per month)

Y^T = permanent income

and the stock adjustment behavior is given by

$$(2)\qquad D\ \ln\left(\frac{B}{P}\right) = \beta_1[\ln\left(\frac{B}{P}\right)^{d} - L\ \ln\left(\frac{B}{P}\right)]$$

where L = lag operator ($L\ X_t = X_{t-1}$)

D = 1-L

Since the expected real return on capital is assumed to be fixed in the short run, its effect has been subsumed into the α_1 term. The level of permanent income (as measured by the trend income level) is taken as a proxy for the level of wealth. The $\ln[Y/Y^T]$ reflects the cyclical component of the demand for bank loans associated with financing extra output during an upturn in economic activity. The exact sign on γ_4 depends on the degree to which firms tend to anticipate cyclical movements. If firms do not anticipate these cyclical movements, then they will be forced to obtain bank credit during a cyclical upturn to finance the unanticipated increase in their output. This would argue for a positive γ_4. Whenever firms anticipate cyclical movements, they may follow a policy of borrowing when the demand for bank credit is relatively low in order to finance inventory accumultion during a slack period. In this case, γ_4 would be negative. The actual value of γ_4 is thus an empirical question. 1/ The financiera loan rate is included to reflect the fact that firms and households can borrow from financieras as well as from banks. 2/ In an economy without controls on capital inflows or outflows, the cost of foreign borrowing (r_F^*) is composed of three elements: the nominal foreign borrowing rate (r_F), any risk premium (Θ) attached to lending to domestic nationals, and the expected rate of depreciation of the exchange rate ($\dot{x}^e$). In Chile, the cost of foreign borrowing has also been affected by the capital controls the authorities have utilized in an attempt to limit capital inflows. These controls have taken a variety of forms including minimum maturity requirements on foreign loans, required deposits at the central bank (at a zero or low interest rate) of up to 25 per cent of foreign borrowing, ceilings limiting both total bank foreign borrowing and loans in foreign currency to a certain percentage of a bank's capital and reserves, and restrictions on the amount of foreign borrowing that could be converted into domestic currency each month. Even though the required deposits on foreign borrowing declined from 25 per cent as the maturity of the loan lengthened, their effects can be approximated by taking the 25 per cent deposit requirement as the representative rate during the period from April 1979 to June 1980. This was the deposit requirement applicable to short term foreign borrowing. If we let δ_0 represent a vector which takes on the value 1 between April 1979 and June 1980 and is zero otherwise, then

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1/ It must be stressed that the $\ln[Y/Y^T]$ term is not the only way in which cyclical developments affect the demand for bank credit. The levels of the interest rates are also affected by cyclical changes in economic activity, and these effects are transmitted through the γ_1, γ_2, and γ_3 terms).

2/ While we have taken the financiera loan and deposit nominal yield as exogenous, they should be included as endogenous variables in our model of financial system behavior. Unfortunately, the absence of time series data on the stocks of outstanding financiera loans and deposits makes identification of the appropriate demand and supply functions impossible.

the cost of foreign borrowing would become $\delta_0(r_F + \dot{x}^e + \Theta)/.75 +$ $(1-\delta_0)(r_F + \dot{x}^e + \Theta)$ ignoring for the moment the effects of all other capital controls.

The impact of the minimum maturity requirements and the changing limits on conversion of foreign currency are much more difficult to capture. To simplify, our analysis uses a series of dummy variables (z_i) to to represent changes in these restrictions. 1/ The cost of foreign borrowing is thus given by: 2/

$$(3) \qquad r_F' = (r_F + \Theta + \dot{x}^e)(1-\delta_0) + \delta_0(r_F + \dot{x}^e + \Theta)/.75 + \sum_{i=1}^{n} \delta_i z_i$$

The nonfinancial sector's desired stock of bank time deposits is assumed to be positively related to the level of permanent income and the expected real return on bank time deposits, and negatively related to the expected real return on currency and demand deposits, the expected return on financiera deposits, and the ratio of current to permanent income.

$$(4) \qquad \ln\left(\frac{T}{P}\right)^d = \alpha_2 - \gamma_5(-\pi^e) + \gamma_6(r_T-\pi^e) - \gamma_7(r_{FT}-\pi^e)$$

$$- \gamma_8 \ln(Y/Y^T) + \ln Y^T$$

where T = nominal stock of bank time deposits

r_T = nominal yield on bank time deposits (in per cent per month)

r_{FT} = nominal yield on time deposits in financieras (in per cent per month)

Y = real income.

1/ The exact nature of these dummies will be discussed in the section on empirical results.

2/ The true interest rate cost (ignoring capital controls) is given by $(1+r_F') = (1+r_F)\ (1+\Theta)(1+\dot{x}^e)$. We have used the linear approximation given in (3) in order to have a variable elasticity formulation for our portfolio demands and supplies.

The negative of the expected rate of inflation is taken as a measure of the own rate of return on currency and demand deposits since interest was not paid on demand deposits during our sample period. 1/ The effect of the financiera deposit yield is important since nonfinancial entities could always hold financiera rather than bank time deposits. The ratio of current to permanent income represents the fact that a relatively high current level of income may increase the proportion of wealth held as transaction balances and hence reduce the proportion held as savings on time deposits.

In attempting to achieve this desired stock of bank time deposits, actual holdings change according to:

$$(5) \qquad D \ln\left(\frac{T}{P}\right) = \beta_2\left[\ln\left(\frac{T}{P}\right)^d - L \ln\left(\frac{T}{P}\right)\right]$$

One portion of the nonfinancial sector's portfolio that is especially important for determining short run economic behavior is its holdings of highly liquid assets (i.e. currency, demand deposits, and time deposits). While each of these asset demands could be modeled separately, 2/ our formulations of inflation and balance of payments behavior can be simplified if there is a general respresentation of the excess stock of liquid assets. In addition, this will allow us to make a direct comparison between our results for the demand for money and those obtained in previous studies which have generally used ordinary least squares regression analysis and have ignored the endogeneity of the money supply. Let us therefore define broad money (M) as the sum of currency (C), bank demand deposits (N), and bank time deposits (T). 3/ The desired stock of liquid assets will be taken as a positive function of the expected real return on currency and bank demand deposit holdings, the real yield on bank time deposits, the level of permanent income, and the ratio of current to permanent income and a negative function of the expected real yield on financiera deposits. Thus:

1/ The real return on currency and demand deposits actually equals $r_c - \pi^e$ where r_c is the nominal return paid on currency and demand deposits. In the Chilean case, however, $r_c = 0$.

2/ As was done in equations (4) and (5).

3/ The absence of consistent time series on financiera deposits prevents the inclusion of these holdings.

$$(6) \qquad \ln\left(\frac{M}{P}\right)^d = \alpha_3 + \gamma_9(-\pi^e) + \gamma_{10}(r_T-\pi^e) - \gamma_{11}(r_{FT}-\pi^e)$$

$$+ \gamma_{12}\ln(Y/Y^T) + \ln Y^T$$

Since the demand for broad money reflects the underlying demands for currency, demand deposits, and bank time deposits, the signs of γ_9 and γ_{10} are ambiguous. For example, a higher expected real yield on bank time deposits would increase the desired holdings of that asset but depress desired holdings of currency and demand deposits. A rise in the level of transaction will increase the demand for currency and demand deposits but lower that for time deposits. In taking γ_{12} as positive, it is also assumed that the transaction demand for currency and demand deposits implicit in γ_{11} outweighs the negative transaction effect associated with time deposits.

The stock adjustment mechanism for liquid assets is given by:

$$(7) \qquad D\ \ln\left(\frac{M}{P}\right) = \beta_3\left[\ln\left(\frac{M}{P}\right)^d - L\ \ln\left(\frac{M}{P}\right)\right]$$

2. The banking system

The banking system holds reserves, loans to domestic residents, and foreign securities as assets and demand deposits, time deposits, foreign borrowing, borrowing from the central bank, and bank capital as liabilities. The banks' willingness to supply loans or deposits reflects their decisions regarding what sources of funds they will utilize and what earning assets they will purchase. Since we are concerned with the short run, we will take the owners' commitments of funds as given and assume the use of other sources of funds depends on the relative cost of these funds and any restrictions the authorities impose on their use. Thus, the use of source S_i as a proportion of total funds (F) will be a function of the vector ($\hat{r}_B$) of the relative nominal costs of the various sources of funds and the returns that can be earned on bank assets. Nominal returns are relevant since bank profits depend on the differential between the cost of bank funds and the returns on their assets. The use of any given source of funds would fall as its cost rises relative to other sources. The bank's use of a given source of funds will also be influenced by any government regulations affecting such portfolio selections (these restrictions will be represented by the vector g). This means $S_i/F = f_{iB}(\hat{r}_B, g)$.

These desired sources of funds and holdings of assets are unlikely to be achieved at each instant in time. Just as for the nonfinancial sector, adjustment cost and uncertainties regarding the sustainability of any interest rate structure mean that banks may want to spread their purchases of assets or issuance of liabilities over time. In addition, banks in a less than perfectly competitive industry may have some influence over the level of market interest rates. For example, banks may attempt to establish a loan rate that reflects the cost of bank funds and ensures an "adequate" level of profits. This type of "mark-up" pricing scheme would imply that banks follow a mixed strategy of changing the quantity of financial instruments supplied or purchased and the yields that banks offer on deposits or charge on loans.

To allow for the possibility of both price and quantity adjustment in the financial system, we will assume first that the banks' desired proportion of total bank funds (F) supplied by time deposits is a negative function of the gaps between the cost of time deposits and the rates of return earned on domestic loans and government securities and the cost of foreign funds. Thus:

$$(8) \quad \ln(T/F)^s = \alpha_4 - \gamma_{13}[r_T - r_E K_T - r_B(1-K_T)] - \gamma_{14}[r_T - r_E K_T - r_F^!] - \gamma_{15}[r_T - r_E K_T - r_G]$$

where F = total bank funds

K_T = required reserve ratio on bank time deposits

r_E = interest paid by central bank on reserves held against time deposits (in per cent per month)

r_G = yield on government securities (in per cent per month).

The net cost to the bank of utilizing time deposits as a source of funds is the difference between the time deposit rate (r_T) and the interest earned on reserves held against time deposits ($r_E K_T$) where K_T is the required reserve ratio on time deposits. In comparing this net cost with the earnings on domestic loans, the bank recognizes that it can lend only ($1-K_T$) pesos of every peso of time deposits. The net addition to bank profits of one more peso of time deposits is thus $r_B(1-K_T) - r_T + r_E K_T$.

Since foreign borrowing is an alternative source of funds, the banks' desired supply of time deposits will be influenced by the differential between the net cost of time deposits ($r_T - r_E K_T$) and the cost of foreign funds ($r_F^!$). Similarly, sales of domestic government securities can be used as substitutes for additional time deposits as a source of funds, so the differential $r_T - r_E K_T - r_G$ is also included in (8).

To reflect the slow adjustment of actual to desired time deposit issuance we will have:

$$(9) \qquad D\ \ln(T/F) = \beta_4[\ln(\frac{T}{F})^s - L\ \ln(\frac{T}{F})]$$

The pricing behavior of the banking system can be represented by assuming that the banks always adjust the interest rate on domestic loans to ultimately achieve a constant long run return on bank equity. In the long run, the loan rate (r_B^*) that will yield a given rate of profit (α_5) is: 1/

$$(10) \qquad r_B^* = \alpha_5 + (\frac{T}{B})^*[r_T - r_E K_T] + (\frac{F}{B})^* r_F' - (\frac{G}{B})^* r_G$$

where an asterisk denotes the long run value. This means that the banks desired loan rate will be positively related to the net cost of time deposits and foreign funds and negatively related to the return that can be earned on government securities. Given the uncertainty regarding the sustainability of the current mix of interest rates, each individual bank will want to adjust its lending rate so as to not only reflect general market adjustments of interest rates (e.g., due to changes in expected inflation) but also to maintain the bank's share of market activity. While a bank's oligopolistic position would allow it to raise its interest rates relative to other banks without loosing all of its loan business, its share of total market lending would decline thereby reducing its level of profits. 2/ In such a situation, banks will move the prevailing loan rate only gradually toward the desired level. To reflect this behavior in a simple framework, it is assumed that the adjustment of the loan rate takes the form:

1/ This relationship can be derived from the banks' profit and loss statement. If E is defined to equal the owners' equity in the bank r_E is the yield on that equity then $r_B B + r_G G = r_T T - r_E K_T T + r_F' F + r_E E$.

Thus, $r_B = (r_T - r_E K_T)\frac{T}{B} + r_F'\frac{F}{B} - r_G\frac{G}{B} + r_E\frac{E}{B}$. In the above equation $\alpha_5 = r_E E/B$.

2/ The bank's profits will decline because it will be in the elastic portion of the "linked" demand it faces in the market. This type of demand curve reflects the assumption that, at any moment in time, other banks would not match loan rate increases above some prevailing market interest rate, but they would match a lower loan rate rates.

$$(11) \quad D\ r_B = \beta_5[\alpha_5 + \gamma_{15}[r_T - r_E K_T] + \gamma_{16}\ r_F^{\dagger} - \gamma_{17}\ r_G - L\ r_B]$$

where γ_{16}, γ_{17}, and γ_{18} are estimates of $(T/B)^*$, $(F/B)^*$, and $(G/B)^*$.

Since portfolio disequilibrium has been allowed in both the bank and nonbank sectors, our model necessarily contains adjustment equations for both its quantities of loans and deposits and the market interest rates on both of these financial instruments. The nonbank sector's flow demands for bank loans and time deposits (see equations (2) and (5) respectively) are determined by a number of variables including the levels of the loan and time deposit rates. These demands thus determine the accumulations of bank loans and time deposits given the values of the loan and time deposit rates. The time deposit rate is assumed to adjust until such time as the nonfinancial sector's flow demand for bank deposits (equation (5)) is equal to the banks' flow supply of time deposits (equation (9)). The loan rate is determined by the banks' desire to gradually move the rate toward the long run profit maximizing level (equation (11)). The banks must therefore supply an amount of loans that is consistent with the nonfinancial sector's flow demand for loans (equation (2)) at the level of the loan rate being quoted by banks. If there are sharp changes in the nonfinancial sector's flow demand for loans, then the bank may have to vary its supply of loans equally sharply in order to keep the loan rate on its desired path. In our model, the required funds for these loans could be obtained via sales of government securities or increased foreign borrowing.

4. The domestic money stock, balance of payments and domestic money creation

The linkage between financial market behavior, domestic monetary creation, and the balance of payments rests on three relationships. First, increases in the stock of base money (H) equal the weighted sum of the growth of central bank domestic credit (CR) and the conversion of international reserves (XR).

$$(12) \quad D \ln H = \left(1 - \frac{XR}{H}\right) D \ln CR + \frac{XR}{H} D \ln R$$

where X = exchange rate.

Second, the stock of base money can be held as currency (C) or bank reserves (CBR). Thus:

$$(13) \quad H = C + CBR$$

Bank reserves reflect holdings of bank required and excess reserves. In Chile there are multiple ratios which vary with the maturity and type of deposit. These ratios have changed frequently in recent years which makes the identification of required and excess reserves quite difficult. To simplify, we will define empirically an "effective" reserve ratio (ERR). We will have:

$$(14) \quad CBR = ERR[N + T + FD + GD]$$

where N = bank demand deposits

T = bank time deposits

FD = foreign currency bank deposits (converted into domestic currency units)

GD = government bank deposits.

ERR is thus the implicit average required reserve ratio in the Chilean banking system, 1/ and it will be taken as exogenous to our analysis. 2/

When the definition of broad money (M = C+N+T) is combined with equations (13) and (14), there is a nonlinear link between the overall stock of money and the stock of base via a money multiplier. While our model could be used to forecast values of this money multiplier, our objective is rather to define the endogenous relationship between M, H, C, and T. Linearizing, we will have:

$$(15) \quad \varepsilon_1 \ln M \simeq \varepsilon_2 \ln H + \varepsilon_3 \ln C + \varepsilon_4 \ln ERR + \varepsilon_5 \ln FD + \varepsilon_6 \ln GD$$

where ε_i = constants with ε_1, $\varepsilon_2 > 0$; ε_3, ε_4, ε_5, $\varepsilon_6 < 0$. (See Appendix II for a definition of these constants.) This implies that the stock of broad money will rise as base money increases but fall with any increase in holdings of currency, foreign currency deposits, and government deposits or an increase in the effective reserve ratio.

1/ Once again, financiera holdings of reserves are being excluded because of the absence of data.

2/ This means we are ignoring the effects of shifts between various classes of deposits on ERR.

The above definitions can also be used to specify the total stock of funds (F) available to banks.

$$(16) \quad F = (1-ERR)\,[N + T + FD + GD] + CCB + CA + OI + FL$$

where CCB = bank capital

OI = other bank sources of funds

FL = foreign borrowing by banks.

The bank funds available for the purchase of assets thus equal the sum of deposits net of reserve holdings bank borrowing from the central bank, bank capital, bank foreign borrowing, and other bank sources of funds. This nonlinear relationship can be linearized to yield (using M = C+N+T):

$$(17) \quad \varepsilon_7 \ln F = \varepsilon_8 \ln M - \varepsilon_9 \ln C - \varepsilon_{10} \ln ERR - \varepsilon_{11} \ln FD - \varepsilon_{12} \ln GD$$

$$+ \varepsilon_{13} \ln[CCB + CA + OI + FL] \text{ 1/}$$

where ε_7, ε_8, ε_9, ε_{10}, ε_{11}, ε_{12}, $\varepsilon_{13} > 0$. (See Appendix II for the derivation of these constants.)

The relationships represented by equations (1) - (17) imply that financial market developments are strongly influenced by events in international markets and such domestic factors as inflation, output, and banking system regulations. What we next want to describe is how financial market developments in turn influence inflation and the balance of payments. 2/

1/ This last variable is used because CCB + CA + OI has negative elements since OI is a variable based on a net definition.

2/ Since our model is estimated over a sample of monthly data, we will take the level of domestic output as exogenous.

5. The balance of payments

Since the domestic monetary base can increase as a result of central bank purchases of foreign or domestic assets, the overall state of the balance of payments will necessarily be closely related to monetary and portfolio disequilibrium. It is therefore assumed that the balance of payments is influenced by attempts to arbitrage goods and security prices across countries, by portfolio disequilibrium, and the state of the domestic business cycle. In the long run, goods and financial market equilibrium require that (i) the prices of domestic goods increase at the same rate as world prices adjusted for any changes in the exchange rate and trade restrictions; and (ii) that domestic interest rates not differ from comparable foreign interest rates plus the expected rate of depreciation of the exchange rate by more than the risk premium attached to lending to Chilean nationals by foreign financial institutions (i.e., interest rate parity must hold). Short run departures from either relative purchasing power parity or interest rate parity will result in arbitrage flows that will lead to changes in the authorities' stock of foreign exchange reserves (assuming that the exchange rate is not perfectly flexible).

In addition, any excess flow demand for money implies an excess demand for base money. If this excess demand for base money is not satisfied by central bank creation of domestic credit, then the resulting portfolio adjustments will help to generate a balance surplus. Finally, the balance of payments may be affected by the state of the domestic business cycle. As the level of output expands relative to the economy's capacity output, imports may increase sharply which will deteriorate the state of the balance of payments. Thus: 1/

$$(18) \quad \frac{XR}{H} D\ lnR = \alpha_6 - \gamma_{19}(D\ lnP_D - D\ lnP_F) + \gamma_{20}(r_B - r_F^*) + \gamma_{21}[\gamma_{22}\{lnM^d - L\ lnM\} - D\ lnCR] - \gamma_{23}ln(Y/Y^T)$$

where P_D = price vector for domestic goods

P_F = price vector for foreign goods (in terms of domestic currency).

1/ This balance of payments equation reflects the fact that Chile did not have a floating exchange rate during our sample period.

6. Price behavior

The overall price level (P) can be defined as a log linear weighted average of the levels of the prices of domestic (P_D) and foreign (P_F) goods. Thus:

$$(19) \quad \ln P = \alpha_7 + \gamma_{24} \ln P_D + (1-\gamma_{24}) \ln P_F$$

Domestic goods are those produced locally, and foreign prices equal world prices adjusted for exchange rate and tariff (or quota) effects.

The prices of domestic goods are influenced by international price arbitrage, domestic monetary disequilibrium, and domestic cyclical developments. Thus:

$$(20) \quad D \ln(P_D/P_F) = \alpha_8 - \gamma_{25} L \ln(P_D \varepsilon_{14}/P_F) + \gamma_{26}[L \ln(\frac{M}{P}) - \ln(\frac{M}{P})^d] + \gamma_{27} \ln(Y/Y^T)$$

The rate of increase of the prices of domestic goods rises relative to the foreign rate of inflation whenever the prices of domestic goods are sufficiently (as given by ε_{14}) below foreign prices, an excess supply of real money develops, or the level of economic activity rises relative to capacity output. The presence of both monetary disequilibrium and international price arbitrage effects reflects the fact that during the Chilean reform period, the Chilean economy was neither completely open nor closed in terms of international transactions.

7. Expectations

In our model the expected rate of inflation and expected rate of depreciation of the exchange rate have played important roles in determining the expected real returns on financial assets. To simplify, we assume that the private sector forms the expectations on the basis of its past experience with actual exchange rate and price movements. Thus:

$$(21) \quad D x^e = \beta_6 L(x - x^e) \text{ with } 0 < \beta_6 < 1$$

where x = actual monthly rate of change of the exchange rate, and

$$(22) \quad D \pi^e = \beta_7 L(\pi - \pi^e) \text{ with } 0 < \beta_7 < 1$$

where π = actual monthly rate of change in wholesale price index. Our study will attempt to identify the values of β_6 and β_7 which best describe the formation of exchange rate and price expectations.

This type of adaptive expectations structure is often regarded as "irrational" in the sense that there can be a significant gap between actual and expected price movements for an extended period. Brunner, Cukierman and Meltzer (1980) and White (1980a) have argued, however, that this expectations structure is "rational" (i.e. represents an optimal forecasting technique) whenever economic agents are uncertain about whether observed shocks to the economy are permanent or transitory. In an economy undergoing extensive structural changes, all past observations are useful in identifying the permanency of past shocks. Brunner et. al. (1980) also argued that the size of β_6 and β_7 are positively related to the ratio of the variance of permanent shocks to the variance of temporary shocks. Thus, if the ratio of the variance of permanent shocks to the variance of temporary shocks is low, then the β_i will be low, giving important weight to past history.

III. Empirical Results

1. Parameter estimates

Table 1 summarizes the empirical results for the model obtained from a sample of monthly data for the period July 1976 to June 1980. The model was estimated using a full information maximum likelihood estimator 1/ which allowed for the imposition of the appropriate cross equation restrictions on parameters. The various behavioral relationships are generally well estimated.

The parameter estimates for the nonfinancial sector indicate a relatively slow adjustment of actual to desired portfolio holdings. The mean time lags involved in the adjustment of actual to desired holdings range from three months for the demand for broad money, to six months for the demand for time deposits, and to 16 months for the demand for bank loans. The relatively rapid adjustment of broad money holdings quite likely reflects fast adjustment of currency holdings. These adjustment speeds imply a sharp difference between the short- and long-run portfolio responses to interest rate, inflation, and income movements. Table 2 illustrates, for example, that a 1 per cent increase in the loan rate would bring about a 0.16 per cent fall in the demand for bank loans in the short run versus a 2.48 per cent decline when all portfolio adjustments are complete.

1/ See Wymer (1978) for a description of the RESIMUL program.

Table 1 (continued). Parameter Estimates for Chile 1/

Equations	Dependent Variable	Explanatory Variable	Parameter	Estimate	T-Ratio
(1) & (2)	$D \ln (\frac{B}{P})$	adjustment parameter	β_1	0.063	7.66
		constant		-0.034	3.00
		$r_B-\pi^e$	γ_1	38.993	7.82
		$r_F'-\pi^e$	γ_2	17.591	4.82
		$r_{FL}-\pi^e$	$\gamma_3 = \gamma_2$ 2/		
		$\ln(Y/Y^T)$	γ_4 2/	0.00	--
		z_1	λ_1	0.011	2.21
(4) & (5)	$D \ln (\frac{T}{P})$	adjustment parameter	β_2	0.182	3.50
		constant		-0.311	4.89
		$-\pi^e$	γ_5	2.765	0.35
		$r_T-\pi^e$	γ_6	102.215	2.71
		$r_{FT}-\pi^e$	γ_7	98.394	2.99
		$\ln(Y/Y^T)$	γ_8	1.404	1.86
		z_2	λ_2	0.165	3.12
		z_3	λ_3	-0.011	3.31
		z_4	λ_4	0.033	2.46
(6) & (7)	$D \ln (\frac{M}{P})$	adjustment parameter	β_3	0.308	9.46
		constant		-0.2892	9.98
		$-\pi^e$	γ_9	11.754	26.13
		$r_T-\pi^e$	γ_{10}	-1.124	1.40
		$r_{FT}-\pi^e$	γ_{11}	4.763	4.92
		$\ln(Y/Y^T)$	γ_{12}	-0.091	0.92

Table 1 (continued). Parameter Estimates for Chile 1/

Equations	Dependent Variable	Explanatory Variable	Parameter	Estimate	T-Ratio
(8) & (9)	D ln(T/F)	adjustment parameter	β_4	0.219	5.79
		constant		-0.271	7.10
		$r_T-r_EK_T-r_B(1-K_T)$	γ_{13}	5.516	1.71
		$r_Tr_EK_T-r_F'$	γ_{14}	4.132	2.58
		$r_T-r_EK_T-r_G$	γ_{15}	1.685	0.78
		z_2	λ_5	0.014	1.65
		z_5	λ_6	0.021	3.45
(11)	D r_B	adjustment parameter	β_5	0.218	5.35
		constant		-0.015	6.00
		$r_T-r_EK_T$	γ_{16}	3.796	4.01
		r_F'	γ_{17}	0.458	1.40
		r_G	γ_{18}	0.867	1.54
(15)	lnC	autocorrelation parameter	ρ_{15}	0.959	92.41
		constant		-0.2384	4.22
		lnM	ε_1	0.596	--
		lnH	ε_2	1.0	--
		lnC	ε_3	-0.076	--
		lnERR	ε_4	-0.070	--
		lnFD	ε_5	-0.043	--
		lnGD	ε_6	-0.1867	--
		z_6	λ_7	0.030	3.46
		z_7	λ_8	0.030	4.51

Table 1 (continued). Parameter Estimates for Chile 1/

Equations	Dependent Variable	Explanatory Variable	Parameter	Estimate	T-Ratio
(16)	lnF	autocorrelation parameter	ρ_{16}	1.011	27.88
		constant		0.006	0.27
		lnF	ε_7	1.0	--
		lnM	ε_8	0.466	--
		lnC	ε_9	0.087	--
		lnERR	ε_{10}	0.325	--
		lnFD	ε_{11}	0.020	--
		lnGD	ε_{12}	0.086	--
		ln[FD+GD+CCB+CA +OI+FL]	ε_{13}	0.752	--
(17)	$\frac{XR}{H}$D lnR	constant		-0.232	9.26
		D $\ln P_D$ - D $\ln P_T$	γ_{19}	0.195	3.29
		$r_B - r_F^{\frac{*}{}}$	γ_{20}	1.579	7.85
		[γ_{21}\{$\ln M^d$-L lnM\} -	γ_{21}	0.997	73.08
		D lnCR]	γ_{22}	0.280	9.88
		$\ln(Y/Y^T)$	γ_{23}	0.49	1.35
		z_2	λ_9	0.005	0.31
		z_3	λ_{10}	-0.002	1.97
		z_8	λ_{11}	0.023	5.15
(18)	lnP	constant		-0.004	6.59
		$\ln P_D$	γ_{24}	0.811	306.58

Table 1 (concluded). Parameter Estimates for Chile 1/

Equations	Dependent Variable	Explanatory Variable	Parameter	Estimate	T-Ratio
(19)	$D\ \ln(P_D/P_F)$	constant		0.481	5.39
		$L\ \ln(P_D e_{14}/P_F)$	γ_{25}	0.338	5.46
		$L\ \ln(\frac{M}{P})-\ln(\frac{M}{P})^d$	γ_{26}	0.358	4.85
		$\ln(Y/Y^T)$	γ_{27}	-0.251	2.84
		z_3	λ_{12}	-0.024	7.24
		z_6	λ_{13}	-0.056	2.37
		z_1	λ_{14}	-0.043	5.91
(20)	x^e		β_6	0.1	--
(21)	π^e		β_7	0.1	--

1/ All behavioral parameters are defined to be positive.
2/ Imposed.

Table 2 (continued). Short and Long-Run Elasticities 1/

Equation	Dependent Variable	Explanatory Variable	Short-Run 2/ Elasticity (t-Ratio)	Long-Run Elasticity (t-Ratio)
(2)	$\ln(\frac{B}{P})$	$-\pi^e$	-0.012 (0.84)	-0.192 (0.83)
		r_B	-0.157 (4.81)	-2.478 (7.82)
		$r_F^{\prime}$	0.054 (3.62)	0.853 (4.82)
		r_{FL}	0.073 (3.62)	1.157 (4.82)
		$\ln Y^T$	0.063 (7.66)	1.0 3/
(5)	ln(T/P)	$-\pi^e$	0.010 (0.25)	0.053 (0.27)
		r_T	0.866 (4.96)	4.758 (2.71)
		r_{FT}	-0.881 (5.61)	-4.841 (2.99)
		lnY	-0.256 (2.31)	-1.404 (1.86)
		$\ln Y^T$	0.438 (3.69)	2.404 (3.18)
(7)	ln(M/P)	$-\pi^e$	0.091 (5.13)	5.867 (8.73)
		r_T	-0.016 (1.30)	-0.052 (1.40)
		r_{FT}	-0.072 (5.40)	-0.234 (4.92)
		lnY	-0.028 (0.93)	-0.091 (0.92)
		$\ln Y^T$	0.336 (7.74)	1.091(11.08)
(9)	ln(T/F)	r_T	-0.115 (4.30)	0.528 (4.35)
		$r_E K_T$	0.029 (4.30)	0.132 (4.35)
		$r_B(1-K_T)$	0.114 (1.98)	0.523 (1.71)
		$r_F^{\prime}$	0.044 (2.45)	0.200 (2.58)
		r_G	0.013 (0.72)	0.058 (0.78)

Table 2 (concluded). Short and Long-Run Elasticities 1/

Equation	Dependent Variable	Explanatory Variable	Short-Run 2/ Elasticity (t-Ratio)	Long-Run Elasticity (t-Ratio)
(11)	r_B	r_T	0.606 (7.48)	2.781 (4.01)
		$r_E K_T$	0.151 (7.48)	0.694 (4.01)
		$r_F^{\ast}$	0.076 (1.21)	0.349 (1.40)
		r_G	0.102 (1.93)	0.474 (1.53)

1/ Evaluated at sample means.
2/ The short run elasticity is the product of the relevant explanatory variable parameter and the corresponding adjustment parameter evaluated at the sample means.
3/ Imposed.

The nonfinancial sector's holdings of bank loans increased whenever there was a higher expected real financiera loan rate, a higher expected real foreign loan rate, or an increase in permanent income. 1/ In contrast, a higher expected real loan rate depressed real borrowing from banks. 2/ As noted earlier, the short run interest rate elasticity of the demand for bank loans is much smaller than the longer term elasticities. This evidence provides further support for the McKinnon (1973) hypothesis that the short run demand for bank funds is dominated by the demand for working capital. As will be discussed later, the interest inelastic nature of the demand for bank loans is one factor in explaining the persistence of high real interest rates in the Chilean reform period.

Nonfinancial sector holdings of real time deposits increased whenever there was an increase in the expected real return on time deposits or in permanent income. A higher real return on currency and demand deposits

1/ The estimation program was unable to identify γ_4 despite a variety of changes in the specification of the demand for bank loans. γ_4 was thus set equal to zero.
2/ The demand for domestic bank borrowing was reduced when restrictions on foreign borrowing were loosened somewhat beginning in June 1979. For discussion see Ffrench-David and Arellard (1981) Table 17.

(given by $-\pi^e$) or financiera deposits worked to reduce real time deposit holdings. As income rose relative to permanent income, holdings of time deposits declined reflecting the shift toward currency and demand deposit holdings in order to satisfy the need for transactions balances.

Since the adjustment parameter β_2 implies a mean time lag for the adjustment of actual to desired real time deposit holdings of slightly over 5 months, the flow demand for time deposits has interest rate elasticities that are less than unity in the short run and considerably larger in the longer term (see Table 2). The results also indicate that time deposits in financieras are viewed as quite close substitutes to time deposits in banks. The short and long run bank time deposit demand elasticities with respect to the expected real yields on bank time deposit and financiera time deposits are of roughly comparable size though of opposite sign. And despite the interest elastic nature of the long run demand for bank time deposits, the short run demand must be characterized as relatively interest inelastic. 1/

The results for the demand for broad money reflect the fact that the estimated interest rate parameters are composite terms which are influenced by the underlying interest rate elasticities for currrency, demand deposits, and time deposits. As noted earlier, a higher $r_T-\pi^e$ which raised the demand for time deposits also lowers that for currency and demand deposits would imply a coefficient of ambiguous sign for the parameter on $r_T-\pi^e$ in the demand for broad money. As shown in Table 1, the demand for broad money responds positively to a fall in the expected rate of inflation, a lower expected real yield on financiera

1/ The nonbank demand for time deposits has also been affected by changes in capital controls and crises in the financiera system. In late 1976 and early 1977 holdings of bank time deposits increased as a result of the failures of some financieras. This shift is represented by two dummy variables z_2 and z_3. z_2 contains one's for the period July 1976 to April 1977 with zeros elsewhere; and z_3 contains a time trend for the period July 1976 to April 1977 and zeros elsewhere. The estimated parameters (λ_2 and λ_3) indicate that this shift of deposits had its greatest impact during July 1976 and then gradually diminished over time. z_4 contains one's between September 1977 and April 1978 and zeros elsewhere; and it represents the impact of imposing a limit on commercial bank conversion of foreign loans into domestic currency. This no doubt influenced the willingness of banks to issue time deposits and quite likely resulted in banks improving the characteristics as well as the yield on time deposits. The effect of the improvement in the characteristics of time deposits on the nonfinancial sector's demand for these assets is represented by z_4.

deposits, a higher ratio of current to permanent income, and a higher level of permanent income. In contrast, a higher expected real time deposit rate does not have a significant effect and is negative in sign. This suggests that changes in the demand for currency and demand deposits have significantly influenced the demand for broad money.

The contrast between the insignificant and negative coefficient on the $r_T-\pi^e$ terms and the significant and negative coefficient on $r_{FT}-\pi^e$ in the demand for broad money, reflects the type of portfolio substitutions generated by interest rate changes. A rise in the expected real yield on financiera deposits will lead to portfolio substitution away from currency, demand deposits, and time deposits. Since all three substitution effects work in the same direction, it is not surprising that γ_{10} is a significant coefficient. An increase in $r_T-\pi^e$, however, leads to substitution out of currency and demand deposits and into bank time deposits; and, therefore, its effect on the demand for broad money is ambiguous. The combination of the highly significant coefficient for $r_T-\pi^e$ in the demand for time deposits (γ_6) and the insignificant coefficient for broad money (γ_9) suggests significant substitution has occurred between the various components of broad money.

There are three general conclusions that emerge from these nonfinancial sector portfolio adjustment equations. First, portfolio adjustment generally occurs gradually with the longer term assets and liability holdings adjusting most slowly. Second, as a result of these relatively slow speeds of adjustment, the short run nonbank demand for financial assets of liabilities tend to highly inelastic even though there is considerable evidence of much higher long term interest rate elasticity. Third, the demand for bank loans and time deposits both show considerable interest rate elasticity with respect to their own interest rates and to those of close substitutes.

The proportion of bank funds derived via time deposits was most significantly related to the differential between the net cost of time deposits and the cost of foreign funds (γ_{14}). Although the coefficients on the differential between the net cost of time deposits and the return on loans (γ_{13}) and the return on government securities (γ_{15}) are of the correct sign, they are not highly significant. The results also indicate that the banks' adjustment of actual to desired holdings of time deposits has a mean time lag of over 4.5 months, which is not much faster than the speed of adjustment associated with the nonfinancial sector's demand for time deposits. This relatively slow speed of adjustment implies that the banks' supply of time deposits has been relatively interest inelastic in both the short and long run. The slow adjustment speed and low interest rate elasticities may reflect the banks' ability to have some influence over domestic market interest rates, the possibility of credit rationing, or high adjustment cost. 1/

Although the results obtained for the loan rate adjustment equation are generally consistent with the hypothesis that banks attempted to achieve a long term profit maximizing loan rate, the estimates of certain parameters appear to be biased by the absence of data on key variables that are important for determining the desired loan rate. The estimate of the adjustment parameter β_5 indicates that banks adjusted the loan rate rather slowly to changes in the determinants of the desired loan rate. The mean time lag in this adjustment process is slightly greater than 4.5 months. The coefficients on the net cost of time deposits (γ_{16}), the cost of foreign funds (γ_{17}), and the government security rate (γ_{18}) are all of the correct sign although only a the net cost of time deposits is statistically significant. In addition, γ_{16} implies an elasticity of the loan rate relative to the net cost of time deposits (2.8) that seems too large. This quite likely reflects the fact that our specification of the determinants of the desired loan rate has excluded a number of variables for which we do not have information. For example, we have not included the cost of operating the bank nor of issuing demand deposits. These excluded variables may have biased our estimate of the γ_{16}, γ_{17}, and γ_{18} parameters (and others as well).

The two linear approximations that were used to define the relationship between base money and broad money (equation (15)) and the determinants of movements in total bank funds (equation (16)) were evaluated at the sample means. Since the sample period witnessed rapid structural change and growth, it was found that the residuals from the original

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1/ The banks' issuance of time deposits was also affected by two exogenous events. During portions of 1976 the financiera system suffered a number of financial institution failures. This led to a flow of funds from the financieras to the banks which raised the portion of time deposits to bank total funds. This was represented by a dummy variable (z_2) which took on the value 1 between July 1976 and April 1977 and was zero otherwise. Second, at the end of 1978, the authorities relaxed capital controls in terms of a higher ceiling on Article 14 borrowing, larger monthly conversion of foreign funds, and a shorter minimum maturity on those borrowings. In the period just prior to this relaxation (September 1978 to November 1978), banks either found the existing restrictions severely limiting their foreign borrowing or decided to delay some of their foreign borrowing to the period of lower restrictions. In either case, there was increased reliance on bank time deposits as a source of funds. This is represented by a dummy variable (z_5) which has one's in September 1978 to November 1978 and zeros elsewhere.

linear approximations exhibited positive serial correlation. To minimize the biases induced by such serial correlation, it was decided to treat each of the identities as if it were a stochastic equation with error term $_{i,t}$ where i denotes the equation and t time. It is assumed that $\mu_{i,t} = \rho_i \mu_{i,t-1} + V_i$ where V_i is white noise with mean zero and variance σ_i^2. The identities were then transformed so that the ρ_i could be directly estimated. These resulting estimates for ρ_{15} and ρ_{16} both indicate that first differencing these identities was the appropriate transformation. 1/

While equations (12) and (15) illustrate the dependence of domestic monetary growth on the central bank's accumulation of foreign exchange reserves, equation (17) also indicates that the state of the balance of payments is strongly influenced by domestic monetary disequilibrium. The results for parameters γ_{21} and γ_{22} in equation (17) show that, whenever central bank domestic credit creation was in excess of the flow demand for money, it led to a deterioration in the state of the balance of payments. In addition, a 1 per cent per month increase in the domestic inflation rate relative to foreign inflation led, ceteris paribus, to a 0.2 per cent per month decline in the rate of growth of Chile's international reserves. In contrast, a 100 basis point increase in the differential between domestic and foreign interest rate resulted in a 1.5 per cent per month increase in the growth of international reserves. While the coefficient on the difference between current and trend output is insignificant, it is of the wrong sign. Ordinarily, one would expect that a level of current income which is high relative to trend income

1/ The linearization for the relationship between broad money and base money was also affected by changes in capital controls which altered the nature of the money multiplier. To capture these shifts, two dummy variables were used. z_6 has a one in July 1976 and zeros elsewhere which represents the effects of the increase in the minimum maturity on foreign borrowing by banks from 6 to 24 months. z_7 has one's in May and June 1980 and zeros elsewhere in order to represent the effects of the elimination of monthly limits placed on banks' monthly conversion of foreign loans into pesos. The impact of these changes in capital controls on the money multiplier implicit in (15) are given by the estimated values of λ_7 and λ_8.

would lead to a deterioration in the current account and hence the state of the balance of payments. 1/

The results for the price equations (18) and (19) imply that both monetary disequilibrium and international price arbitrage have affected domestic price behavior. Equation (18) indicates that domestic prices receive a weight of 81 per cent in the overall price index. The rate of increase in domestic prices relative to foreign inflation responded significantly to the lagged ratio of domestic to foreign prices and to the excess demand for money. The size of γ_{25} implies that there was approximately a mean lag of three months between any change in foreign prices and the resulting change in domestic prices. The coefficient on the ratio of current to trend income is significant but of the wrong sign. One would have expected greater price pressure as domestic demand rises relative to trend output. It may be, however, that this variable is more indicative of the availability of domestic goods rather than demand pressure. $\ln(Y/Y^T)$ would then be high during periods when the supply of goods is high relative to trend output, and this helps to depress prices. 2/

1/ The state of the balance of payments was also affected by both financial system crises and changes in capital inflows. The impact of the 1976 financiera system failures is represented by z_2 and z_3 (see footnote 1 on page 22 for a description). z_8 contained ones in July 1979 to October 1979 which basically represented the period between the end of the ceiling on bank foreign borrowing under Article 14 of the foreign investment law (in late June 1979) and the imposition of the monthly limit on banks' conversion of foreign exchange into pesos which was established in mid-September 1979. This relaxation of capital controls naturally results in a substantial capital inflow that raised the accumulation of reserves.

2/ The linkages between domestic price and domestic monetary disequilibrium were influenced by domestic financial crises and changes in capital controls. The financiera system crisis of 1976 is represented by z_3 (see footnote 1 on page 22 for a description) and indicates that the real growth of broad money holdings (especially bank time deposits) observed during this period reflected, in addition to the ordinary demand determinant, a shift in the demand for bank deposits relative to financiera deposits. λ_{12} provides a rough estimate of the effects of the shift in the demand for broad money on price behavior during this period. z_1 and z_6 are described, respectively, in footnote 1 on page 22 and footnote 1 on page 25. These variables represent effects of the establishment of the two year minimum maturity on foreign borrowing (z_6) and the temporary relaxation of capital controls during mid-1979 (z_1), on the linkage between domestic price formation and monetary disequilibrium.

The likelihood function for our estimator attains its maximum value when the adaptive expectations coefficients for both exchange rate and price expectations are assigned the value 0.1. The mean time lag in the adjustment of actual to expected price and exchange rate changes is thus 11 months. These relatively long lags could imply that the ratio of the variance of permanent shocks to the variance of temporary shocks is low and that important weight has been given to past history in determining underlying trends in inflation and exchange rate movements. This type of behavior could reflect private sector uncertainty about the sustainability of certain reforms.

2. In-sample forecasting efficiency

Table 3 provides the static and dynamic in-sample forecasts of our model. The static forecasts utilize the actual values of the exogenous variables and the lagged endogenous variables; whereas the dynamic forecasts use the lagged endogenous variables generated by the model. The mean squared errors for the static forecasts are less than one per cent except for currency (which is derived via the linear approximation of the relationship between broad money and base money) as implied by equation (15). The dynamic forecasts not surprisingly suggest somewhat larger errors ranging up to 7 per cent for currency. The relative large error for currency reflect the fact that the linear approximation of the nonlinear money multiplier relationship is not entirely accurate.

IV. Comparisons with Earlier Empirical Results

There are certain similarities between the results obtained in this study and those from an earlier study of Argentina (see Mathieson (1981)). Although the model used in the Argentine study has characteristics quite close to those utilized in our current analysis, the Argentine model did not allow for portfolio disequilibrium in the banking system and did not fully identify the linkages between base money, the balance of payments and broad money. In both cases, however, the nonfinancial sector exhibited a relatively slow adjustment of actual to desired stock holding for time deposits, broad money, and bank loans. The mean time lags in the adjustment process for time deposits were 6 months for Chile and 16 months for Argentina. For broad money, the mean time lags were 3 months for Chile and 26 months for Argentina; and for bank loans, the comparable mean time lags were 16 months for Chile and 33 months for Argentina. The slower adjustment speeds for Argentina could reflect the fact that, in the Argentine model, banks were assumed to be in continuous portfolio equilibrium. If market adjustments in holdings of these assets really reflected the portfolio disequilibrium of both banks and nonbanks, then misspecifying the portfolio adjustment process for banks could lead to slower estimates of the adjustment process for the nonfinancial sector.

Table 3. Mean-Squares Errors of In-Sample Forecasts
July 1976 to June 1980

Variable	Mean-Squared Error of Static Forecasts	Mean-Squared Error of Dynamic Forecasts
lnB	0.057	0.643
lnT	0.096	1.053
lnM	0.054	0.298
r_T 1/	0.0003	0.0003
r_B 1/	0.0013	0.0052
lnC	1.9791	6.960
lnF	0.039	0.418
lnR	0.044	0.047
lnP	0.026	0.100
lnP_D	0.040	0.153
lnH	0.044	0.329

1/ Prediction errors on the interest rates are in units of percentage points. Static and dynamic mean squared errors as a proportion of the average interest rates are 0.020 and 0.082 per cent respectively for the loan rate and 0.007 and 0.007 per cent respectively for the time deposit rate.

The relatively slow speeds of adjustment for nonbank portfolio holdings imply a sharp difference between short and long run interest rate and income elasticities in both Chile and Argentina. The short run demands for financial assets and liabilities therefore have been much more interest inelastic than the long run demands. By far the most interest inelastic short run demand curves have been those for bank loans. In Argentina, the short run interest rate elasticity was only -0.03 which was even lower than the -0.16 elasticity in Chile. As will be discussed shortly, these interest rate elasticity characteristics have been one factor contributing to the persistence of high real loan rates in both countries.

In these studies the overall state of the balance of payments was significantly influenced by both monetary disequilibrium and price and interest rate arbitrage. Since the Argentina model did not allow for the full simultaneous relationship between money and the balance of payments, the estimates are not directly compatible with those of the current model. It is interesting to note, however, that a greater proportion of any excess supply of money seems to have spilled over into the balance of payments in the case of Chile than in the case of Argentina. This could reflect the fact that, during the time periods we are considering, Chile had proceeded much further along in its trade reforms than Argentina. In contrast, the overall state of the balance of payments seems to have been much more responsive to price and interest rate arbitrage in Argentina than in Chile. Argentina's greater responsiveness to interest rate differentials is likely related to the lower level of capital controls in Argentina. The more rapid response to inflation differentials in the case of Argentina is somewhat puzzling in view of the fact that, during the time periods considered, Chile had fewer trade barriers than Argentina. This result could be modified by a more appropriate specification for the Argentine model of the linkages between the balance of payments and domestic monetary equilibrium.

The price equations indicate that, although international price arbitrage had roughly comparable effects on domestic inflation, the effect of any excess money supply was much more inflationary in Argentina than Chile. This is again consistent with the view that Chile was a more open economy and hence any excess supply of money would spill over more readily into the balance of payments than into the domestic inflation.

The results for the bank and nonfinancial portfolio demands and supplies also imply that the high level of nominal interest rates have encompassed quite different real interest rates behavior for loans and deposits. During the July 1976 to June 1980 period, the Chilean nominal loan rate averaged 6.4 per cent per month and the nominal time deposit rate averaged 4.7 per cent per month. Given our estimate of the adaptive expectation parameter (β_7), the average expected rate of inflation was 5.0 per cent. This implied an average real loan rate of 1.4 per cent per month and an average real time deposit of a negative 0.3 per cent per month. For the period March 1977 to December 1979, Argentina experienced an average expected real 30-days loan rate of 0.9 per cent per month and an average expected real time deposit rate of a negative 0.5 per cent. 1/

1/ Although there is no accurate estimation of the average cost of funds for the banks, it is interesting to note that in Chile the nominal average cost of funds derived from time deposits (inclusive of interest on reserves) was 3.49 per cent per month (-1.51 per cent in real terms), from foreign loans (nominal rate plus expected rate of depreciation only) was 4.85 per cent per month (-0.15 per cent in real terms), and from sale of government securities 3.47 per cent per month (-1.53 per cent in real terms).

Thus, for both countries, there was a relatively high ex ante real loan rate combined with a low or slightly negative expected real time deposit rate. 1/ These results raise two related questions. First, why was there such a high real loan rate and second, why was there such a large spread between the lending and deposit rates.

The high real loan rate seems to have reflected both an interest inelastic demand for bank loans on the part of nonfinancial sector portfolio owners and also a relatively slow adjustment on the part of banks toward increasing the real supply of bank loans. As noted earlier, the Chilean nonfinancial sector demand for bank loans had a short run interest elasticity of only -0.16. 2/ This alone would mean that an exogenous increase in the demand for loans or a reduction in the supply of loans would ensure a sharp increase in the loan rate unless the supply of bank loans was quite interest elastic. Given the nature of Chilean controls on capital inflows, any short run increse in the supply of bank loans would have to come via an increase in the issuance of bank time deposits. As shown in Table 2, however, the bank supply of time deposits had a short run interest elasticity (with respect to the loan rate) of only 0.11. In the short run, both the nonbank demand for bank loans and the bank supply of such loans were therefore quite interest inelastic. These portfolio interest elasticity characteristics thus provide some insights into why there might be considerable short run instability of interest rates; but, by themselves, these characteristics do not explain the sustained high level of the real loan rate.

The combination of a persistent high real loan rate, the need to maintain an extensive system of capital controls (at least in Chile), and rapid real growth in the amount of real credit available can be

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1/ It must be remembered that these estimates of the real interest rates on loans and deposits are based on the assumption that price expectations are formed on the basis of an adaptive expectations structure which back on a previous experience with inflation to form future inflationary expectations. Since inflation was generally declining over our sample period, a more forward looking expectations structure might imply somewhat higher real rates of return.

2/ This low elasticity estimate could also be affected by the fact that many bank loans in Chile are not made at the peso interest rate which we have used but rather a variety of other rates tied to the cost of borrowing in U.S. dollar terms. Although we have included an estimate (r_F') of the dollar costs, it may not have captured the full effects of the ability of banks and nonbanks to substitute dollar for peso loans.

explained in terms of the financial market conditions that prevailed at the start of the financial reform and markets response to the reforms undertaken. The Chilean financial system started its reform with a small initial real stock of credit and a large excess demand for that stock at the prevailing ceiling loan and deposit interest rates. The small initial stock reflected the highly variable and negative real returns on financial assets of the prereform period. When this small real stock of credit was combined with an interest inelastic demand for credit, it is not surprising that a high real loan rate prevailed. This excess demand persisted over time because neither capital inflows nor larger real holdings of time deposits grew sufficiently rapidly to eliminate the excess demand for credit. 1/ Capital inflows were inhibited by capital controls established to assist monetary control; and, at least in the short run, the supply of bank time deposits was relatively interest inelastic with respect to both the loan and time deposit rate. Thus, to encourage banks to undertake continued issuance of time deposits, there was the need for a loan rate that was high relative to the cost of time deposits. It was still the case in Chile, however, that there was a significant change in the relative real returns on bank loans and time deposits. During the first half of the sample period (July 1976 to June 1978), the ex ante real loan rate averaged 2 per cent per month whereas the ex ante real time deposit rate had an average value of negative 0.6 per cent. For the second half of the sample period, the ex ante real loan rate declined to only 0.7 per cent per month while the ex ante real time deposit rate rose to a negative 0.2 per cent. Thus, the expected real loan rate fell by two thirds during the two subperiods while the expected real deposit rate continued to rise.

The actual size of the required spread between the loan and deposit rates also reflected the effects of government regulation, and a number of economic factors. First, the deposit and loan rate spread was affected by such government regulations as the required reserve ratio and the payment of interest on reserves. The resulting net spread equaled the loan rate less the time deposit rate adjusted for the payment of interest on required reserves ($r_E K_T$) divided by one minus the required reserve ratio on time deposits ($r_B - [r_T - r_E K_T]/(1-K_T)$). The division by $1-K_T$ reflects the fact that banks could only use $1-K_T$ per cent of each peso of time deposits they received. The net spread for the period July 1976 to June 1980 has tended to decline over the sample period but still averaged 1.3 per cent per month. During the June 1979-July 1980 period, however, the mean spread declined to only 0.5 per cent per month.

1/ An alternative explanation also consistent with our model is that the persistence of the high real loan rate reflects the loan rationing that banks have undertaken in order to achieve a desired path for the loan rate that maximizes profits over time.

The continued existence of a positive net spread reflected the cost of financial intermediation, the impact of inflation, the desire of banks to earn an adequate return on their equity capital, the risks associated with interest rate and exchange rate variability, and the competitive structure of the financial system. Banks must earn some positive net spread in order to cover their operating cost. In addition, the required reserve ratio is a means of imposing an inflation tax on both borrowers, whose loan cost is driven up, and lenders, whose return on deposits is driven down as the tax is imposed. The gap between the nominal loan and deposit rates can be shown (see McKinnon and Mathieson (1981)) to be directly related to the expected rate of inflation by a factor of proportionally equal to $K_T/(1-K_T)$ in our present case. While Chilean inflation and required reserves were both quite high at the beginning of our sample, they declined over time. Since banks must bear the risks associated with interest rate and exchange rate variability, the net spread will be larger the greater are these risks. This provides some explanation of why the spread between lending and deposit rates was large at the beginning of the period and declined over time. Finally, the spread also could have reflected some element of oligopoly power on the part of financial institutions. Our empirical results do not allow us to identify the importance of this factor.

V. Conclusions

Our analysis has shown that it is possible to estimate a financial programming model for periods during which the economy is undergoing extensive trade, fiscal, and financial reforms. Our current model reflects a modification of earlier models in that it allows specifically for endogenous interest rates and the continuous impact of programs designed to gradually open the economy to international trade and capital flows.

The estimation results for Chile indicate domestic bank and nonfinancial portfolio owners have adjusted their actual to their desired asset or liability holdings only gradually. This produced a sharp distinction between the short and long run income and interest rate elasticities of demands for and supplies of financial assets. The nonfinancial sector demand for bank loans has been especially interest inelastic. The results indicate that both monetary disequilibrium and international price and interest rate arbitrage played significant roles in explaining the behavior of the domestic rate of inflation and overall balance of payments position. The presence of both monetary and arbitrage effects reflects the fact that the Chilean economy was in a period of transition from a closed to an open economy.

A comparison with earlier results obtained for Argentina suggests that there were certain common characteristics found in both the Argentine and Chilean reform periods. In both countries, the reform periods witnessed average _ex ante_ real loan rates of roughly 1 per cent a month and an average _ex ante_ real deposit rate that was approximately zero or slightly negative. The high real loan rates encountered during the early stages of the financial reform reflected the low initial stocks of real credit and deposits and the uncertainties created by high and variable rates of inflation. While the real loan and time deposit interest rates have declined over time, these real interest rates have shown considerable variability and remained high as a result of interest inelastic nonfinancial sector demand for bank loans and banking system supply of time deposits. The short run interest inelastic nature of these portfolio demands and supplies reflected in part a rather slow adjustment of actual to desired portfolio holdings. The level of interest rates and the spread between deposit and lending rates has also proved sensitive to such government policy as the level of required reserve ratio, the payment of interest on reserves, controls on capital inflows, and policies governing entry into the financial system.

The characteristics of the price and balance of payments equations for the two countries also show evidence of the effects of both monetary disequilibrium and international price and interest rate arbitrage.

APPENDIX I

Notation

B = nominal stock of bank loans.

P = wholesale price index.

r_B = bank loan rate (in per cent per month).

π^e = expected rate of inflation (in per cent per month).

r_F = nominal interest rate on foreign borrowing (in per cent per month).

r_F^* = nominal interest rate on foreign borrowing plus expected rate of change in exchange rate plus any risk premium (in per cent per month).

r_{FL} = nominal interest rate on loans from financieras.

Y^T = permanent income.

X = exchange rate (pesos per dollar).

$\dot{x}^e$ = expected rate of change in exchange rate (in per cent per month).

T = nominal stock of time deposit.

Y = current output.

r_{FT} = nominal yield on deposits in financieras.

N = nominal stock of demand deposits.

C = nominal stock of currency.

M = nominal stock of broad money (= C+N+T).

F = total bank funds.

r_E = nominal interest rate paid on bank reserves.

K_T = required reserve ratio on time deposits.

r_G = return on government securities (in per cent per month).

H = nominal stock of base money.

R = foreign exchange reserves.

CR = central bank domestic credit.

CBR = commercial bank reserve.

ERR = effective reserve ratio.

FD = foreign currency deposits.

GD = government deposits.

CCB = commercial bank borrowing from the central bank.

CA = commercial bank capital.

OI = other bank sources of funds.

FL = foreign borrowing by banks.

P_D = domestic component of wholesale price index.

P_F = foreign component of wholesale price index.

APPENDIX II

Variable Definitions and Sources

IFS = International Monetary Fund, International Financial Statistics. The line numbers reported below refer to the page containing the Chilean data.

BCC = Banco Central de Chile, Boletin Mensual.

The stocks used in the analysis are the monthly averages of the end-of-month stocks given below.

Currency	=	Line 14A in IFS.
Demand Deposits	=	Line 24 in IFS.
Time and Savings Deposits	=	Line 25A in IFS.
Broad Money	=	Sum of lines 14A, 24 and 25A in IFS.
Bank Loans	=	Line 22D in IFS.
Government Deposits	=	Line 26D in IFS.
Foreign Currency Deposits	=	Line 25B in IFS.
Base Money	=	Line 14 in IFS.
Foreign Exchange Reserves	=	Difference between lines 11 (Central Bank Foreign Assets) and 16C (Central Bank Foreign Liabilities).
Commercial Bank Reserves	=	Line 20 in IFS.
Commercial Bank Borrowing from the Central Bank	=	Line 26G in IFS.
Commercial Bank Capital	=	Line 27A in IFS.
Other Sources of Bank Funds	=	Line 27R in IFS.
Foreign Borrowing by Banks	=	Line 26C in IFS.

Price Level (Wholesale Price Index)	=	"Indice de precios al por mayor, Indice General" (BCC).
Domestic Component of Wholesale Price Index	=	"Indice de precios al por mayor, Productos Nacionales" (BCC).
Foreign Component of Wholesale Price Index	=	"Indice de precios al por mayor, Productos Importados" (BCC).
Income - Monthly Industrial Production Index	=	"Indice de produccion industrial manufacturea. Indice General" (BCC).
Permanent Income	=	Time trend for monthly industrial production index.
Loan Rate (in per cent per month)	=	"Tasas de interes effectivas mensuales cobradas en colocaciones a corto plazo. I. Bancos" (BCC).
Time Deposit Rate (in per cent per month)	=	"Tasas de interes effectivas mensuales paqadas en captaciones a corto plazo. I. Bancos" (BCC).
Foreign Interest Rate (in per cent per month)	=	Rate paid by domestic national under Article 14 borrowing (Source: Central Bank of Chile).
Government Security Rate (in per cent per month)	=	Until December 1978 this yield equals the midpoint in the range on Tasas de Interes en el Mercado Secundario de Pagares de Tesoreria por Bancos (BCC). From January 1980, pagares de Tesoreria no longer issued. Thus, used midpoint in monthly range on Pagares Descontables del banco Central".
Interest Paid on Required Reserves against Time Deposits (in per cent per month)	=	Series provided by the Western Hemisphere Department of the International Monetary Fund.
Financiera Loan Rate (in per cent per month)	=	"Tasas de interes effectivas mensuales cobrades en colocaciones a corto plazo. Il Sociedades Financieras" (BCC).
Financiera Time Deposit Rate (in per cent per month)	=	"Tasas de interes effectivas mensuales paqadas en captaciones a corto plazo. Il Sociedades Financieras" (BCC).

Required Reserve Ratio on Time Deposits	=	"Tasas de Encaje del Sistema Financiero, Moneda Nacional, Depositos y Captaciones de 30 a 89 dias plazo". (BCC).
Exchange Rate	=	Line AE of IFS.

Exogenous Variables

z1 Dummy for when capital controls on foreign borrowing loosened somewhat at the end of June 1979. Included reduction in the percentage of any loan that was required to be deposited in the central bank and removal of ceiling on bank foreign borrowing. (1 in June to December 1979).

z2 Dummy for impact of financiera crises in early and mid 1976 (involving the closure and merger of various financieras). This led to sharp increase in deposits at banks. (1 in July 1976 to April 1977).

z3 Dummy representing same event as z2 but contains time trend between July 1976 and April 1977.

z4 Dummy representing imposition of limitation on monthly conversion of foreign loans into pesos. The individual banks were initially limited to an amount equal to 5 per cent of the bank's capital and reserves. (1 in September 1977 and April 1978).

z5 Dummy representing period prior to the relaxation of capital controls at the end of 1978. These changes included a higher ceiling on Article 14 borrowing, larger limits on the monthly conversion of foreign exchange, and a shorter minimum maturity on these borrowings. (1 in September - November 1978).

z6 Dummy which represents the increase in the minimum maturity on foreign borrowing to 2 years. (1 in July 1976).

z7 Dummy which represents the initial effects of elimination in April 1980 of the monthly ceiling on conversion of foreign loans into pesos. (1 in May - June 1980).

z8 Dummy which represents the period between the end of the ceiling on total bank foreign borrowing under Article 14 (in late June 1979) and the imposition of the monthly limit on bank conversion of foreign borrowing into pesos (in mid September 1979). (1 in July to October 1979).

The constants given in equations (15) and (16) will equal (with $m = M/H$).

$$\mu_1 = e^{\overline{\ln m.ERR.c}} - e^{\overline{\ln m.c}} - e^{\overline{\ln m.ERR.M}} - e^{\overline{\ln m.ERR.FD}}$$
$$- e^{\overline{\ln m.ERR.GD}}$$

$$\varepsilon_1 = 1 - e^{\overline{\ln m.ERR.M}}/\mu_1 + e^{\overline{\ln M}}/\mu_1$$

$$\varepsilon_2 = 1$$

$$\varepsilon_3 = + [e^{\overline{\ln c}} - e^{\overline{\ln m.ERR.c}}]/\mu_1$$

$$\varepsilon_4 = [e^{\overline{\ln m.ERR.M}} - e^{\overline{\ln m.ERR.c}} + e^{\overline{\ln m.ERR.FD}} + e^{\overline{\ln m.ERR.GD}}/\mu_1$$

$$\varepsilon_5 = e^{\overline{\ln m.ERR.FD}}/\mu_1$$

$$\varepsilon_6 = e^{\overline{\ln m.ERR.GD}}/\mu_1$$

$$\varepsilon_7 = e^{\overline{\ln F}}$$

$$\varepsilon_8 = e^{\overline{\ln M}} - e^{\overline{\ln ERR.M}}$$

$$\varepsilon_9 = e^{\overline{\ln C}} - e^{\overline{\ln ERR.c}}$$

$$\varepsilon_{10} = e^{\overline{\ln ERR.M}} - e^{\overline{\ln ERR.C}} - e^{\overline{\ln ERR.FD}} + e^{\overline{\ln ERR.GD}}$$

$$\varepsilon_{11} = e^{\overline{\ln ERR.FU}}$$

$$\varepsilon_{12} = e^{\overline{\ln ERR.GD}}$$

$$\varepsilon_{13} = e^{\overline{\ln[CCB+CA+OI+FL]}}$$

where a bar over a variable denotes the mean, and ln is the natural logarithm, and e is the exponential.

Bibliography

Brunner, K., A. Cukierman and A.H. Meltzer, "Stagflation, Persistent Unemployment and the Permanence of Economic Shocks," Journal of Monetary Economics, October 1980, pp. 467-492.

Fry, M.J., "Financial Development and Stabilization Models for Financially Repressed Developing Economies," paper presented at the American Economic Association Meeting, Denver, September 5-7, 1980.

International Monetary Fund, International Financial Statistics, Washington, D.C.

Ffrench-Davis, R. and Arellano, J.P., "Financial Liberalization and Foreign Debt: The Chilean Experience, 1973-80," unpublished 1981.

Khan, M.S. and M.D. Knight, "Stabilization Programs in Developing Countries: A Formal Framework," International Monetary Fund, DM/80/63, September 29, 1980.

Knight, M.D. and D.J. Mathieson, "Economic Change and Policy Response in Canada under Fixed and Flexible Exchange Rates," International Monetary Fund, DM/80/21, March 21, 1980.

Leff, N.H. and K. Sato, "Macroeconomic Adjustment in Developing Countries: Instability, Short-Run Growth and External Dependency," The Review of Economics and Statistics, May 1980, pp. 170-179.

Mathieson, D.J., "Financial Reform and Capital Flows in a Developing Economy," International Monetary Fund, Staff Papers, September 1979, pp. 450-489.

_____, "Financial Reform and Stabilization Policy in a Developing Economy," Journal of Development Economics, September 1980, pp. 359-395.

_____, "Inflation, Interest Rates and the Balance of Payments During a Financial Reform: The Case of Argentina," DM/81/47, June 18, 1981.

_____, "Interest Rates and Monetary Aggregates During a Financial Reform," International Monetary Fund, DM/79/95, December 26, 1979.

McKinnon, R.I., Money and Capital in Economic Development, The Brookings Institution, Washington, D.C., 1973.

McKinnon, R.I. and D.J. Mathieson, "How to Manage a Repressed Economy," Princeton Essays in International Finance, No. 145, December 1981.

Shaw, E.S., Financial Deepening in Economic Development, Oxford University Press, New York, 1973.

Tobin, J., "A General Equilibrium Approach to Monetary Theory," Journal of Money, Credit and Banking, February 1969, pp. 15-29.

Tobin, J. and W. Brainard, "Pitfalls in Financial Model Building," American Economic Review, May 1968, pp. 99-122.

White, W.H., "The Case For and Against 'Disequilibrium' Money," International Monetary Fund, Staff Papers, September 1981, pp. 534-72.

_____, "The Importance of 'Blocked' Compensating Deposit Balances for Monetary Policy in LDCs," International Monetary Fund, DM/80/15, February 27, 1980.

Wymer, C., "Computer Programs: Resimul Manual," unpublished, March 1978.