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"A Macroeconometric Policy Model for Brazil"

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A MACROECONOMETRIC POLICY MODEL FOR BRAZIL

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INTRODUÇÃO

O presente trabalho é parte integrante da tese de doutorado do autor pela JOHNS HOPKINS UNIVERSITY. Esta versão preliminar apresenta a especificação e estimação de um modelo macroeconômico para o Brasil e se constitui no Capítulo 6 da tese. A elaboração teórica das equações de comportamento, assim como os experimentos realizados com o uso do método dos mínimos quadrados, estão nos Capítulos 4 e 5. Os exercícios de simulação e as conclusões de política encontram-se no Capítulo 7. Os capítulos iniciais, por sua vez, apresentam a introdução do trabalho e uma análise institucional do país.

O objetivo desta divulgação é a discussão das principais propriedades do modelo macroeconômico utilizado. Apesar deste projeto de pesquisa ser bastante integrado, o assunto proposto para discussão está em grande parte contido neste texto para discussão interna.

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CHAPTER 6

A Macroeconometric Model for Brazil

6.1 - Introduction

In this chapter a probabilistic 38 equation macroeconomic model is presented, estimated, and analyzed. The structure of the model is shown in section 6.2. In this section we discuss the main properties of the model including the links between the financial and the real sectors. Then in section 6.3 the model's identification and estimation problems are discussed, and a modified 2SLQ method of estimation using principal components is employed to estimate the behavioral equations. In this section we also present the 2SLQ estimate of the whole macro model. This model is a quantitative characterization of the structure of the Brazilian economic system. The analysis of the statistical results of the 2SLQ estimates and the economic meaning of the coefficient estimates are presented in section 6.4. In this section was also compare the OLSQ and 2SLQ coefficient estimates of the behavior equations of the macroeconomic model.

6.2 - The Structure of the Macroeconomic Model

The macroeconomic model is a complete system of 38 simultaneous equations with the same number of endogenous variables and 39 predetermined variables. The predetermined variables consist of lagged endogenous and exogenous variables of which nine are under the control of the government. The specifications of the 14 behavior equations were "suggested" by economic theory and the ordinary least squares estimates presented in Chapters 4 and 5. The rest of the model consists of definitional and equilibrium condition equations.

To help the understanding of the characteristics of the macroeconomic model, Chart 6.1 presents the structural equations of the model and a glossary of the variables. In this chart, the endogenous and predetermined variables head the columns, while the rows represent the structural equations. In order to help future analysis, the endogenous variables are divided into financial and real variables and the predetermined variables into policy, financial, and real ones. Nine economic policy variables are under the control of the government: the reserve requirement ratio on demand deposits (RQDDB); the reserve requirement ratio on time deposits (RQDTB); the discount rate (IBBCB); government loans (LCBN); unborrowed high-powered money (HPM); government securities (GS); the exchange rate (RATE); the interest rate on time deposits (IDTB); and federal government expenditures (GOVEXP).

The model is dynamic since it contains endogenous variables lagged by one period and since private and total capital accumulation is the result of the addition of net investment to the base year capital stock. Besides this, the model's structure is simultaneous and not recursive since each structural equation includes two or more endogenous variables.*

*In a recursive model, each equation determines a dependent variable. The other dependent variables in the equation are "predetermined sucessively by equations earlier in the hierarchy". See Christ (1966), pp. 454-455.

The model's market for financial assets consists of bank reserves, currency, loans, government securities, demand deposits, time deposits, and international reserves. The distribution of these assets among the private banking, private non-banking, government, and foreign sectors was analyzed in Chapter 4 and the corresponding balance sheets presented in Table 4.1 Below, is presented the financial sector building blocks, which consists of demand, supply, and market equilibrium conditions for the assets listed above.

Glossary of the Variables

RRR	required reserves, real value
RDEPD	total disposable deposits, real value
RRE	excess reserves, real value
RLBN	bank loans, real value
RGSB	government securities with banks, real value
GSB	government securities with banks, nominal value
RBBCB	bank borrowing from Central Bank, real value
DEPRAT	deposit ratio
LORAT	loan ratio
RCURR	currency, real value
RDDB	demand deposits, real value
RDTB	time deposits, real value
ILBN	interest rate on bank loans
RNBBF	foreign loans, real value
RLCBN	government loans, real value
RHPM	unborrowed high-powered money, real value
GSPI	government bonds with private non-banks, nominal value

RFR	foreign reserves, real value
PRICE	price level
RRATE	exchange rate, real value
YGS	interest on government securities, nominal value
FR	foreign reserves, nominal value
IGS	interest rate on government securities
RLT	total loans, real value
TAX	tax, nominal value
RINVP	private investments, real value
RGOVEXP	federal government expenditures, real value
RCONPH	private per capita consumption, real value
RCONP	private consumption, real value
RINCDH	per capita disposable income, real value
RIMP	imports, real value
REXP	exports, real value
REXPM	exports of manufactures, real value
INC	national income, nominal value
INCDI	disposable income, nominal value
RINCDI	disposable income, real value
RINC	national income, real value
RINCNA	non-agricultural income, real value
RQDDB	reserve requirement ratio on demand deposits
RQDTB	reserve requirement ratio on time deposits
IBBCB	discount rate
LCBN	government loans, nominal value
HPM	unborrowed high-powered money, nominal value
GS	government securities, nominal value
RATE	exchange rate

IDTB	interest rate on time deposits
GOVEXP	federal government expenditures, nominal value
URRATL	lagged rate of increase of unborrowed reserves
RREL	lagged excess reserves, real value
RGSBL	lagged government securities with banks, real value
RCUURRL	lagged currency, real value
RDDBL	lagged demand deposits, real value
RDTBL	lagged time deposits, real value
IBF	interest rate on foreign loans
RLBNL	lagged bank loans, real value
RFRL	lagged foreign reserves, real value
RNBBFL	lagged foreign loans, real value
FRL	lagged foreign reserves, nominal value
GSL	lagged government securities, nominal value
LCBNL	lagged government loans, nominal value
HPML	lagged unborrowed high-powered money, nominal value
$\overline{X}$	other private sector net revenue, nominal value
TIME	time
RKPIL	lagged private capital, real value
RKGOV	government capital, real value
RKFOR	foreign capital, real value
RINVF	foreign investment, real value
OGOVR	other government revenues, nominal value
RCONPHL	lagged per capita consumption, real value
POP	population
RIMPL	lagged imports, real value
REXPA	exports of non-manufactures, real value
RINCW	rest of the world income, real value index

REXPML	lagged exports of manufactures, real value
RINCA	agricultural income, real value
RKAPL	lagged capital, real value
TECN	technology
RGOVNF	non-federal government expenditure, real value

Bank's demand for reserves is composed of the demand for excess reserves (equation 6.6) and for required reserves (equation 6.20). Part of these reserves are financed by bank's demand for loans (or supply of liabilities) from the monetary authorities (equation 6.9). As was already discussed in Chapter 4, the Central Bank fixes the discount rate and lets bank demand, ceteris paribus, fix the quantity of loans. Since the supply of unborrowed high-powered money in nominal terms is supposedly under the control of the government, bank loans from the monetary authorities are subtracted from the demand for reserves, which than becomes a demand for unborrowed reserves.

The demand for currency by the private non-banking sector (equation 6.1) plus the demand for unborrowed reserves by the banking sector compose the real demand for unborrowed high-powered money. The supply of unborrowed high-powered money in real terms depends on the price level (equation 6.30). The equilibrium condition in the market for unborrowed high-powered money is satisfied when demand and supply are equal (equation 6.16). Besides this, the supply of unborrowed high-powered money is distributed among unborrowed reserves and currency according to the behavior of the private banking and non-banking sectors. Therefore, the demand equations for currency, excess reserves, and required reserves are also the equilibrium conditions for these markets.

The demand equation for private non-banking sector demand deposits (equation 6.2) is also the equilibrium condition in this market. This occurs because the supply of demand deposits by the banks is supposedly infinitely elastic at the nominal interest rate determined institutionally (zero). In the same way, the demand equation for time deposits (equation 6.3) is also the equilibrium condition for this market. The interest rate on time deposits is determined by the Central Bank, and supply is presumedly infinitely elastic at this rate.* Therefore, given the interest rate on time deposits, the market equilibrium quantity is determined by demand.

The bank's demand equation for government securities (equation 6.8) is first determined in real terms and then multiplied by the general price level in order to determine nominal demand (equation 6.31). Since the nominal supply of government securities is exogenous, the market equilibrium condition (equation 6.19) determines private non-banking sector demand. Besides this, since the supply of government securities is distributed between the banking and non-banking sectors, the banks' demand equation for securities is also equal to supply.

Private non-banking sector loans come from commercial banks, the foreign sector, and the government (equation 6.24).

The demand for bank loans (supply of liabilities) by the private non-banking sector (equation 6.4) is equal to the supply of bank loans (asset demand equation 6.7). However, the

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*See the analysis of the banks' portfolio in Chapter 4, pp. 25-28, and especially the footnote on page 26 for the justification of this hypothesis.

supply of foreign loans is supposedly infinitely elastic at the interest rate determined in the world market. Therefore, given the interest rate, the demand equation for foreign loans (equation 6.5) is also the equilibrium condition in this market. Government loans in current prices are presumedly exogenously determined. However, government loans in real terms depend on the general price level (equation 6.29).

The stock of international reserves is demanded by the government and supplied by the foreign sector. However, this market is not directly explained by means of demand and supply equations. In this study, the flow of international reserves is given by the balance in the commercial account plus the flow of international capital (equation 6.17), whose markets are explained in another part of the model.

The goods and services market is highly aggregated. This market enters the model in order to characterize it as the general equilibrium type. The equilibrium condition in the goods and services market is satisfied when ex-ante real aggregate expenditures are equal to real income (equation 6.25).

Aggregate expenditures are equal to the sum of private consumption (equation 6.10) and investment (equation 6.11), exports (equations 6.28 and 6.13), federal government expenditures (equation 6.33), and foreign investment and non-federal government expenditures (supposedly exogenously determined), minus imports (equation 6.12). On the other hand, aggregate supply (equation 6.27) is equal to non-agricultural sector supply (equation 6.14) plus exogenous determined agricultural supply. Aggregate supply is distributed according to the behavior of the various aggregates in the economy; thus the demand equations of the aggregates are also the equilibrium conditions.

In the model, the transmission of monetary and fiscal policy occurs by means of the government budget restraint (equation 6.15), which determines government tax receipts. This hypothesis is convenient because total tax yields would have to be an endogenous variable even if the different tax rates were considered exogenous. Besides this, since the relations between the revenues derived from different taxes and the various tax bases may change due to modifications in tax law, income distribution, consumption habits, etc., it is very difficult to estimate time series for the different tax rates.

The rest of the model's equations are definitions of variables. Equation 6.21 determines total available deposits in the commercial banks. This variable is defined as total demand and time deposits minus their respective required reserves. The current commercial bank deposit and loan ratios are defined, respectively, by equations 6.22 and 6.23.

Equation 6.38 defines the real exchange rate as the exchange rate determined by the government divided by the general price level. Equation 6.32 defines the nominal stock of international reserves as the product of the stock of international reserves (determined in real terms by equation 6.17) and the general price level.

Interest on government securities, which is an expenditure included in the government budget restraint, is defined in equation 6.18 as the product of the stock of government securities and the interest rate.

Nominal national income (equation 6.36) is defined as the product of real income and the general price level. When taxes and other government receipts are subtracted from nominal income, disposable nominal income is determined (equation 6.26). Real disposable income (nominal disposable income divided by the general price level) is determined by equation 6.37.

Equations (a), (b), (c), and (d) below, which represent the balance sheets of the private banking, private non-banking, government, and foreign sectors are indirectly determined by the model (See the Glossary for definitions of the variables).

(a) RLBN + RRE + RRR + RGSB = RDDB + RDTB + RBBCB + OLB

(b) RDDB + RDTB + RCURR + RGSPI + RKPI = RLBN + RLCBN + RNBBF + RWPI

(c) RBBCB + RLCBN + RFR + RKGOV = RRE + RRR + RCURR + RGSB + RGSPI + + RWG

(d) RNBBF + RKFOR = RFR + RWF

These equations were excluded from the specification of the model because the endogenous variables OLB, RWPI, RWG, and RWF, which are determined by these equations, do not appear in any other part of the model. Equations (e) and (f) below were also excluded because they define variables which only appear in the excluded balance sheet equations.

(e) RGSPI = GSPI ÷ PRICE

(f) RKPI = RKPIL + RINVP

However, equation (f) is necessary for making forecasts more than one year in advance since lagged private capital (RKPIL) enters the demand equation for private investment (equation 6.11). In the same way, since lagged total capital (RKAPL) is an explanatory variable in the production function (equation 6.14), an equation which defines lagged total capital as the sum of the lagged capital of the private, government, and foreign sectors would also be necessary for forecasts longer than one year.

The Links Between the Model's Financial and Real Sectors

Analyzing Chart 6.1, it can be seen that the model's real and financial sectors are linked by means of several variables. The influence of the financial sector on the real sector is by means of the effects of changes in the interest rate on government bonds (IGS) and in total loans (RLT) on private sector real investment demand (equation 6.11). Since the supply of government securities is determined exogenously by the government, the interest rate is determined by private sector demand. Therefore, an increase in the supply of government securities, *ceteris paribus*, results in a higher interest rate and consequently a decrease in private investment and in aggregate demand. On the other hand, increases in total available loans to the private sector (equation 6.24) decrease excess demand originating from imperfections in the loan market, as well as raising private sector investment.

In the preliminary estimation of the investment function by ordinary least squares, which was presented in Chapter 5, we verified that the long run partial mean elasticities of the interest rate (-0.10) and of total loans (0.11) were relatively small. These results are similar to those encountered by 2SLQ, which will be analyzed in Section 6.4, and are consistent with the stage of development of the country's financial sector. The effect of the interest rate on the demand for investment ought to increase in the future with the development of the financial market and probably approximate the elasticities (about -0.5) attained in developed countries.*

*Bischoff, C.W., "Business Investment in the 1970's: A Comparison of Models", *Brookings Papers on Economic Activity*, vol.1, 1971.

As was shown in Chapter 5, the effects of imperfections in the financial market are also felt on aggregate supply. The elasticity of total loans in the non-agricultural production function (equation 6.14) is equal to 0.16 when estimated by either OLSQ or 2SLQ. This result proves another significant link from the financial sector to the real sector.

The government budget restraint (equation 6.15) also transmits the effects of changes in some financial variables to the real side of the economy. Changes in the financial variables exogenously determined by the government (government loans, the stock of high-powered money, and government securities) or endogenously determined by the model (the interest rate on securities and international reserves) result, ceteris paribus, in a change in taxes (in order to satisfy the government budget restraint) and, therefore, in private sector disposable income. In turn, changes in disposable income affect aggregate consumption, imports, and, therefore, aggregate demand. This causal direction from the financial sector to the real sector is extremely important because aggregate consumption is responsible for approximately 85 per cent of national income.

The estimates of the consumption function also capture another effect of the financial sector on the real sector. The estimated coefficients of the interest rate on time deposits, which jointly with savings accounts are the most accessible financial assets for the majority of the population, are statistically significant in both the OLSQ and 2SLQ estimations of the consumption function. However, this link is very tenuous since, as will be shown later, the long-run elasticity estimated by 2SLQ is only 0.08.

Variations in the real exchange rate affect the real side of the economy by means of effects on exports of manufactured goods and on imports. The long-run elasticities estimated by OLS, respectively 0.66 and -0.63, are lower than those estimated by 2SLQ, which are 0.94 and -1.0. These results show that changes in the exchange rate exogenously determined by the government, ceteris paribus, have an important impact on net exports and, therefore, on aggregate demand.

On the other hand, the effects of the real sector on the financial sector occur principally by means of changes in private non-bank sector disposable income. Changes in disposable income affect this sector's demands for currency (equation 6.1); demand deposits (equation 6.2); time deposits (equation 6.3); bank loans (equation 6.4); and foreign loans (equation 6.5).

The government budget restraint also provides a link from the real to the financial sector. Increases in government expenditures, ceteris paribus, increase taxes. The resulting decrease in private sector disposable income negatively affects private non-bank sector demands for the financial assets mentioned above.

Variations in imports, exports, and foreign investment cause changes in the stock of international reserves, providing another link between the real and financial sectors.

The various transmission mechanisms presented above show the high degree of interdependence between the financial and real sectors of the macroeconomic model. Because of these mechanisms, any variation in the real or financial sector spreads through the entire system. In this study, we are particularly interested in the effects of changes in the economic policy instruments on the endogenous variables of the model. The estimated final effects of these variables on the intermediate and ultimate target variables will be presented in the next chapter. In order to analyze these effects, it is necessary to first present the 2SLQ estimation of the macroeconomic model. This is done in the next section.

6.3 - The 2SLQ Estimation of the Macroeconomic Model

Previous analysis of the structure of the macroeconomic model of simultaneous equations showed that some of the equations are not linear in the variables. Besides this, the number of predetermined variables (39) is larger than the number of available observations (28), which cover the period from 1948 to 1975. The first of these considerations impedes the direct application, without qualifications, of the usual identification criteria for a system of linear equations. The second requires for the reduced form to be identified that the system be estimated by a modified form of 2SLQ.* The two problems will be discussed below.

The problem of identification of a system which is linear in the parameters but non-linear in the variables is analyzed by Fisher (1961, 1965). This author shows that in the majority of practical cases the rank condition for identification of a linear system is also a necessary and sufficient condition for a system which is linear in the parameters but not in the variables.

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*The description and the properties of the 2SLQ estimation method for a system of linear simultaneous equations is presented by Christ (1966), pp. 432-453.

In our model, the behavior equations were linearized in the variables, i.e. the non-linearities were removed from the behavior equations and defined separately in the model. This procedure naturally improves the possibility of identifying the behavior equations because it results in an increase in the number of restrictions, i.e. in the number of variables that belong to the system but which are excluded from the equation. The problem is that the rank conditions of the behavior equations can not be verified because the true parameters of the model are not known.

In practice, identification is verified by use of the order condition, which is a necessary though not a sufficient condition. The order condition does not depend on the values of the unknown parameters. Fisher (1965, p. 204) argues that generally it is reasonably safe to use only the order condition.*

Analyzing Chart 6.1, it can be verified that all the behavior equations are overidentified since the number of included variables minus one in each of these equations is always less than the total number of predetermined variables in the model (39).* Besides this, the identities are automatically identified since they do not include any unknown parameters. Therefore, we can conclude that the proposed macroeconomic model is identified.

The use of the 2SLQ estimator in an econometric system of simultaneous equations which are linear in the parameters but

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*An exception to this rule can occur in segmentable models. See Christ (1966), p. 322.

*In the rank and order conditions for identification, the constant term is considered as a variable. See Christ (1966), pp. 314-334 for an analysis of the conditions for identification.

not in the variables is formally analyzed by Kelejian (1971). Besides this, an extension of the optimality properties of the usual 2SLQ estimator for non-linear models in shown by Amemiya (1974). However, the use of the 2SLQ estimator in large simultaneous equation econometric models presents the problem of the limited size of the available sample. The problem is that in the first stage of the method it is not possible to regress the endogenous explanatory variables of the behavior equations on all the predetermined variables in the model since the number of regressors is larger than the number of observations. In our model, this problem exists because there are 39 predetermined variables and 28 observations.

One procedure, which is called the structurally ordered instrumental variable method, is to divide the complete system into blocks of equations in such a way that the number of predetermined variables in each block is smaller than the number of observations. In this case, only those predetermined variables included in the block are used as regressors in the first stage.*

A practical solution to the problem of an insufficient number of observations is given by Kloek and Mennes (1960). These authors suggest that only one set of principal components of the predetermined variables be used for the whole system.* The rela-

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*Klein (1950) was one of the first to use blocks of predetermined variables for different blocks of equations. However, computational problems caused this author to later use only one block of predetermined variables in the first stage of estimation of the behavior equations in the system. See Klein (1955), pp.47-50.

*Kloeck and Mennes (1960, p. 50) suggest the use of a number of principal components not larger than one-third of the number of observations.

tive merits of these estimators are not formally known. However, empirical studies realized by Mitchell (1971) suggest that when a sufficient number of principal components is used (10 or 15), the parameters estimated by this method are relatively more stable than when the structurally ordered instrumental variable method is used. This author also suggests that the structurally ordered method may be superior when used to estimate a strongly block recursive structure.

The high degree of simultaneity in our model suggests the use of the principal components method. The 39 predetermined variables are substituted by nine principal components which correspond to approximately one-third of the number of observations.* This number is always larger than the number of variables in the behavior equations in the model, and therefore the order condition for identification is satisfied.

The nine principal components used in this study explain 98 per cent of the variation in the predetermined variables, which is sufficient to capture the most important causes of the economic fluctuations in the model. Therefore, the contributions of a larger number of principal components as first-stage re-

*This is also the maximum number of principal components that can be estimated by the available program (ESP - Econometric Software Package by J.P. Cooper, University of Chicago, 1971). However, this problem can be resolved by dividing the set of predetermined variables into subsets and estimating their corresponding principal components. In the estimation of the investment function, the predetermined variables were divided into two subsets. This was necessary because since there were six variables in the function, the use of nine principal components resulted in few degrees of freedom and in the insignificance of the estimated parameters.

gressors are absolutely marginal and can be disregarded. Experiments made by varying the number of principal components showed that the standard deviations of the estimated parameters decrease when the number of principal components is increased and obtain satisfactory results with the use of nine principal components.

Table 6.1 presents the estimations of the macroeconomic model obtained by means of the modified 2SLQ method. For each of the behavior equations, the *t* statistic is presented in parentheses below the estimated coefficients.* The significance levels of the estimated parameters are ten, five, or one percent. These levels are represented, respectively, by the symbol *, **, or *** next to the *t* statistic. A one-tail test is used since the signs of the coefficients are known *a priori*. The following statistics are also shown: the squared correlation coefficient, R^2; the Durbin-Watson statistic, DW; and the standard error of the estimate, SEE.*

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*The *t* ratio, defined as the ratio between the coefficient and its standard error estimated by a simultaneous equation method, does not have a *t* distribution, but is approximately normally distributed. Because of this, the use of the "*t* test" is widely accepted as a test of significance of the 2SLQ estimated parameters. See Christ (1966), p. 515 and 598.

*The Durbin-Watson test is correctly applicable only in regression equations in which the independent variables are exogenous. In the case of a simultaneous equation system in which the structural equations are overidentified and in which the predetermined variables are strictly exogenous, it is a good approximate test. However, in the more general case in which the predetermined variables are exogenous and lagged endogenous, the validity of the test is questionable. See Durbin (1957).

TABLE 6.1

The Macroeconometric Model Estimated by the 2SLQ Method

6.1 - Demand for Currency by the Private Non-Banking Sector

RCURR = 2291.81 + 0.0483 RINCDI - 33.59 IDTB - 61.90 ILBN + 0.4204 RCURRL

(4.40) (6.45)*** (-1.83)* (-5.87)*** (3.52)***

R^2 = 0.99, DW = 1.89, SEE = 426.70

6.2 - Demand for Demand Deposits by the Private Non-Banking Sector

RDDB = 1696.32 + 0.1027 RINCDI - 60.48 IGS - 84.34 ILBN + 0.3953 RDDBL

(2.27) (6.47)*** (-2.04)* (-3.21)*** (3.01)***

R^2 = 0.99, DW = 2.08, SEE = 1098.95

6.3 - Demand for Time Deposits by the Private Non-Banking Sector

RDTB = 260885.00 + 0.0155 RINCDI + 81.79 IDTB - 35.59 IGS - 133.78 TIME + 0.6026 RDTBL

(1.83) (1.72)* (3.11)*** (-2.25)** (-1.84)* (3.12)***

R^2 = 0.91, DW = 1.56, SEE = 387.45

6.4 - Demand for Bank Loans by the Private Non-Banking Sector

RLBN = 5945.69 + 0.0609 RINCDI - 88.82 ILBN + 0.2047 RLBNL

(4.78) (5.56)*** (-4.13)*** (1.25)

R^2 = 0.96, DW = 1.93, SEE = 856.33

6.5 - Demand for Foreign Loans by the Private Non-Banking Sector

RNBBF = 5601.14 + 0.1656 RINCDI - 340.75 IBF

(-1.76) (9.46)*** (-4.77)***

R^2 = 0.80, DW = 0.52, SEE = 5824.13

6.6 - Demand for Excess Reserves by the Private Banking Sector

RRE = 583.14 + 0.0208 RDEPD - 36.69 IGS + 42.65 IBBCB + 579.08 URRATL + 0.5912 RREL

(1.58) (1.79)* (-2.76)*** (1.85)* (2.12)** (3.55)***

R^2 = 0.65, DW = 2.57, SEE = 300.79

6.7 - Supply of Loans by the Private Banking Sector

RLBN = 2172.54 + 0.5795 RDEPD + 77.22 ILBN - 59.43 IGS - 1.21 DEPRAT

(3.79) (25.23)*** (2.64)*** (-1.96)* (-1.68)

R^2 = 0.98, DW = 1.89, SEE = 641.06

6.8 - Demand for Government Securities by the Private Banking Sector

RGSB =-174987.00 + 0.0755 RDEPD + 35.16 IGS - 39.33 ILBN - 620.62 URRATL + 89.67 TIME + 0.3413 RGSBL

(-1.81) (1.84)* (3.85)*** (-1.67) (-3.07)*** (1.80)* (1.57)

R^2 = 0.98, DW = 1.61, SEE = 283.51

6.9 - Demand for Central Bank Loans by the Private Banking Sector

RBBCB = -984.62 + 0.0133 RDEPD + 5.13 ILIBB + 12.31 LORAT

(-1.11) (1.85)* (2.13)** (1.48)

R^2 = 0.35, DW = 1.62, SEE = 104.96

6.10- Private Per Capita Consumption Demand

RCONPH = -0.04 + 0.3937 RINCDH + 0.003 IDTB + 0.5388 RCONHL

(-1.17) (2.75)*** (1.84)* (3.06)***

R^2 = 0.99, DW = 1.76, SEE = 0.04

6.11 - Private Investment Demand

RINVP = 1661.5 + 0.1309 RINC - 0.0326 RKPIL - 107.62 IGS + 0.0673 RLT + 0.9744 RIMP
(0.40) (1.71)* (-1.33) (-2.33)** (1.19) (2.26)**
R^2 = 0.99, DW = 1.85, SEE = 1698.11

6.12 - Import Demand

RIMP = 2854.51 + 0.0391 RINCDI - 636.68 RRATE + 0.6922 RIMPL
(1.29) (2.46)** (-1.95)* (4.49)***
R^2 = 0.96, DW = 1.75, SEE = 1639.20

6.13 - Exports of Manufactures

REXPM =-872.92 + 12.6903 RINCW + 58.49 RRATE + 0.6931 REXPML
(-1.86) (3.66)*** (1.67) (5.42)***
R^2 = 0.97, DW = 1.59, SEE = 182.48

6.14 - Non-Agricultural Production Function

RINCNA = -22054.1 + 0.3465 RKAPL + 0.5479 RLT + 1403.34 TECN
(-1.31) (11.06)*** (4.67)*** (1.54)
R^2 = 0.99, DW = 0.81, SEE = 6551.57

6.15 - Government Budget Restrain

GOVEXP + LCBN - LCBNL + YGS + FR - FRL = GS - GSL + HPM - HPML + TAX + OGOVR

6.16 - Unborrowed High Powered Money Identity

RHPM = RRE + RRR + RCURR - RBBCB

6.17 - Foreign Reserves Identity

RFR = RFRL + REXP - RIMP + RNBBF - RNBBFL + RINVF

6.18 - Interest on Government Securities

$$YGS = GS \cdot \frac{IGS}{100}$$

6.19 - Government Securities Identity

$$GS = GSB + GSPI$$

6.20 - Bank Required Reserves

$$RRR = RQDDB \cdot RDDB + RQDTB \cdot RDTB$$

6.21 - Bank Disposable Deposits

$$RDEPD = RDDB + RDTB - RRR$$

6.22 - Bank Deposit Ratio

$$RDDB = \frac{DEPRAT}{100} \cdot RDTB$$

6.23 - Bank Loan Ratio

$$RLBN = \frac{LORAT}{100} \cdot RDEPD$$

6.24 - Total Loans with Private Non-Banking Sector Identity

$$RLT = RLBN + RLCBN + RNBBF$$

6.25 - Income Expenditure Identity

$$RINC = RCONP + RINVP + RINVF + RGOVEXP + REXP - RIMP + RGOVNF$$

6.26 - Private Income Disposable Identity

$$INCDI = INC - TAX + \overline{x}$$

6.27 - Aggregate Supply Identity

RINC = RINCA + RINCNA

6.28 - Total Export Identity

REXP = REXPA + REXPM

6.29 -

LCBN = RLCBN . PRICE

6.30 -

HPM = RHPM . PRICE

6.31 -

GSB = RGSB . PRICE

6.32 -

FR = RFR . PRICE

6.33 -

GOVEXP = RGOVEXP . PRICE

6.34 -

RCONP = RCONPH . POP

6.35 -

RINCDI RINCDH POP

6.36 -

INC = RINC . PRICE

6.37 -

INCDI = RINCDI . PRICE

6.38 -

RATE = RRATE . PRICE

6.4 - Analysis of the Empirical Results

Comparing the OLSQ and 2SLQ Estimates

In the 2SLQ estimation of the behavior equations, various specifications were tested. Some were "suggested" by the experiments realized with OLSQ, whereas others are permitted by the theories presented in Chapters 4 and 5. In spite of the fact that the best adjustments were obtained with the specifications suggested by OLSQ, the values of the coefficients estimated by 2SLQ differ from those estimated by OLSQ. However, the majority of coeffients and their estimated significance levels are similar for OLSQ and 2SLQ. A happy exception occurred with the estimated coefficient of the discount rate (IBBCB) in the demand for excess reserves (equation 6.6), which is not significant when estimated by OLSQ but is when 2SLQ is used.

A comparison between the values of the coefficients of the behavior equations estimated by 2SLQ (Table 6.1) and by OLSQ (the first lines of the tables in Chapters 4 and 5) is presented in Table 6.2.

TABLE 6.2

Comparison of the Coefficients Estimated
by OLSQ and 2SLQ*

OLSQ > 2SLQ

Range	Nº of Coefficients
0% - 5%	9
5% - 10%	1
10% - 15%	1
15% - 20%	0
20% -	6
Total	17

OLSQ < 2SLQ

Range	Nº of Coefficients
0% - 5%	19
5% - 10%	1
10% - 15%	3
15% - 20%	1
20% -	12
Total	36

* The coefficient estimated by 2SLQ is used as the unit of measure.

Excluding the coefficients of the constant terms, 53 coefficients were estimated. The coefficients estimated by OLSQ were smaller than those estimated by 2SLQ in 36 cases and larger in 17 cases. However, the distribution of these coefficients shows no systematic form. In absolute terms, the difference was superior to 20 per cent for only 18 coefficients.

In the 2SLQ estimation, the coefficients of the interest rates in the demand equation for excess reserves (equation 6.6), in the supply of liabilities (equation 6.7), and in the demand for government securities (equation 6.8) were much larger (25 to 65 per cent) than those estimated by OLSQ. These new estimates improve the functioning of the macroeconomic model since they increase the importance of the effects of interest rates in the transmission mechanism. Besides this, the estimated coefficients of the exchange rate in the demand equation for imports and the supply of exports increased, respectively, 34 and 27 per cent in relation to the OLSQ estimated. The coefficient of the exchange rate estimated by 2SLQ corresponds to a long-run mean elasticity of approximately one, which shows the importance of exchange rate policy in the macroeconomic model.

On the other hand, the coefficients estimated by 2SLQ were at least 20 per cent smaller than those estimated by OLSQ in only six cases. Among these, a substancial decrease occurred in the effect of changes in the interest rate on government securities on the demand for time deposits (equation 6.2). The coefficients of available deposits and the loan ratio also decreased in the demand for bank loans from the Central Bank (equation 6.9), and the same occurred with the coefficients of the interest rate on time deposits and of disposable income in the equation for private consumption (equation 6.10).

Below is presented a more detailed analysis of the 2SLQ estimations of the behavior equations of the macroeconomic model.

Analysis of the 2SLQ Estimates of the Behavior Equations

The signs of the coefficients estimated by 2SLQ for the behavior equations are consistent with the theories presented in Chapters 4 and 5. Therefore, in the analysis of the empirical results which is presented below, only the statistical performance and the economic meaning of the 2SLQ estimates are discussed. The long-run partial mean elasticities of the explanatory variables are used to verify if the estimated coefficients are reasonable.* In order to simplify the exposition, the term "long-run elasticity" or only "elasticity" is used to refer to this variable. Since the variables are in different units, the importance of the explanatory variables is measured by the Beta coefficients. In Table 6.3 are presented the slopes, t-ratios, Beta coefficients, and short and long-run partial mean elasticities of the explanatory variables of the behavior equations.

The 2SLQ estimates for each behavior equation will be discussed separately. To simplify the presentation, these equations are grouped by private bank and non-bank sectors and by the real sector of the macroeconomic model. The reader is reminded that the assets of the government and foreign sectors of this model are considered exogenous or are determined indirectly. The Durbin-Watson statistics are recorded in Table 6.1, but since the validity of the test is questionable, these statistics are not discussed in the analysis that follows.*

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*The long-run partial mean elasticity of an explanatory variable is estimated by multiplying the estimated long-run coefficient by the ratio between the average of the explanatory and dependent variables during the period under analysis (1948-1975).

*See the footnote on page.

TABLE 6.3

Slopes, t - Ratios, Beta Coefficients, Short and Long Run Partial Mean Elasticities
of the Behavior Equations of the Macroeconomic Model Estimated by 2SLQ[*]

Equation Number and Explained Variable (Sector)	RINC (1)	RINCDI (2)	RINCDH (3)	ROEPD (4)	ILBN (5)	IGS (6)	IDTB (7)	IBBCD (8)	IDF (9)	DEPRAT (10)	LCRAT (11)	URRATL (12)	RRATE (13)	RLT (14)	RIMP (15)	RKPIL (16)	RKPAL (17)	RINCW (18)	TECN (19)	TIME (20)	RCURRL (21)	RDDBL (22)	RDTBL (23)	RLBNL (24)	RREL (25)	RGSBL (26)	RCONHL (27)	RIMPL (28)	REXPML (29)
6.1 - Currency[1] - RCURR		0.0483			-61.90		-33.59														0.4204								
(private non-bank)		6.45			- 5.07		- 1.83														3.52								
		0.832			- 0.204		- 0.082														-								
		0.622			- 0.248		- 0.034														-								
		1.073			- 0.427		- 0.058														-								
6.2 - Demand Deposits - RDDB		0.1027			-84.34	-60.48																0.3953							
(private non-bank)		6.47			- 3.21	- 2.04																3.01							
		0.787			- 0.124	- 0.085																-							
		0.758			- 0.169	- 0.060																-							
		1.263			- 0.281	- 0.101																-							
6.3 - Time Deposits - RDTB		0.0155				-35.59	81.79													-133.78			0.6026						
(private non-bank)		1.72				- 2.25	3.11													- 1.84			3.12						
		0.861				- 0.364	0.647													-			-						
		0.939				- 0.249	0.573													-			-						
		2.350				- 0.623	1.431													-			-						
6.4 - Bank Loans - RLBN		0.0609			-88.82																			0.2047					
(private non-bank)		5.56			- 4.13																			1.25					
		0.953			- 0.266																			-					
		0.565			- 0.266																			-					
		0.706			- 0.333																			-					
6.5 - Foreign Loans - RNBBF		0.1656							-340.75																				
(private non-bank)		9.46							- 4.77																				
		0.867							- 0.437																				
		-							-																				
		1.995							- 0.682																				
6.6 - Excess Reserves - RRE				0.0208		-36.69		42.65				579.06													0.5912				
(banks)				1.79		- 2.76		1.85				2.12													3.55				
				0.319		- 0.962		0.569				0.419													-				
				0.124		- 0.183		0.171				0.090													-				
				0.303		- 0.447		0.416				0.221													-				
6.7 - Loans - RLBN				0.5795	77.22	-59.43				-1.21																			
(banks)				25.23	2.64	- 1.96				-1.68																			
				0.978	0.231	- 0.171				-0.110																			
				-	-	-				-																			
				0.734	0.232	- 0.059				-0.051																			
6.8 - Bonds - RGSB				0.0755	-39.33	35.16						-620.62								89.67						0.3413			
(banks)				1.84	- 1.67	3.85						- 3.07								1.80						1.57			
				0.313	- 0.289	0.249						- 0.121								-						-			
				0.908	- 0.983	0.387						- 0.195								-						-			
				1.376	- 1.490	0.570						- 0.296								-						-			
6.9 - Central Bank Loans - RBBCB				0.0133	5.13			- 5.13			12.31																		
(banks)				1.85	2.13			- 2.13			1.48																		
				0.759	0.520			- 0.255			0.634																		
				-	-			-			-																		
				0.673	0.538			- 0.186			3.176																		
6.10 - Consumption - RCONPH			0.3937				0.003																				0.5388		
			2.75				1.84																				(3.06)		
			0.429				0.065																						
			0.486				0.032																						
			1.057				0.075																						
6.11 - Investment - RINVP	0.1309					-107.62								0.0673	0.9744	-0.0326													
	1.71					- 2.33								1.19	2.26	-1.33													
	0.739					- 0.093								0.138	0.538	-0.399													
	-					-								-	-	-													
	0.804					- 0.108								0.099	0.474	-0.401													
6.12 - Imports - RIMP		0.0391											-636.68															0.6922	
		2.46											- 1.95															4.49	
		0.331											- 0.114															-	
		0.419											- 0.318															-	
		1.351											- 1.027															-	
6.13 - Manufactures Exports - REXPM													58.49					12.6903											0.6931
													1.67					3.66											5.42
													0.036					0.426											-
													0.292					0.876											-
													0.943					2.856											-
6.14 - Non-Agricultural Production - RINCNA														0.5479			0.3465		1403.34										
														4.67			11.06		1.54										
														0.210			0.965		0.086										
														-			-		-										
														0.161			0.962		0.140										

[*]The values are presented in this order.

Private Non-Banking Sector Behavior Equations

The statistical results of the demand for currency equation (equation 6.1) are excellent. The regression coefficient is 0.99, and the estimated coefficients are highly significant. Disposable income (RINCDI) is the most important explanatory variable, and its estimated long-run mean elasticity is 1.07. Among the explanatory financial variables, changes in the interest rate on bank loans (ILBN) have the largest effect on the demand for currency. The estimated long-run elasticity (-0.43) probably reflects the importance of bank loans in the firms' demand for currency. The effect of changes in the interest rate on time deposits (IDBT) is small. This variable's low elasticity (-0.06) suggests that currency is only marginally used as a store of value by the population. On the other hand, the estimated coefficient of lagged currency (RCURRL) implies an adjustment coefficient of 0.58, which signifies that 82 per cent of the adjustment between two long-run equilibrium points occurs within two years.

The results obtained in the estimation of the demand equation for demand deposits (equation 6.2) are statistically as good as those obtained for the demand for currency. The estimated t statistics are all larger than two, and the regression coefficient is 0.99. The long-run income elasticity (1.26) shows that economic growth is accompanied by an increase in the importance of bank money. The difference between the income elasticities of the demand for currency and for demand deposits suggests that the hypothesis of homogeneity which is normally used in the estimations of the demand for money (definition M1) may be subject to criticism. Besides this, the interest rates on financial assets which enter these two equations as explanatory variables are not exactly the same. In the demand equation for demand deposits, the financial variables which enter as explanatory variables are the interest rates on bank loans (ILBN) and on government securities (IGS). The estimated long-run elasticities for ILBN (-0.28) and IGS (-0.10) show that changes in these variables only slightly affect the demand for demand deposits. On the other hand, the estimated adjustement coefficient (0.60) signifies that 84 per cent of the long-run adjustment is completed within two years.

In the 2SLQ estimation of the demand equation for time deposits (equation 6.3), the estimated coefficients are all significant at the 5 per cent level. The estimated long-run income elasticity (2.35) shows the importance of voluntary savings when economic growth occurs. On the other hand, the demand for time deposits is very sensitive to changes in the interest rate on time deposits, as is shown by the estimated long-run elasticity (1.43). Both of these elasticities are favorable to the economic growth of the country. Changes in the interest rate on government securities also influence the demand for time deposits. The estimated long-run elasticity for this variable is -0.62. The effect of the growing organization of the financial system, which began to offer alternate assets to time deposits, is captured by the variable TIME. The estimated coefficient of lagged time deposits (RDTBL) shows that the adjustment between two long-run equilibrium points is slow since only 64 per cent of the adjustment occurs in the first two years.

On the other hand, the estimation of the demand equation for commercial bank loans (equation 6.4) shows that the adjustment between two equilibrium points is realized rapidly since 80 per cent of the adjustment occurs in the first year. However, in the demand for foreign loans (equation 6.5), all the attempts to include lagged foreign loans (RNBBFL) resulted in extremely slow adjustment speeds and extremely high long-run income elasticities which did not have economic meaning. Because of this, RNBBFL does not appear as an explanatory variable. The estimated long-run income elasticity of foreign loans (1.99) is substantially larger than that for bank loans (0.71). This result is consistent with the importance of foreign loans in the country's accelerated growth plans. In the demand equation for bank loans, the low elasticity (-0.33) of the interest rate on bank loans probably reflects the scarcity of alternatives for borrowers. On the other hand, changes in the interest rate on foreign loans have a stronger effect on the demand for foreign loans since the long-run elasticity is -0.68. The attempts to estimate cross effects in these markets resulted in poor statistical results in the same way as the experiments with OLSQ in Chapter 4.

Private Banking Sector Behavior Equations

In the 2SLQ estimation of the demand for excess reserves (equation 6.6), the estimated coefficients of the explanatory variables are all significant at, at least, the five per cent level. The long-run elasticity of available deposits (RDEPD) is low (0.30), probably because the liquidity of the banks' portfolio depends substantially on other factors such as the composition of the portfolio, the stock of government securities held by the banks, the distribution of loans' maturity, etc. In the long-run, only five per cent of the increase in available deposits becomes part of the stock of excess reserves. On the other hand, banks' excess reserves are sensitive to changes in the interest rate on government securities (IGS) and in the discount rate (IBBCB). The estimated long-run elasticities of these variables were respectively -0.45 and 0.42. Attempts to include the interest rate on bank loans (ILBN) resulted in coefficients with the opposite signs from those predicted by economic theory. Because of this, ILBN was excluded from the equation. However, the effects of changes in the interest rate on loans are felt indirectly by means of its effects on the market for government securities. An increase in the rate of growth of previous period unborrowed reserves (URRATL) is used as a proxy for the monetary policy expected by the banks in the next period. In the same way as in the OLSQ estimations, the estimated coefficient of URRATL is positive, signifying that the banks believe that a liberal monetary policy in one period will be followed by a restrictive one in the next period. Therefore, they increase excess reserves. The estimated long-run elasticity of URRATL is 0.22, i.e. a 10 per cent increase in the growth rate of previous period unborrowed reserves results in a two per cent increase in excess reserves. The adjustment speed between long-run equilibrium points is slow since the estimated adjustment coefficient is 0.41. The explanatory variables discussed above explain a substantial part of the variation in excess reserves in the period analyzed ($R^2 = 0.65$).

The explanatory variables in the supply equation for bank loans (demand for private non-bank liabilities, equation 6.7) are: available deposits (RDEPD); the deposit ratio (DEPRAT);

and the interest rates on bank loans (ILBN) and government securities (IGS). These variables explain 98 per cent of the variation in the supply of bank loans.

Available deposits is the most important variable in explaining the variations in bank loans, and its estimated lon-run elasticity is equal to 0.73. In the long-run, 58 per cent of the increase in available deposits is used by the banks to make loans. Since the estimated t statistic of the coefficient of RDEPD is 25.23, this coefficient is highly significant. Increases in the interest rate on loans has a relatively small effect on loans since the long-run elasticity is 0.23. Besides this, changes in the interest rate on government securities also have a small effect on loans since the long-run elasticity is -0.06. The estimated coefficients of ILBN and IGS are significant, respectively, at the one and five per cent levels. However, the weak effects of the interest rates on the supply of loans contrasts with the stronger effects on the demand for excess reserves, as was seen above, and on the demand for government securities and the demand for loans from the monetary authorities, as will be seen below. The ratio between demand and time deposits (DEPRAT) is a proxy for the degree of uncertainty due to the composition of deposits, since demand deposits fluctuate more than time deposits. The estimated coefficient of DEPRAT is negative, as was expected, and the long-run elasticity (-0.05) shows that this effect is small in part because time deposits can normally be withdrawn at any time as long as the client gives a short advance notice. The estimated coefficient of DEPRAT is significant at the ten per cent level. Attempts to exclude

DEPRAT and/or include lagged loans (RLBNL) did not improve the statistical results. The estimated coefficients of RLBNL had extremely low t statistics and implied almost instantaneous adjustment.

The demand for government securities (equation 6.8) is a function of available deposits (RDEPD); the interest rates on government securities (IGS) and on bank loans (ILBN); the lagged rate of growth of unborrowed reserves (URRATL); the variable TIME; and lagged government securities (RGSBL). These variables explain 98 per cent of the variation in the dependent variable. The estimated coefficient of RDEPD is significant at the five per cent level. In the long-run, eleven per cent of the increase in available deposits are applied to purchases of government securities. The estimated long-run elasticity (1.38) probably reflects the growing importance of government securities in the financial system after 1964. However, the use of dummy variables to capture the effect of the observations after 1964 substantially worsened the statistical results and were rejected. The estimated long-run elasticities of the interest rates on government securities (0.57) and on bank loans (-1.49) show that purchases of government securities are very sensitive to changes in the interest rate on loans. This result is reasonable since loans constitute the principal activity of the banks. The estimated coefficients of the interest rates on government securities and loans are significant, respectively, at the one and ten per cent levels. On the other hand, the negative estimated coefficient of URRATL is consistent with the positive coefficient for this variable estimated in the demand equation for excess reserves. This signifies that an increase in the growth rate of lagged unborrowed reserves causes the banks to expect that monetary policy in the next period will be restrictive, making it necessary to increase excess reserves and decrease the stock of government securities. The estimated coefficient of URRATL in the demand for government securities is significant at the one per cent level, and its long-run elasticity is -0.30. The TIME variable has a positive effect on the demand for government securities and reflects the increasing organization of this market. The estimated adjustment coefficient (0.66) implies that 88 per cent of the adjustment between long-run equilibrium points occurs by the end of the second year.

The estimation of the demand equation for bank loans from the monetary authorities (equation 6.9) was the most difficult of the macroeconomic model. The best adjustment included as explanatory variables: available deposits (RDEPD); the interest rate on loans (ILBN); the discount rate (IBBCB); and the loan ratio (LORAT). These variables explain 35 per cent of the variation in Central Bank loans in the period under analysis.

The estimated coefficient of RDEPD is significant at the five per cent level, and corresponds to a long-run elasticity of 0.67. Attempts to estimate separately the effects of the interest rates on financial assets resulted in poor statistical results and/or signs opposite to those predicted by economic theory. The best adjustment was obtained with a variable representing the difference between the interest rate on loans and the discount rate (the estimated coefficient of the difference between the interest rate on government securities and the discount rate was not significant and had the opposite sign from that predicted). The estimated coefficient of this variable is significant at the 2.5 per cent level, and the lon-run elasticities of the interest rate on loans and the discount rate are, respectively, 0.54 and -0.19. These results show that the demand for loans from the monetary authorities is not very sensitive to changes in the discount rate but is reasonably sensitive to changes in the interest rate on bank loans. This result is consistent with the widely accepted view of Brazilian banks' behavior in relation to liquidity loans. On the other hand, the higher the ratio between loans and available deposits (the loan ratio - LORAT), the greater the pressure on the banks to borrow from the monetary authorities. The estimated coefficient of LORAT is significant at the ten per cent level, and the long-run elasticity is 3.17. This shows that pressures originating from the composition of the banks' portfolio are extremely important in explaining the demand for loans from the monetary authorities. Several attempts were made to include lagged loans from the monetary authorities (RBBCBL). However, the estimated coefficients of RBBCBL had very low t statistics, and the coefficients of the interest rate variables in these equations were not significant. Because of these results, RBBCBL was not included in this equation.

Behavior Equations of the Real Sector

Excellent statistical results were obtained in the estimation of the private per capita consumption function (equation 6.10). The estimated coefficients of per capita disposable income and lagged per capita consumption are significant at the one per cent level, and the estimated coefficient of the interest rate on time deposits (IDTB) is significant at the five per cent level. These variables explain the majority of the variation in per capita consumption since the estimated regression coefficient is equal to 99 per cent. Moreover, the estimated coefficients are very reasonable. The long-run marginal propensity to consume is 0.86, and the long-run income elasticity is 1.06. The effect on consumption of changes in the interest rate on time deposits is very small since the long-run elasticity is 0.08. In the experiments made without IDTB, the marginal propensity to consume is very high (almost equal to one), and the Durbin-Watson statistic is much lower than that estimated in equation 6.10. Because of these results, IDTB is included in the consumption equation in spite of its effect being small. The adjustment speed is rather slow since the estimated adjustment coefficient is 0.47. At the end of two years, 72 per cent of the adjustment between two long-run equilibrium points has taken place.

The explanatory variables of the demand for private investment equation (equation 6.11), are: national income (RINC); lagged private capital (RKPIL); the interest rate on government securities (IGS); total loans (RLT); and imports (RIMP). These variables explain 99 per cent of the variation in private investment, whereas the Durbin-Watson statistic for this equation is 1.85. The estimated long-run propensity to invest (0.13) is significant at the five per cent level, and the long-run income elasticity is 0.84. The effects of the financial system on private investment, and therefore on the real sector of the economy, are through the variables IGS and RLT. The estimated coefficient of IGS is significant at the 2.5 per cent level, and the long-run elasticity is -0.11. The small value of this elasticity is consistent with the level of development of the country's financial market. The variable RLT was introduced into the investment equation in order to capture the imperfections of the financial market, and its long-run elasticity is equal to 0.10. In spite of the estimated t statistic (1.19) of the coefficient of RLT being small, this variable was maintained in the specification of the investment equation because excluding it caused the coefficient of RINC to become extremely large. Besides this, RLT is one of the most important links between the model's financial and real sectors. Another market imperfection is the availability of imported capital goods, as was discussed in Chapter 5. The estimated coefficient of imports (used as a proxy for imports of capital goods) is significant at the 2.5 per cent level, and the long-run elasticity is 0.47. This value is consistent with the general opinion of the importance of imported capital goods in investment, and therefore in the accelerated growth process since the Second World War. The estimated coefficient of the lagged stock of private capital is significant at the ten per cent level, and the long-run elasticity is -0.40. Estimations made without this variable resulted in large coefficients for RINC and small ones for IGS. These results and the importance of RKPIL in economic theory caused this variable to be maintained in the private investment function.

The import demand equation (equation 6.12) is a function of: disposable income (RINCDI), the exchange rate (RRATE), and lagged imports (RIMPL). In spite of the restrictiveness of the homogeneity hypothesis used in the specification of the import function (this hypothesis will be examined in a later phase of this study), the explanatory variables are important for the functioning of the macroeconomic model. Moreover, these variables explain the majority of the variation in imports in the period 1948 to 1975, since the estimated regression coefficient is 0.96. The estimated long-run marginal propensity to import, 0.13 (the long-run elasticity is 1.35), is significant at the 2.5 per cent level and is consistent with the importance of imports for economic growth. The estimated coefficient of RRATE is significant at the five per cent level, and the long-run elasticity is -1.03. On the other hand, the estimated coefficient of RIMPL (0.69) is significant at the one per cent level, and results in a slow adjustment between two long-run equilibrium points.

The analysis of manufactured exports also ought to be disaggregated in a future study. However, in this study, total exports of manufactured goods (equation 6.13) is a function of: rest of the world income (RINCW); the exchange rate (RRATE); and lagged exports (REXPML). The estimated long-run elasticity of RINCW (2.83) is high, which probably reflects Brazil's small share of the world market in manufactured goods and the marked dependence of exports on the international economic situation. The estimated coefficient of RINCW is significant at the one per cent level. Changes in the exchange rate also affect exports. The estimated long-run elasticity is 0.94, and the estimated coefficient of RRATE is significant at the ten per cent level. Adjustment between two long-run equilibrium points takes place slowly, since the adjustment coefficient is 0.31 and is significant at the one per cent level. Since the regression coefficient is 0.97, the above explanatory variables explain almost all of the variation in exports of manufactured goods during the period analyzed.

The last behavior function presented in Table 6.3 is the non-agricultural production function (equation 6.14). The explanatory variables - lagged capital (RKAPL), total loans (RLT), and technological progress (TECN) - explain 99 per cent of the variation in the dependent variable. The estimated coefficients of these variables are reasonable and statistically significant. The long-run elasticity of RKAPL is 0.96, and the estimated coefficient of this variable is significant at the one per cent level. The estimated coefficient of RLT is also significant at the one per cent level, and the long-run elasticity is 0.16. The estimated coefficient of TECN is only significant at the ten per cent level, and the long-run elasticity is 0.14. Experiments with specifications that excluded TECN resulted in extremely low Durbin-Watson statistics and substantially larger standard errors of the estimate (SEE) than those which included TECN. Therefore, this variable was maintained in the specification.

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