Annual Model for the Brazilian Economy

Marco Antônio F.H. Cavalcanti

IPEA/JICA Workshop

August 14-15, 2001

Rio de Janeiro, Brazil

Annual Model for the Brazilian Economy

Marco Antônio F.H. Cavalcanti

IPEA/JICA Workshop

August 14-15, 2001

Rio de Janeiro, Brazil

ANNUAL MODEL FOR THE BRAZILIAN ECONOMY[†]

Marco Antônio F. H. Cavalcanti

Diretoria de Estudos Macroeconômicos - DIMAC
Instituto de Pesquisa Econômica Aplicada - IPEA

cavalcanti@ipea.gov.br

August 2001

[†] This paper is a revised version of Reis et Al. (1999).

Abstract

This paper presents Version 5 of the annual econometric model for the Brazilian economy developed by the Directorate of Macroeconomic Studies at IPEA. The model is designed to make medium run projections and policy simulations. The specification of the model is basically keynesian. Estimation features include the use of time series methods, such as FIML (full information maximum likelihood) cointegration analysis, besides OLS and instrumental variables estimation. In general, the development of the model's equations has explicitly tried to ensure desirable long-run properties as well as reasonable short-run dynamics.

MOPSE-B: Model for Projections and Simulations of the Brazilian Economy

August 2001

Introduction

This paper presents Version 5 of the annual econometric model for the Brazilian economy developed by the Directorate of Macroeconomic Studies at IPEA - Institute of Applied Economic Research -, in Rio de Janeiro, Brazil.

The model is designed to make medium run projections and policy simulations for the Brazilian economy. It is a large-scale annual model built upon the main identities of the Brazilian National Accounts and Balance of Payments.

The specification of the model is basically keynesian. Estimation features include the use of single-equation and FIML (full information maximum likelihood) cointegration analysis, besides OLS and instrumental variables estimation. The use of systems methods is usually not possible due to the lack of sufficiently long data for many variables.

In general, the development of the model's equations has explicitly tried to ensure desirable long-run properties as well as reasonable short-run dynamics.

This paper is organized as follows. The first section sketches the structure of the model. The second section presents the main specification and estimation results for each block. The third section concludes with a discussion of the model's shortcomings and the next improvements to be made.

I. The model structure

As it stands now, the model is basically keynesian. Aggregate demand is given by individually estimated equations for aggregate consumption, aggregate investment and net exports of goods and services, while aggregate supply is determined by a Cobb-Douglas constant return production function. The equalization of aggregate demand and supply will determine real output, capacity utilization, employment and prices, and will typically correspond to an equilibrium with under-employment.

Appendix I presents the model's flow diagram and equations. The model contains 171 equations out of which 20 are stochastic and 41 are identities which define nominal variables and GDP proportions. Equations can be grouped in five major blocks: Aggregate Demand (equations 1 to 16), Aggregate Supply (17 to 24), Price Determination (equations 25 to 29), Monetary Sector (30 to 42), Public Sector Accounts (equations 43 to 49), Balance of Payments Accounts (equations 50 to 94) and the Labour Market (95 to 130).

The Aggregate Demand block defines and specifies the determinants of aggregate consumption and major categories of fixed investment (construction and equipment). Lack of reliable data preludes the estimation of investment in inventories, as well as the disaggregation of consumption into durables/non-durables.

The Aggregate Supply block specifies the economy's production function and the determination of the domestic capital stock, disaggregated into construction and machinery and equipment components.

The Price Determination block consists of a Phillips Curve-type equation for wholesale prices and a set of equations relating the evolution of other price indices to this "key" price. As a first

approximation, all prices are supposed to grow at the same rate, so that the model behaves as if there were just one domestic price.

The Monetary Sector block also consists of a small set of equations that determine the real money stock, the amount of credit to the private sector, the nominal and real interest rate.

The Public Sector block specifies the evolution of the public debt and nominal deficit as a function of GDP growth and primary deficit.

The Balance of Payments block defines and specifies the determinants of the main categories of exports (manufactured, semi-manufactured, and primary products) and imports (consumer, intermediate, and capital goods), as well as other items of the current accounts, and the external debt dynamics. For now, foreign investments (both equity and portfolio) and changes in reserves are exogenously specified. With a floating exchange rate, the real exchange rate is determined in this block in order to equalize supply and demand of foreign reserves.

The Labour Market includes two main sets of equations that determine labour supply and demand respectively. Adjustments in the labour market are accomplished either by changes in unemployment or in real wages.

The main policy variables in the model are:

- Nominal interest rate
- Public Sector Investment
- Tax rates
- Import tariff rates
- Export subsidy rates

Other important exogenous variables are:

- Net Foreign Investment (Direct and Portfolio)
- International reserves
- Imports of Fuels and Lubrificants
- United States' Wholesale Price Index
- Libor rate
- World imports

We will typically simulate the model under exogenously given trajectories for these variables. It should be noted, however, that some of the policy variables may be considered partially endogenous, as most General Government expenditures and revenues depend on current GDP growth and inflation, while the nominal interest rate may be endogenized depending on the particular model closure adopted; e.g. some form of interest rate parity, real interest rate rule, inflation targeting rule, etc. On the other hand, the nominal exchange rate may be exogenized if we wish to simulate a fixed exchange rate regime.

II. Specification and estimation

This section discusses the estimation methodology and main results for each block of equations.

II.1. Aggregate demand

Private Consumption

Real private consumption expenditure (CFTPP) - equation 3 - is specified as a function of real disposable income (RDOPP), real interest rates (TJCDB) and total real credit granted to the private sector (EMPTR). The equation is estimated in first differences plus an error-correction mechanism which incorporates the existence of an

1:1 long-run relationship between consumption and income -- thus ensuring that these two variables cannot drift permanently away from each other. The equation is estimated by instrumental variables in order to account for the endogeneity of both disposable income and credit, thus providing consistent coefficient estimates.

This is one of the most important equations of the model, as the dynamics of real demand will depend to a large extent on the value of the keynesian multiplier. The estimated coefficient on disposable income is approximately 0.4, which implies a reasonably low short-run multiplier and therefore prevents the model from becoming too unstable.

It should be noted that the effect of interest rate movements on both consumption and investment (as we shall see below) is relatively weak, so that the effect of credit on private consumption is perhaps the main channel through which monetary policy may affect aggregate demand.

Private Investment

Real private investment is disaggregated into two main components: construction and equipment fixed investment.

The demand for investment in construction (FBKCP) is a function of GDP, the real interest rate and inflation acceleration (equation 8). The equation is specified as an error-correction model, in which the cointegrating vector includes a 1:1 relationship between investment and GDP. It is interesting to note that GDP does not enter the equation unlagged, so that its only effect on construction investment operates through the error-correction term. This also means that the equation can be consistently estimated by OLS.

Total demand for machinery and equipment is equal to the sum of capital goods imports and spending on domestic machinery. Capital goods imports are determined within the foreign sector block. Investment in domestic machinery (FBKMPD) depends on the real interest rate and on the rate of capacity utilization (equation 10). It is worth noting that investment in domestic machinery displays a pattern of slow adjustment to exogenous shocks, as no exogenous variable enters the equation contemporaneously. Once again, the absence of unlagged GDP implies that the equation may be consistently estimated by OLS.

II.2. Aggregate Supply

Aggregate supply (equation 17) is given by a constant returns to scale Cobb-Douglas-type production function whereby domestic capital stock (ELKT), multiplied by the capacity utilization rate (UTIND), is combined with employed labour to produce output. Employed labour is proxied by active urban population (PEAURB) multiplied by the complement of the unemployment rate (TXDES). The equation is specified in terms of growth rates and estimated by OLS. Due to the lack of unemployment data before 1980, the sample period is very short, which may cause estimation biases. Estimation results, however, are quite reasonable: capital and labour account for roughly 70% and 30% of output growth, respectively; although very high compared with international standards, this seems to be consistent with the observed pattern of income distribution. The main problem seems to lie in the negative sign of the estimated constant term, which implies negative productivity growth. This may reflect the stagnation of the Brazilian economy during the estimation period or other estimations problems. For simulation purposes, it is necessary to arbitrarily assume some other value for the constant term (interpreted as an exogenously given rate of growth of total factor productivity - PTF) while ignoring the econometric problems associated with such approach.

The domestic capital stock is calculated according to a perpetual inventory method, where the durability of net capital stock in residential construction (ELKCER), non-residential construction (ELKCENR) and machinery and equipment (ELKM) is assumed to be 50, 40 and 20 years, respectively.[1]

The capacity utilization rate will vary in order to equalize aggregate supply and demand.

II.3. Price Determination

Domestic prices are determined by a Phillips Curve-type equation where current inflation depends on past inflation, variation in foreign prices multiplied by the exchange rate and capacity utilization (equation 25). All parameters are calibrated, subject to the restriction that the coefficients on past inflation and foreign prices (in domestic currency) sum to one. The ad-hoc specification of the price equation derives from the technical difficulties in the estimation of price behavior in an annual model for an economy which has experienced hyperinflation in recent history.

As a first approximation, all prices are supposed to grow at the same rate.

[1] This methodology follows Morandi,L.(1998).

II.4. Monetary Sector

The evolution of M1 is indirectly given by the variation in the velocity of money (M1PIB), which is a function of the nominal interest rate (equation 31). This equation was estimated by OLS.

M0 is assumed to be a constant proportion of M1, calculated as the observed mean ratio between these variables (equation 33).

Total real credit granted to the private sector (EMPTR) depends on the percent change in M1 (equation 35). This equation was also estimated by OLS.

Depending on the model closure adopted, the nominal interest rate may be either exogenous or endogenous. In a fixed exchange rate regime, the nominal interest rate would be given by a parity condition, according to which the domestic interest rate must equal the international interest rate (LIBOR) corrected by expected domestic currency nominal devaluation and a risk premium. The risk premium would depend negatively on the trade balance and positively on Public Sector borrowing requirements and the next external debt — all measured as a percent of GDP (equation 35). In a floating regime, the interest rate may be set either exogenously or according to some rule representing the monetary authorities' reaction function, such as an inflation targeting rule or a real interest rate rule (equation 39).

II.5. Public Sector

The Public Sector block specifies the evolution of the public debt and nominal deficit as a function of GDP growth and primary deficit.

II.6. Balance of Payments

Trade Equations

The import and export equations follow a very standard specification; imports depend on the real exchange rate (corrected by a category-specific tariff index) and real domestic activity (GDP), whereas exports' performance is determined by the rate of growth of world imports (MW), the real exchange rate (corrected by a sector-specific subsidy index) and domestic capacity utilization (UTIND).

The equations have been estimated by Johansen's cointegration procedure within an error-correction model framework. It is important to note that all equations except one (consumer goods imports) have passed a battery of diagnostic tests, including Chow structural stability tests. Besides, various exogeneity tests were performed and, in most cases, the equations were found to possess all the desirable properties for making efficient and unbiased forecasts and policy simulations -- i.e., strong and superexogeneity of the conditioning variables.[2]

Import equations were estimated separately for each category of use, capital, intermediate and consumer goods. Oil imports are exogenous.

The export equations were estimated for primary, semi-manufactured and manufactured products.

Services

The Services accounts' equations are disaggregated according to standard classification into non-factor and factor services. Non-factor services basically depend on the value of the country's total trade; in the case of tourism expenditure, the real exchange rate is

[2] See Castro and Cavalcanti (1997).

also included as an explanatory variable. Factor services depend on the international interest rate plus a spread, the net stock of foreign capital and net external debt. All equations are specified as autoregressive-distributed-lag (ADL) models and estimated by OLS and are usually characterized by well-behaved residuals and constant parameters.

External Debt

In a fixed exchange rate regime, the external debt dynamics is determined by the current account balance. Given that flows of foreign direct and portfolio investment (IEDL and IEPL) and changes in international reserves (HACP) are assumed to be exogenous, the Current Account Deficit determines the variation in the country's external debt. The equation also captures the changes in the value of non-dollar denominated debt that arise from variations in the exchange rate of the US dollar vis-a-vis other currencies.

Exchange rate

It is possible to adopt two basic model closures:

1. **Fixed nominal exchange rate** - The Central Bank sets the nominal exchange rate; given domestic and foreign prices, we obtain the real exchange rate, which determines the Current Account Balance. We assume that any deficits/surpluses will be financed either through capital inflows/outflows or through changes in international reserves.
2. **Floating nominal exchange rate** - Net capital inflows and changes in international reserves, assumed to be exogenous, determine the supply of foreign currency. Demand for foreign reserves is given by the Current Account deficit. The real (and nominal) exchange rate must therefore vary in order to equalize supply and demand of foreign reserves.

Given that Brazil now has a floating exchange rate regime, the current version of MOPSE-B adopts the second model closure.

It should be noted that:

(i) since Services accounts are relatively insensitive to the real exchange rate, Current Account adjustments must be accomplished mainly through changes in Trade Balances;

(ii) given the relatively low short-run trade elasticities for Brazil, shifts in foreign capital inflows require relatively large changes in exchange rates.

II.7. Labour Market

Labour supply depends on a set of demographic and economic factors. Following Barros, Fogel and Mendonça (1997), we use three basic elements in order to determine its evolution: (1) population growth projections, by age and sex; (2) education indicators, by age and sex; and (3) estimates of the "activity rate", by age, sex and education level. We classify the population in three age categories — 10 to 24 (the "young"), 25 to 65 (the "mature") and over 65 (the "elderly") — and two schooling levels — up to 8 years (the "unqualified") and over 8 years (the "qualified"). Under exogenously given trajectories for these variables, we obtain growth rates for each of the twelve possible population categories and can therefore determine the evolution of qualified and unqualified labour supply (equations 182 and 183).

Demand for qualified and unqualified labour is determined separately in the agriculture, industrial and services sectors. In each sector, labour demand depends on the real wage, sectoral production, overall

technology level and sector-specific "technology bias". By summing up labour demand in each sector, we determine total demand for qualified and unqualified labour (equations 196-197).

The labour market is assumed to be characterized by rigidities that will typically prevent the equalization of labour supply and demand. A "wage curve" determines the degree of flexibility in real wages and, therefore, the degree to which adjustments in the labour market are accomplished by variations in wages or in the rate of unemployment[3]. Real wages for qualified and unqualified workers are thus given by their respective wage curves (equations 202 and 203).

III. Conclusion

The current version of the model already allows relatively rich projections and simulation exercises, which seem to provide fairly reasonable outcomes. Nonetheless, there still are significant improvements to be made.

Among the main shortcomings of the model we should point out the following:

1 - The price equation is specified in an ad-hoc manner, due to the difficulties in estimating price behaviour in an economy with a history of hyperinflation;

2 - The monetary sector is poorly specified and has relatively little effect on real variables;

3 - Capital flows are not explicitly modelled, which does not allow us to infer the positive impacts of high domestic interest rates/investment returns on the financing of current account deficits and on the accumulation of international reserves;

4 - Inventories are not modelled, due to the lack of reliable data. This considerably constrains the model´s investment dynamics - although it should be said that this problem is probably worse in higher frequency models;

5 - There is no role played by expectations, so that the model is inherently backward-looking. This problem is especially important in the specification of financial variables;

6 - As a general difficulty, the estimated equations usually require a number of dummy variables to account for the frequent breaks and/or outliers in Brazilian macroeconomic series. It is very hard to avoid such modelling shortcomings that arise in economies with a history of severe structural breaks and policy regime changes.

The next improvements to be made shall focus on overcoming some of these difficulties.

REFERENCES

Barros, R. and Mendonça, R.S.P. Flexibilidade do Mercado de Trabalho Brasileiro: uma Avaliação Empírica, IPEA Discussion Paper 452, 1997.

Barros, R., Fogel, M. and Mendonça, R.S.P. Perspectivas para o Mercado de Trabalho Brasileiro ao Longo da Próxima Década, IPEA Discussion Paper 526, 1997.

Castro, A.S. and Cavalcanti, M.A.F.H. Estimação de Equações de Exportação e Importação para o Brasil - 1955/95 (English version available), IPEA Discussion Paper 469, 1997.

[3] The slope coefficient is taken from Barros and Mendonça(1997).

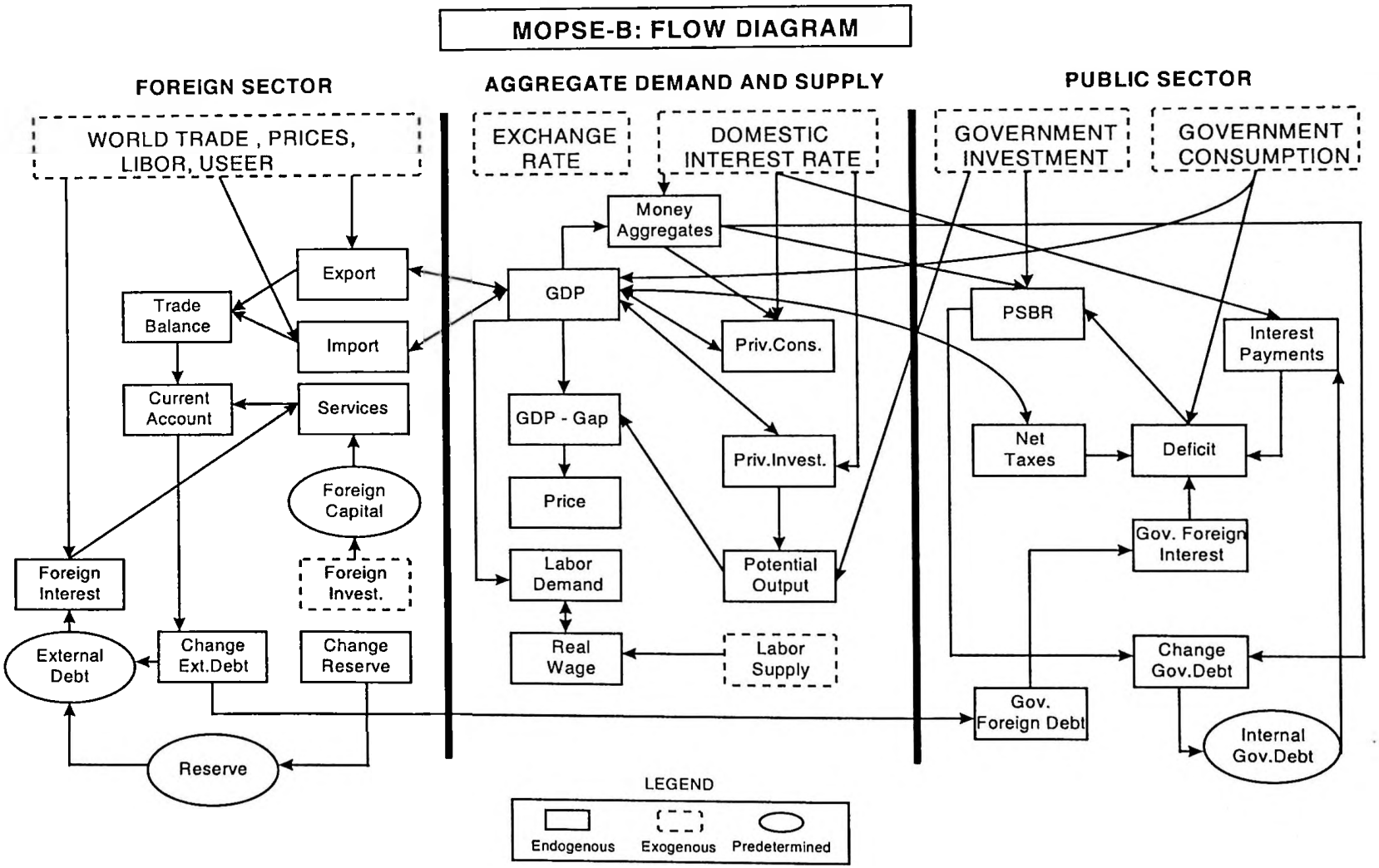
Hernandez, B.C.M. Um Modelo Econométrico da Conta Corrente do Governo no Brasil - 1951/95, IPEA Discussion Paper 543, 1998.

Morandi, L. Estoque de Riqueza e a Poupança do Setor Privado no Brasil - 1970/95, IPEA Discussion Paper 572, 1998.

Reis, E. et al. Model for Projections and Simulations of the Brazilian Economy, IPEA Discussion Paper 619, 1999.

APPENDIX I

MODEL STRUCTURE, VARIABLES AND EQUATIONS


MOPSE-B: FLOW DIAGRAM
FOREIGN SECTOR
AGGREGATE DEMAND AND SUPPLY
PUBLIC SECTOR
WORLD TRADE , PRICES, LIBOR, USEER
EXCHANGE RATE
DOMESTIC INTEREST RATE
GOVERNMENT INVESTMENT
GOVERNMENT CONSUMPTION
Money Aggregates
Export
GDP
Trade Balance
Import
PSBR
Interest Payments
Priv.Cons.
Current Account
Services
GDP - Gap
Net Taxes
Deficit
Priv.Invest.
Foreign Capital
Price
Gov. Foreign Interest
Foreign Interest
Foreign Invest.
Labor Demand
Potential Output
External Debt
Change Ext.Debt
Change Reserve
Real Wage
Labor Supply
Change Gov.Debt
Gov. Foreign Debt
Internal Gov.Debt
Reserve
LEGEND
Endogenous
Exogenous
Predetermined

MODEL FOR PROJECTIONS AND SIMULATIONS OF THE BRAZILIAN ECONOMY
(IPEA/DIMAC, August 2001)

EQUATIONS:

(I) AGGREGATE DEMAND

Real Gross Domestic Product (Reais, 1980 prices)
1: PIB PIB = (CFT+FBKF+(XBSNF-MBSNF)*ERV/DIPIB)*1000000
Total Final Consumption (Millions of Reais,1980 prices)
2: CFT CFT = CFTPP+CTGG
Total Private Final Consumption (Millions of Reais,1980 prices)
3: CFTPP DEL(1: LOG(CFTPP)) = A24.1*DEL(1: LOG(RDOPP))+A24.2*DEL(1: LOG(EMPTR))+A24.3*(LOG(CFTPP(-1))-LOG(RDOPP(-1)))+A24.4*DEL(1: TJCDB)
Real Disposable Income (Millions of Reais,1980 prices)
4: RDOPP RDOPP = (PIB/1000000-CTRIBL-(RLE*ERV-TUN*ERV)/DIPIB)*DUMRDOPP
Total Gross Fixed Capital Formation (Millions of Reais,1980 prices)
5: FBKF FBKF = FBKFP+FBKFGG
Gross Fixed Capital Formation- Private Sector (Millions of Reais,1980 prices)
6: FBKFP FBKFP = FBKCP+FBKMP+FBKO
Gross Fixed Capital Formation - Construction - Private Sector (Millions of Reais,1980 prices)
7: FBKCP DEL(1: LOG(FBKCP)) = -0.89-1.063*DEL(1: LOG(CTRIB/PIB))-0.401*(LOG(FBKCP(-2))-LOG(PIB/1000000(-2)))+DUMFBKCP
Gross Fixed Capital Formation - Machinery and Equipment - Private Sector (Millions of Reais,1980 prices)
8: FBKMP FBKMP = (FBKMPD+MBKV*ERV/DIPIB)*DUMFBKMP
Gross Fixed Capital Formation - Domestic Machinery and Equipment - Private Sector (Millions of Reais,1980 prices)
9: FBKMPD DEL(1: LOG(FBKMPD)) = 1.849*DEL(1: UTIND(-2))-0.005*DEL(1: TJCDB(-1))+0.292*DEL(1: LOG(FBKFGG))+0.399*DEL(1: LOG(FBKMPD(-1)))
Gross Fixed Capital Formation - Other - Private Sector (Millions of Reais,1980 prices)
10: FBKO FBKO = FBKFP*FBKOPCT
Gross Fixed Capital Formation - Machinery - Total (Millions of Reais,1980 prices)
11: FBKM FBKM = FBKMG+FBKMP
Gross Fixed Capital Formation - Machinery - General Government (Millions of Reais,1980 prices)
12: FBKMG FBKMG = FBKFGG-FBKCG
Gross Fixed Capital Formation - Construction - Total (Millions of Reais,1980 prices)
13: FBKC FBKC = FBKCG+FBKCP
Gross Fixed Capital Formation - Construction - General Government (Millions of Reais,1980 prices)
14: FBKCG FBKCG = 0.85*FBKFGG
Industrial Production Index
15: YS DEL(1: LOG(YS)) = -0.0183+1.5309*DEL(1: LOG(PIB))
Services Production Index
16: YT YT = PIB-YP-YS

(II) AGGREGATE SUPPLY

Aggregate Production Function
17: PROD DEL(1: PIB)/PIB(-1) = PTF/PTF(-1)-1+A26.1*DEL(1: ELKT*UTIND)/(ELKT(-1)*UTIND(-1))+(1-A26.1)*DEL(1: PEAURB*(1-TXDES/100))/(PEAURB(-1)*(1-TXDES(-1)/100))
Total Net Domestic Capital Stock (Millions of Reais,1980 prices)
18: ELKT ELKT = ELKCER+ELKCENR+ELKM
Net Domestic Capital Stock in Residential Construction (Millions of Reais,1980 prices)
19: ELKCER ELKCER = ELKCER(-1)+FBKCER-1/50*(0.5*(FBKCER+FBKCER(-50))+SUM(I = -49 TO 0: FBKCER(I)))
Net Domestic Capital Stock in Non-Residential Construction (Millions of Reais,1980 prices)
20: ELKCENR ELKCENR = ELKCENR(-1)+FBKCENR-1/40*(0.5*(FBKCENR+FBKCENR(-40))+SUM(I = -39 TO 0: FBKCENR(I)))
Gross Fixed Capital Formation - Residential Construction - Total (Millions of Reais,1980 prices)
21: FBKCER FBKCER = 0.6*FBKC
Gross Fixed Capital Formation - Non-Residential Construction - Total (Millions of Reais,1980 prices)
22: FBKCENR FBKCENR = FBKC-FBKCER
Net Domestic Capital Stock in Machinery and Equipment (Millions of Reais,1980 prices)

```
23: ELKM      ELKM = ELKM(-1)+FBKM-0.05*(0.5*(FBKM+FBKM(-20))+SUM(I = -19 TO 0
              : FBKM(I)))
    Capacity Utilization - Manufacturing
24: UTCAP     UTCAP/UTCAP(-1) = UTIND/UTIND(-1)
```

(III) PRICES

```
    Wholesale Price Index, period average
25: IPA       DEL(1: IPA)/IPA(-1) = 0.4*DEL(1: IPA(-1))/IPA(-2)+0.25*DEL(1: ERV
               *IPAUS)/(ERV(-1)*IPAUS(-1))+0.5*(UTIND-0.845)+DUMIPA
    General Price Index, period average
26: IGP       IGP/IGP(-1) = IPA/IPA(-1)
    General Price Index, end of period
27: IGPF      IGPF/IGPF(-1) = IGP/IGP(-1)
    Consumer Price Index, period average
28: IPC       IPC/IPC(-1) = IGP/IGP(-1)
    GDP Implicit Price Deflator, period average
29: DIPIB     DIPIB/DIPIB(-1) = IGP/IGP(-1)+DUMDIPIB
```

(IV) MONETARY SECTOR

```
    Real M1 (Millions of Reais, 1980 prices)
30: M1        M1 = M1PIB*DIPIB/IGP*PIB/1000000
    Velocity of Money
31: M1PIB     DEL(1: M1PIB) = A28.1*DEL(1: TJCDBN)/TJCDBN(-1)
    Real Monetary Base, Year Average (Millions of Reais,1980 prices)
32: M0        M0 = 0.62*M1
    Real Monetary Base, End of Period (Millions of Reais,1980 prices)
33: M0FR      M0FR/M0FR(-1) = M0/M0(-1)
    Nominal Monetary Base, End of Period (Millions of Reais)
34: M0FN      M0FN = M0FR*IGPF
    Total Credit to Private Sector (Millions of Reais, 1980 prices)
35: EMPTR     DEL(1: EMPTR)/EMPTR(-1) = A29.1*DEL(1: M1)/M1(-1)
    Nominal Interest Rate - Overnight (% per month)
36: TJOVER    TJOVER = ((1+TJCDBN/100)**(1/12)-1)*100
    Real Interest Rate - Bank Deposits (% a.a.)
37: TJCDB     TJCDB = ((1+TJCDBN/100)/(IGPF/IGPF(-1))-1)*100
    Nominal Interest Rate - Bank Deposits (% a.a.)
38: TJCDBN    TJCDBN = ((MIN(MAX(5,TJCDB(-1)+DEL(1: (IGPF/IGPF(-1)-1)*100)),10)
               /100+1)*IGPF/IGPF(-1)-1)*100
    Real Exchange Rate (US$/R$)
39: CR        CR = ERV*IPAUS/IPA
    Nominal Exchange Rate, Real/US$, end of period
40: ERVF      ERVF/ERVF(-1) = ERV/ERV(-1)
    Nominal Exchange Rate, Real/US$
41: ER        ER/ER(-1) = ERV/ERV(-1)
    Nominal Exchange Rate - Corrected for Special Regimes, Real/US$
42: ERNPT     ERNPT/ERNPT(-1) = ERV/ERV(-1)
```

(V) PUBLIC SECTOR

```
    Real Total Gross Tax Revenue
43: CTRIB     CTRIB = CTRIBPIB*PIBN/1000/DIPIB
    Real Total Net Tax Revenue (Millions of Reais, 1980 prices)
44: CTRIBL    CTRIBL = CTRIB-TAPGG
    Transfers to Households (Millions of Reais,1980 prices)
45: TAPGG     TAPGG/TAPGG(-1) = PIB/PIB(-1)+DUMTAPGG
    Public Sector Gross Fixed Capital Formation
46: FBKFGG    FBKFGG = FBKFGN/(1000*DIPIB)
    Public Sector Total Debt as proportion of GDP
47: DTSPPIB   DEL(1: DTSPPIB) = (TJCDB/100-DEL(1: PIB)/PIB(-1))*DTSPPIB(-1)+
               NFSPPPIB
    Public Sector Total Debt Nominal Interest as proportion of GDP
48: JDTSPPIB JDTSPPIB = TJCDB/100/(PIB/PIB(-1))*DTSPPIB(-1)
    Public Sector Borrowing Requirements, Nominal as proportion of GDP
49: NFSPNPIB NFSPNPIB = NFSPPPIB+JDTSPPIB
```

(VI) FOREIGN SECTOR

```
    Balance of Payments' Current Account Surplus  (Millions of US$)
50: STC       STC = SBC+SER+TUN
    Trade Balance (Millions of  US$)
51: SBC       SBC = XTV-MTV
    Total Exports (Millions of  US$)
52: XTV       XTV = XMV+XSV+XBV+XTEV
    Manufactured Products Exports (Millions of  US$)
53: XMV       DEL(1: LOG(XMV/IPAUS)) = A3.0+A3.1*DEL(1: LOG(XMV(-1)/IPAUS(-1)))
               +A3.2*DEL(1: LOG(MW/IPAUS))+A3.3*DEL(1: LOG(MW(-1)/IPAUS(-1)))+
               A3.4*DEL(1: LOG(ER*SXM*IPAUS/IPA))+A3.5*DEL(1: LOG(ER(-1)*SXM(-1
               )*IPAUS(-1)/IPA(-1)))+A3.6*DEL(1: UTCAP)+A3.7*(LOG(XMV(-2)/IPAUS
               (-2))-1.727*LOG(ER(-2)*IPAUS(-2)*SXM(-2)/IPA(-2))-2.002*LOG(MW(-
               2)/IPAUS(-2))+0.6524*UTCAP(-2))+A3.8*D5563+DUMXMV
    Semi-manufactured Products Exports (Millions of  US$)
54: XSV       DEL(1: LOG(XSV/IPAUS)) = A4.0+A4.1*DEL(1: LOG(XSV(-1)/IPAUS(-1)))
```

```
              +A4.2*DEL(1: LOG(XSV(-2)/IPAUS(-2)))+A4.3*DEL(1: LOG(MW/IPAUS))+
              A4.4*DEL(1: LOG(MW(-1)/IPAUS(-1)))+A4.5*DEL(1: LOG(ER(-2)*SXS(-2
              )*IPAUS(-2)/IPA(-2)))+A4.6*(LOG(XSV(-3)/IPAUS(-3))-0.1365*LOG(ER
              (-3)*IPAUS(-3)*SXS(-3)/IPA(-3))-1.392*LOG(MW(-3)/IPAUS(-3)))+
              A4.7*D82+DUMXSV
    Primary Products Exports (Millions of  US$)
55: XBV       DEL(1: LOG(XBV/IPAUS)) = A5.0+A5.1*DEL(1: LOG(MW/IPAUS))+A5.2*(
              LOG(XBV(-1)/IPAUS(-1))-0.7747*LOG(ER(-1)*IPAUS(-1)*SXB(-1)/IPA(-
              1))-0.2806*LOG(MW(-1)/IPAUS(-1)))+A5.3*D62+A5.4*D7273
    Exports - Special Transactions (Millions of  US$)
56: XTEV      XTEV = (XMV+XSV+XBV)*XTEVPCT
    Total Imports (Millions of  US$)
57: MTV       MTV = MBKV+MBIV+MBCV+MCLV
    Capital Goods Imports (Millions of  US$)
58: MBKV      DEL(1: LOG(MBKV/IPAUS)) = A6.0+A6.1*DEL(1: LOG(PIB))+A6.2*DEL(1:
              LOG(ER*TLBK*IPAUS/IPA))+A6.3*(LOG(MBKV(-1)/IPAUS(-1))+2.402*LOG(
              ER(-1)*IPAUS(-1)*TLBK(-1)/IPA(-1))-0.8902*LOG(PIB(-1)))+A6.4*D95
              +DUMMBKV
    Intermediate Goods Imports (Millions of  US$)
59: MBIV      DEL(1: LOG(MBIV/IPAUS)) = A7.0+A7.1*DEL(1: LOG(PIB))+A7.2*DEL(1:
              LOG(ER*TLBI*IPAUS/IPA))+A7.3*(LOG(MBIV(-1)/IPAUS(-1))+2.414*LOG(
              ER(-1)*IPAUS(-1)*TLBI(-1)/IPA(-1))-0.9402*LOG(PIB(-1)))+A7.4*D74
              +A7.5*D95
    Consumption Goods Imports (Millions of US$)
60: MBCV      DEL(1: LOG(MBCV/IPAUS)) = A8.0+A8.1*DEL(1: LOG(PIB))+A8.2*DEL(1:
              LOG(ER*TLBC*IPAUS/IPA))+A8.3*(LOG(MBCV(-1)/IPAUS(-1))+1.644*LOG(
              ER(-1)*IPAUS(-1)*TLBC(-1)/IPA(-1))-0.722*LOG(PIB(-1)))+A8.4*D86+
              A8.5*D9495
61:           XSITC01 = XBV+0.02*XSV
62:           XSITC24 = 0.81*XSV
63:           XSITC3 = 0.06*XSV
64:           XSITC59 = XMV+XTEV+0.11*XSV
65:           MSITC01 = 0.36*MBCV+0.12*MBIV
66:           MSITC24 = 0.15*MBIV
67:           MSITC3 = MCLV+0.04*MBIV
68:           MSITC59 = MTV-MCLV-(0.15*MBIV+0.36*MBCV+0.16*MBIV)
    Net Services (Millions of US$)
69: SER       SER = SF+SNF
    Net Factor Services (Millions of US$)
70: SF        SF = JUR+SFEXJ
    Net Interest (Millions of US$)
71: JUR       JUR = JURREC-JURDES
    Interest Revenues (Millions of US$)
72: JURREC    JURREC/RES(-1) = JURDES/DEXT(-1)-SPREAD
    Interest Expenditures (Millions of US$)
73: JURDES    JURDES/DEXT(-1) = A19.1+A19.2*LIBOR/100
    Net Factor Services minus Interest (Millions of US$)
74: SFEXJ     -SFEXJ = KED(-1)*TXSFEXJ
    (Millions of US$)
75: SNF       SNF = TUR+TRPSEG+OSNF
    Net International Travel (Millions of US$)
76: TUR       TUR = TURREC-TURDES
    International Travel Revenue (Millions of US$)
77: TURREC    LOG(TURREC+1) = A10.0+A10.1*LOG(TURREC(-1)+1)+A10.2*LOG(GDPUS(-1)
              )+A10.3*D82
    International Travel Expenditure (Millions of US$)
78: TURDES    DEL(1: LOG(TURDES)) = 7.29-1.65*DEL(1: LOG(ER*IPCUS/IPC))-0.2*(
              LOG(TURDES(-1))+LOG(ER*IPCUS/IPC)(-1)-1.5*LOG(RDOPP(-1)))
    Net Freight and Insurance (Millions of US$)
79: TRPSEG    TRPSEG = TRPSEGR-TRPSEGD
    Freight and Insurance Revenue (Millions of US$)
80: TRPSEGR   DEL(1: TRPSEGR) = (-0.45)*DEL(1: TRPSEGR(-1))+0.03*DEL(1: XTV)-87
    Freight and Insurance Expenditure (Millions of US$)
81: TRPSEGD   DEL(1: TRPSEGD) = 0.05*DEL(1: MTV)+70
    Net Other Non-Factor Services (Millions of US$)
82: OSNF      OSNF = OSNFREC-OSNFDES
    Other Non-Factor Services Revenues (Millions of US$)
83: OSNFREC   LOG(OSNFREC) = A13.0+A13.1*LOG(OSNFREC(-1))+A13.2*LOG(MTV+XTV)+
              A13.3*LOG(MTV(-2)+XTV(-2))+A13.4*D90+A13.5*D96
    Other Non-Factor Services Expenditures (Millions of US$)
84: OSNFDES   LOG(OSNFDES) = A12.0+A12.1*LOG(OSNFDES(-1))+A12.2*LOG(MTV+XTV)+
              A12.3*LOG(MTV(-1)+XTV(-1))+A12.4*D90+A12.5*D93+A12.6*D72
    Exports - Goods and Non-factor Services (US$ Millions)
85: XBSNF     XBSNF = XTV+TURREC+OSNFREC+TRPSEGR
    Imports - Goods and Non-factor Services (US$ Millions)
86: MBSNF     MBSNF = MTV+TURDES+OSNFDES+TRPSEGD
    International Reserves - Internacional Liquidity (Millions of US$)
87: RES       RES = RES(-1)-HACP
    External Debt Total (Millions of US$)
88: DEXT      DEXT = EF+DEXT(-1)*(1+0.045*(TXCAEJP(-1)/TXCAEJP-1)+0.045*(
              TXCAEAL(-1)/TXCAEAL-1)+0.029*(TXCRFFR(-1)/TXCRFFR-1))
```

```
    External Finance Requirement
 89: NFEXT    NFEXT = -(XMV+XSV+XBV+XTEV-MBKV-MBIV-MBCV-MCLV+SER+TUN)-IEDL
 90: ERV      EF+IEPL = NFEXT-HACP
    Foreign Capital Stock (Millions of Dollars)
 91: KED      KED = KED(-1)*(1-TXDEPR)+IEDL+REINV
    Net Payments of Factor Income to the Rest of the World (Millions of US$)
 92: RLE      RLE = -(SF+TUN)
    Net External Debt
 93: DEXL     DEXL = DEXT-RES
    Ratio of Net External Debt to Exports
 94: DEXLXBSNF DEXLXBSNF = DEXL/XBSNF

    (VII) LABOUR MARKET

    (VII.1) LABOUR SUPPLY

    Active population - Young(1),Male(M),Qualified(Q)
 95: O1MQ     O1MQ = P1M*E1MQ*T1MQ
    Active population - Mature(2),Male(M),Qualified(Q)
 96: O2MQ     O2MQ = P2M*E2MQ*T2MQ
    Active population - Elderly(3),Male(M),Qualified(Q)
 97: O3MQ     O3MQ = P3M*E3MQ*T3MQ
    Active population - Young(1),Female(F),Qualified(Q)
 98: O1FQ     O1FQ = P1F*E1FQ*T1FQ
    Active population - Mature(2),Female(F),Qualified(Q)
 99: O2FQ     O2FQ = P2F*E2FQ*T2FQ
    Active population - Elderly(3),Female(F),Qualified(Q)
100: O3FQ     O3FQ = P3F*E3FQ*T3FQ
    Active population - Young(1),Male(M),Unqualified(N)
101: O1MN     O1MN = P1M*E1MN*T1MN
    Active population - Mature(2),Male(M),Unqualified(N)
102: O2MN     O2MN = P2M*E2MN*T2MN
    Active population - Elderly(3),Male(M),Unqualified(N)
103: O3MN     O3MN = P3M*E3MN*T3MN
    Active population - Young(1),Female(F),Unqualified(N)
104: O1FN     O1FN = P1F*E1FN*T1FN
    Active population - Mature(2),Female(F),Unqualified(N)
105: O2FN     O2FN = P2F*E2FN*T2FN
    Active population - Elderly(3),Female(F),Unqualified(N)
106: O3FN     O3FN = P3F*E3FN*T3FN
    Active population - Qualified
107: OQ       OQ = O1MQ+O2MQ+O3MQ+O1FQ+O2FQ+O3FQ
    Active population - Unqualified
108: ON       ON = O1MN+O2MN+O3MN+O1FN+O2FN+O3FN
    Active population
109: PEA      PEA = OQ+ON
    Active population - Young
110: O1       O1 = O1MQ+O1FQ+O1MN+O1FN
    Active population - Mature
111: O2       O2 = O2MQ+O2FQ+O2MN+O2FN
    Active population - Elderly
112: O3       O3 = O3MQ+O3FQ+O3MN+O3FN
    Active population - Male
113: OM       OM = O1MQ+O1MN+O2MQ+O2MN+O3MQ+O3MN
    Active population - Female
114: OF       OF = O1FQ+O1FN+O2FQ+O2FN+O3FQ+O3FN

    (VII.2) LABOUR DEMAND

    Qualified Labour Demand - Agriculture
115: LQP      LOG(LQP) = AQP+BP*LOG(YP/(H*VPQ))+CQ*LOG(WQ)
    Qualified Labour Demand - Industry
116: LQS      LOG(LQS) = AQS+BS*LOG(YS/(H*VSQ))+CQ*LOG(WQ)
    Qualified Labour Demand - Services
117: LQT      LOG(LQT) = AQT+BT*LOG(YT/(H*VTQ))+CQ*LOG(WQ)
    Unqualified Labour Demand - Agriculture
118: LNP      LOG(LNP) = ANP+BP*LOG(YP/(H*VPN))+CN*LOG(WN)
    Unqualified Labour Demand - Industry
119: LNS      LOG(LNS) = ANS+BS*LOG(YS/(H*VSN))+CN*LOG(WN)
    Unqualified Labour Demand - Services
120: LNT      LOG(LNT) = ANT+BT*LOG(YT/(H*VTN))+CN*LOG(WN)
    Qualified Labour Demand
121: LQ       LQ = LQP+LQS+LQT
    Unqualified Labour Demand
122: LN       LN = LNP+LNS+LNT
    Labour Demand
123: L        L = LQ+LN
```

(VII.3) UNEMPLOYMENT AND WAGES

```
     Unemployment - Qualified Labour
124: UQ        UQ = 1-LQ/OQ
     Unemployment - Unqualified Labour
125: UN        UN = 1-LN/ON
     Unemployment (PNAD)
126: U         U = 1-(LQ+LN)/PEA
     Real Wage - Qualified Labour
127: WQ        LOG(WQ) = ALFAQ-BETAQ*LOG(UQ)
     Real Wage - Unqualified Labour
128: WN        LOG(WN) = ALFAN-BETAN*LOG(UN)
     Unemployment (IBGE)
129: TXDES     TXDES = TXDES(-1)*U/U(-1)+DUMDES
     Real Wage Index (Year Average)
130: SALR      SALR/SALR(-1) = (WQ*LQ/L+WN*LN/L)/(WQ(-1)*LQ(-1)/L(-1)+WN(-1)*LN(
                -1)/L(-1))
```

(VIII) VARIABLES AS PROPORTION OF GDP

```
     External Debt as a proportion of GDP
131: DEXTPIB   DEXTPIB = DEXT*ERV/(PIBN/1000)
     Net External Debt as a proportion of GDP
132: DEXLPIB   DEXLPIB = (DEXT-RES)*ERV/(PIBN/1000)
     External Debt as a proportion of Total Exports
133: DEXTXTV   DEXTXTV = DEXT/XTV
     Gross Fixed Capital Formation Construcion - Private Sector as proportion
     of GDP
134: FBKCPPIB FBKCPPIB = CN_FBKCPN/PIBN
     Public Sector Gross Fixed Capital Formation as proportion of GDP
135: FBKFGGPIB FBKFGGPIB = CN_FBKFGN/PIBN
     Total Gross Fixed Capital Formation as proportion of GDP
136: FBKFPIB   FBKFPIB = CN_FBKFN/PIBN
     Gross Fixed Capital Formation- Private Sector as proportion of GDP
137: FBKFPPIB FBKFPPIB = CN_FBKFPN/PIBN
     Gross Fixed Capital Formationem Machinery and  Equipment - Private Sector
     as proportion of GDP
138: FBKMPPIB FBKMPPIB = CN_FBKMPN/PIBN
     External Debt Interest Payments as a proportion of GDP
139: JURDESPIB JURDESPIB = JURDES*ERV/(PIBN/1000)
     External Debt Interest Payments (Net) as a proportion of GDP
140: JURPIB    JURPIB = JUR*ERV/(PIBN/1000)
     Total Imports as a proportion of GDP
141: MTVPIB    MTVPIB = MTV*ERV/(PIBN/1000)
     Net External Liabilities as a proportion of GDP
142: PELPIB    PELPIB = (DEXT+KED)*ERVF/(PIBN/1000)
     Reserves as a proportion of Total Imports
143: RESMTV    RESMTV = RES/MTV
     International Reserves as a proportion of GDP
144: RESPIB    RESPIB = RES*ERV/(PIBN/1000)
     Trade Balance as a proportion of GDP
145: SBCPIB    SBCPIB = SBC*ERV/(PIBN/1000)
     Services (Net) as a proportion of GDP
146: SERPIB    SERPIB = SER*ERV/(PIBN/1000)
     Factor Services (Net), Excluding Interest payments, as a proportion of GDP
147: SFEXJPIB SFEXJPIB = SFEXJ*ERV/(PIBN/1000)
     Factor Services (Net) as a proportion of GDP
148: SFPIB     SFPIB = SF*ERV/(PIBN/1000)
     Non -Factor Services (Net) as a proportion of GDP
149: SNFPIB    SNFPIB = SNF*ERV/(PIBN/1000)
     Current Account Balance as a proportion of GDP
150: STCPIB    STCPIB = STC*ERV/(PIBN/1000)
     Unrequited Transfers (Net) as a proportion of GDP
151: TUNPIB    TUNPIB = TUN*ERV/(PIBN/1000)
     Total Exports as a proportion of GDP
152: XTVPIB    XTVPIB = XTV*ERV/(PIBN/1000)
```

(IX) VARIABLES IN NOMINAL TERMS

```
     Total Net Tax Revenue (Millions of Reais)
153: CTRIBLN   CTRIBLN = CTRIBL*DIPIB
     Total Gross Tax Revenue (Reais millions)
154: CTRIBN    CTRIBN = CTRIB*DIPIB
     Gross Fixed Capital Formation Construction - Private Sector(Thousands of
     Reais)
155: FBKCPN    FBKCPN/1000 = FBKCP*DIPIB
     Gross Fixed Capital Formation- Private Sector (Thousands of Reais)
156: FBKFPN    FBKFPN/1000 = FBKFP*DIPIB
     Gross Fixed Capital Formation - Domestic Machinery and Equipment -
     Private Sector (Thousands of Reais)
157: FBKMPDN   FBKMPDN = FBKMPD*1000*DIPIB
     Gross Fixed Capital Formation - Machinery and  Equipment - Private
```

```
     Sector(Thousands of Reais)
158: FBKMPN    FBKMPN/1000 = FBKMP*DIPIB
     Nominal Gross Domestic Product(Thousands of Reais)
159: PIBN      PIBN = PIB/1000*DIPIB
     Nominal Wage Index (Year Average)
160: SALN      SALN = SALR*IGP
161: CN_FBKCPN CN_FBKCPN/CN_FBKCPN(-1) = FBKCPN/FBKCPN(-1)
162: CN_FBKMPN CN_FBKMPN/CN_FBKMPN(-1) = FBKMPN/FBKMPN(-1)
163: CN_FBKFPN CN_FBKFPN/CN_FBKFPN(-1) = FBKFPN/FBKFPN(-1)
164: CN_FBKFGN CN_FBKFGN/CN_FBKFGN(-1) = FBKFGN/FBKFGN(-1)
165: CN_FBKFN CN_FBKFN = CN_FBKFPN+CN_FBKFGN
166: CN_CFPPN CN_CFPPN/CN_CFPPN(-1) = CFTPP/CFTPP(-1)*DIPIB/DIPIB(-1)
167: CN_CFGGN CN_CFGGN/CN_CFGGN(-1) = CTGG/CTGG(-1)*DIPIB/DIPIB(-1)
168: CN_CTN    CN_CTN = CN_CFPPN+CN_CFGGN
169: CN_XBSZN CN_XBSZN/CN_XBSZN(-1) = XBSNF/XBSNF(-1)*ERV/ERV(-1)
170: CN_MBSZN CN_MBSZN/CN_MBSZN(-1) = MBSNF/MBSNF(-1)*ERV/ERV(-1)
171: CN_VESTON CN_VESTON = PIBN-CN_FBKFN-CN_CTN-CN_XBSZN+CN_MBSZN
```