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INFLATION AND STABILIZATION IN ARGENTINA AFTER 1975

Part 2: Structural Estimation: Tentative Results

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1. <u>Introduction</u>

This paper reports on the tentative estimation results with a short-run computable general equilibrium model (CGE) of the Argentine economy described in the Department of Economics Working Paper No. 91-07 entitled "Inflation and Stabilization in Argentina After 1975: A Computable General Equilibrium Model" by Klein, Ortiz and Rao [1991]. Whereas the original theoretical model consisted of thirty-one equations with unknown parameters, the number of such equations is reduced to twenty seven in the structure presented in this paper. The main reason for eliminating some equations was the unavailability of data on relevant variables, coupled with the conviction that these equations would only play a minor role, if at all, in the determination of the overall behaviour of the model. Specifically, equations for unreported capital flows, demand for and supply of free US dollars, and stock of foreign assets held by residents were excluded.

Generally, before any attempt is made to estimate the unknown parameters in a *linear model*, we have to make sure that the parameters of the equations are identified. Unfortunately, the theory regarding identification of parameters in a *non-linear model* which contains simultaneous difference and/or differential equations such as the present one, is still in its infancy. Hence no attempt is made in this study to identify the equations and it is assumed that the parameters of interest are identifiable.

In section 2, we explain the procedures which were followed in constructing the required data series for estimating the structure. The equations of the model and the procedures adopted in estimating the structure are described in section 3. In section 4 the estimated structure is reported and discussed.

2. Data

The main sources of data for this study consist of DATAFIEL, a data bank of the Fundación de Investigaciones Económicas Latinoamericanas in Buenos Aires and its statistical monthly journal "INDICADORES DE COYUNTURA", the study "ANALISIS Y PROYECCIONS DEL DESARROLLO ECONOMICO, Vol.V, EL DESARROLLO ECONOMICO DE LA ARGENTINA, Parte 1, CEPAL 1959", various issues of "INTERNATIONAL FINANCIAL STATISTICS", IMF, and various issues of the "FEDERAL RESERVE BULLETIN" of the USA. The data series cover the period from 1978 to 1989.

In selecting time series data, several alternatives, such as yearly, quarterly or monthly data, may be considered. It was felt that if annual data were used, the series would get smoothened and would conceal the very fluctuations which the model is intended to capture. On the other hand, if monthly data were used, too much detail would crowd in the short-run fluctuations which we wish to explain with the model. Hence, a compromise was struck by selecting quarterly data.

During the period from 1978 to 1989, different currencies were used in Argentina. Among the initially collected raw data, some series were measured in old pesos which were in circulation before the Austral Plan of 1985. Some later series were measured in Australes and still some more recent series were measured in new pesos which began to circulate in January 1992. In this study, all series have been converted into new pesos to ensure consistency. In addition, the year 1988 has been chosen as the base year for all indexes.

Money supply is an important variable in the model. The relatively broader definition of money supply M2 was preferred to the narrower definition M1 in this study because in the last two decades the Argentine government several times imposed on banks the policy of one hundred percent reserve requirement for demand deposits. With this policy, the money multiplier of M1 was equal to or even less than unity in those periods.[1] In the case of Argentina, which exhibited frequent episodes of high inflation, M2 provides a better measure of money supply.

The model includes some foreign variables, such as foreign prices and foreign interest rate. In estimating the model structure, the relevant US economic variables were selected as representatives of foreign variables because most domestic variables in the external sector are related to the US currency. In addition, the "dollar standard" plays a key role in the convertibility based stabilization program which was adopted in March 1991.

Data on some variables (both endogenous and exogenous) are directly taken from DATAFIEL and the publications cited above while data on other

[1]Statistics show that, in the period from 1978 to 1989, on average, $\Delta M1=0.78723*\Delta MB$, where MB is the monetary base and 0.78723 is the money multiplier of M1. On the other hand, the multiplier of M2 is 1.1557, on average, for the same period.

variables have to be constructed from the available primary data, or even conjectured on the basis of what are deemed to be reasonable assumptions.[2]

3. Estimation Methods

The present version of the model contains twenty-seven equations with the unknown parameters which have to be either estimated or conjectured based on plausible assumptions. For convenience, these equations are reproduced below with the same notations used in the original working paper cited earlier. The list of all variables in the theoretical model is also provided in the Appendix.

1. Supply of exportables

$$yes = \{pe/[a_{11}a_{12}(wr**a_{13})*(pz**a_{14})*(ke**a_{15})*(1+a_{16}*ir)]\}$$
$$**(1/(a_{11}-1))$$

2. Supply of importables

$$yis = \{pi/[a_{21}a_{22}(wr**a_{23})*(pz**a_{24})*(ki**a_{25})*(1+a_{26}*ir)]\}$$
$$**(1/(a_{21}-1))$$

3. Supply of nontradables

$$yns = yns_{t-1}*[(ynd_{t-1}/yns_{t-1})**a_{31}]$$

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[2]See Wang [1994] for the explanations about the construction of some data series. It should be noted that Argentine National Accounts figures have been revised in 1992. However, in this research, only data preceding the revision were used because no new quarterly data on GDP and its components were available to us as late as July 1993. Estimation of the model with the revised data is planned for the future.

4. Demand for imported inputs by the exportables industries

$$zed = (1+a_{16}*ir)a_{14}a_{12}(wr**a_{13})*(ke**a_{15})*(yes**a_{11})/[pz**(1-a_{14})]$$

5. Demand for imported inputs by the importables industries

$$zid = (1+a_{26}*ir)a_{24}a_{22}(wr**a_{23})*(ki**a_{25})*(yis**a_{21})/[pz**(1-a_{24})]$$

6. Demand for imported inputs by the nontradables industries

$$znd = a_{41}*yns$$

7. Expenditure on exportables

$$yed=\{[b_{11}(logpe-logyyd)+b_{12}(logpi-logyyd)+b_{13}(logpn-logyyd)+b_{14}]/$$
$$[-1+b_{15}(logpe-logyyd)+b25(logpi-logyyd)+b_{35}(logpn-logyyd)]\}*yyd/pe$$

8. Expenditure on importables

$$yid=\{[b_{21}(logpe-logyyd)+b_{22}(logpi-logyyd)+b_{23}(logpn-logyyd)+b_{24}]/$$
$$[-1+b_{15}(logpe-logyyd)+b_{25}(logpi-logyyd)+b_{35}(logpn-logyyd)]\}*yyd/pi$$

9. Expenditure on nontradables

$$ynd=\{[b_{31}(logpe-logyyd)+b_{32}(logpi-logyyd)+b_{33}(logpn-logyyd)+b_{34}]/$$
$$[-1+b_{15}(logpe-logyyd)+b_{25}(logpi-logyyd)+b_{35}(logpn-logyyd)]\}*yyd/pn$$

10. Private expenditure

$$ypd = (yd**b_{41})*(mms**b_{42})*(ir**b_{43})$$

11. Real reported capital flaws

$$kar = c_{11}+c_{12}*(IR-IRF-rp-dre)$$

12. Nominal exchange rate

$$ER = ERP + c_{21}*\Delta FF$$

13. Risk premium

$$rp = c_{31}*ER*DE/PP*yys$$

14. Real government deficit

$$df=ged-ta-ty-tx-tz+ir_{t-1}*(DDs_{t-1}/PP)+(ER*DE_{t-1}*IRF_{t-1}/PP)+d_{11}ri$$

15. Real demand for money

$$mmd = (ww^{**}e_{11})^*(yys^{**}e_{12})^*\exp\{e_{13}^*IR+e_{14}^*dre\}$$

16. Nominal money supply

$$MMs = MMs_{t-1}+e_{21}(BP+LO-\Delta DDs+e_{31}DF)$$

17. Real demand for government bonds

$$ddd = (ww^{**}e51)^*(yys^{**}e52)^*\exp\{e53^*IR+e54^*dre\}$$

18. Nominal supply of government bonds

$$DDs = DDs_{t-1}+(1-e_{31})^*DF+e_{41}DDs_{t-1}$$

19. Nominal interest rate adjustment mechanism

$$IR-IR_{t-1} = e_{81}(IRF+dre+rp-IR_{t-1})+e_{82}(\log MMs-\log MMs_{t-1})$$

20. Nominal wage rate

$$WR = (PPe^{**}f_{11})^*\exp[f_{12}((yyd-yys)/yys)]$$

21. Expected inflation rate

$$rie = g_{21}^*dre$$

22. Expected devaluation rate

$$dre = g_{31}^*[ER_{t-1}-ERP_{t-1}]$$

23. General price index

$$PP = (PE^{**}h_{11})^*(PI^{**}h_{12})^*(PN^{**}h_{13})$$

24. Price index of importables

$$PI = (PZ^{**}h_{21})^*[PI_{t-1}^{**}(1-h_{21})]$$

25. Actual price index of nontradables

$$PN = PN_{t-1}^*[(PNd_{t-1}/PN_{t-1})^{**}h_{31}]$$

26. Mark-up rate for nontradables

$$qf = (PPe^{**}h_{41})^*\exp[h_{42}((yyd-yys)/yys)]$$

27. Nominal Variable cost in the nontradables sector

$$VCN = WR*ln/yns+PZ*znd/yns+h_{51}(WR*ln/yns)*IR+h_{52}(PZ*znd/yns)*IR +KN/yns$$

The equations (1), (2), (4), (5), (7), (8), and (9) are non-linear so that ordinary least squares (OLS) cannot be directly applied. Equations (6), (13) and (27) include coefficients which cannot be estimated either because data on the dependent variables are not available (such as VCN and znd) or can not be observed (such as rp). In these cases, the values of coefficients were simply conjectured. In addition, for purposes of policy simulation, the coefficient d_{11} in equation (14), which measures the Olivera-Tanzi effect (see Olivera [1977] and Tanzi [1977]) in a linear approximation, is allowed to take alternative non-negative values. Finally, the coefficients h_{11}, h_{12}, and h_{13} in equation (23) are equal to 0.2242, 0.1919, and 0.5839 respectively. These were computed in the process of constructing the data on the general price index. The remaining equations are either linear or log-linear so that their coefficients can be directly estimated by OLS.

The supply equations (1) and (2) may be estimated in two ways, namely, by using Taylor expansion to linearize them and then applying OLS, or by using the non-linear least squares (NLS)[3] estimator. In practice, the OLS method was first applied but with the result that not all estimated parameters satisfied the theoretical properties.[4] However, these preliminary estimates

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[3]Some basic details regarding non-linear estimation can be found in Maddala [1977]. A more rigorous treatment of non-linear estimation can be found in Davidson and MacKinnon [1993].

[4]The supply equations were derived from variable cost equations (see Klein-Ortiz-Rao [1991]). For example, equation (1) is consistent with theory if and only if $a_{11} \geq 0$, $a_{12} > 0$, $a_{13} \geq 0$, $a_{14} \geq 0$, $a_{15} \leq 0$, and $a_{13} + a_{14} = 1$. Clearly, parameters in equation (2) must also meet these requirements. See,

shed some light on the possible values of some unknown parameters in equations (1) and (2) and allow us to apply NLS to estimate the parameters of the equations. Several different sets of initial values for the unknown parameters, hinted by the initial OLS estimates, were alternatively experimented with. From these estimations, the parameters a_{16} in equation (1) and a_{26} in equation (2), which measure the proportions of working capital that are financed by borrowing, fluctuated between -0.4 (unreasonable) and 0.28, but appeared very often in the range of 0.08 to 0.25, while the estimates of other parameters were not satisfactory. To improve these estimates, a_{16} and a_{26} were set equal to 0.22 and 0.1 respectively[5] - which imply that 22% of working capital in the exportables sector and 10% of working capital in the importables sector are financed by borrowing - and the supply equations were re-estimated with the best sets of initial values. The results, after 100 iterations, were reasonable and consistent with the restrictions that the parameters are expected, in theory, to satisfy. The parameters of equations (1) and (2) also occur in equations (4) and (5). Hence, equations (4) and (5) need not be estimated.

The translog system of demand equations was first linearized and estimated by OLS. Here too, the preliminary OLS estimates were used as the basis for specifying several different sets of initial values for the NLS estimation. The standard parameter restrictions regarding integrability of the

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for example, Lau [1976], McFadden [1978], and Hazilla and Kopp [1986].

[5]We also experimented with other values, but these two plausible values yielded the best results.

demand functions were imposed with satisfactory results.[6] Although, as stated, several sets of different starting values were experimented with, the procedure converged after 27 iterations and a unique set of estimates was obtained. Therefore, it could be concluded that at least a local minimum of the sum of squares of residuals was guaranteed to have been reached in estimating this demand system.[7]

The OLS estimates of the coefficients c_{11} and c_{12} in equation (11), i.e., real reported capital flows (kar), were poor. Part of the reason is possibly that kar was measured in levels while the explanatory variables, IR, dre, rp, and IRF were given in percentage terms. Thus, a very large OLS estimate of the intercept was obtained, which smoothened to a large extent the actual fluctuations of kar. Several methods may be adopted to improve the estimation, without violating the theoretical specification of the behaviour of capital flows. A frequently used method is introducing lagged explanatory variables. In our case, we introduced lagged explanatory variables with their powers (up to and including the third power) into the equation to capture the fluctuations in capital movements. A dummy variable was also introduced identifying those periods when a liberalized policy regarding capital movements was implemented. The equation actually estimated was

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[6]To ensure homogeneity, symmetry, and summability of demand functions, the following restrictions were imposed in estimation: $\Sigma_i b_{i4}=-1$, $b_{ij}=b_{ji}$, and $\Sigma_i\Sigma_j b_{ij}=0$, where i, j, = 1, 2, 3. Note that $b_{15}=b_{11}+b_{21}+b_{31}$, $b_{25}=b_{12}+b_{22}+b_{32}$, and $b_{35}=b_{13}+b_{23}+b_{33}$ in the demand system. See Jorgenson and Lau [1979] and Conrad and Jorgenson [1979]. Note that, from a rigorous theoretical perspective, one need not assume that aggregate demand functions satisfy more than homogeneity and summability unless one postulates the existence of a "social utility function" or a "representative agent" - see Sonnenschein [1973]. We do not insist here on such an interpretation but point to the allocative nature of this model.

[7]This is also a local maximum if maximum likelihood method is applied.

$$\text{11.1} \qquad kar_t = c_{11} + c_{12}X_t + c_{13}X_{t-1} + c_{14}X^2_t + c_{15}X^2_{t-1} + c_{16}X^3_t + c_{17}X^3_{t-1} + c_{18}dum$$

where X_t = $(IR\text{-}IRF\text{-}rp\text{-}dre)_t$ and dum denotes the dummy variable. This modified equation is still consistent with the theoretical specification of the capital flows equation in Klein, Ortiz, and Rao [1991]. Equation (11.1) was estimated by OLS which captured more satisfactorily the capital movements than the original equation (11).

Equation (19), the nominal interest rate adjustment mechanism, was also modified. During 1978-1989, nominal interest rates in Argentina followed closely the inflation rates. But in some periods regulated interest rates and free market interest rates co-existed, as, for instance, during the Austral Plan period. This situation deserves special consideration when estimating this equation. Another interesting problem relates to the quarterly nature of data to the extent that three months may be too long a period for the adjustment of nominal interest rates in a "small open economy", such as the Argentine economy. Recognizing this, the lagged nominal interest rate in the equation was assigned an average value of the current rate and that of the previous quarter, i.e., $(IR_t+IR_{t-1})/2$. Thus, equation (19) is modified to read:

$$\text{19.1} \qquad Y_t = e_{51}X_{1,t} + e_{52}X_{2,t} + e_{53}dum$$

where $Y_t=IR_t-(IR_t+IR_{t-1})/2$, $X_{1,t}=(IRF_t+rp_t+dre_t-(IR_t+IR_{t-1})/2)$, $X_{2,t}=\log(MMs_t)-\log(MMs_{t-1})$, and dum is a dummy variable. The inclusion of a dummy variable in equation (19.1) is to account for the government regulations which were in effect during some periods.

The original equation describing the formation of expectations regarding devaluation of the exchange rate, i.e., equation (22), was modified by adding a new variable to determine expectations, namely, the changes in the nominal money supply. The modified equation is

$$22.1 \qquad dre_t = g_{31}(ER/ERP)_{t-1}+g_{32}(MMs/MMs_{t-1})$$

Clearly, if ER > ERP in the last period, dre is expected to fall, while if MMs > MMs_{t-1}, dre is expected to rise. Hence the expected sign of g_{31} is negative and of g_{32} is positive.

The mark-up equation (26) was also modified. In order to improve estimation results, a constant term was added to the logarithmic transform of this equation. The regression equation in logarithmic form is

$$26.1 \qquad Y_t = h_{41} + h_{42}X_{1,t} + h_{43}X_{2,t}$$

where $Y_t=\log(qf_t)$, $X_{1,t}=\log(PPe_t)$, and $X_{2,t}=((yyd-yys)/yys)_t$.

In the CGE model, demand for and supply of real money balances are assumed to be equal in every period. A similar equilibrium condition holds also for the demand for and supply of real bonds. We note that once these equilibrium conditions are imposed, to avoid over-determination, only one equation in each demand-supply pair may be used in computing the equilibrium solution. We report below the estimation results for the demand equations and leave the supply equations for the policy simulation experiments to be performed later on. Finally, we note that improved estimates were obtained when the total wealth variable was dropped and the expected devaluation rate variable was replaced by the expected inflation rate in both the demand for money and the demand for bonds equations.

4. Estimation Results

The estimation results are presented and commented upon below. The sample size is of 48 observations, starting with the first quarter of 1978 and ending with the last quarter of 1989. The disturbances u_{ti} for equation i ($i=1,2,...,27$) in period t are not shown explicitly. They are assumed to be additive and *nid* $(0,\sigma^2_i)$.[8] A hat is placed to denote an estimated coefficient. The figures given in parentheses are t-ratios. The signs *, ** and *** following t-ratios indicate significance levels of 0.01, 0.05, and 0.10 respectively.

Supply of exportables

(1) yes = {pe/[$a_{11}a_{12}$(wr**a_{13})*(pz**a_{14})*(ke**a_{15})*(1+a_{16}*ir)]}

**(1/(a_{11}-1))

This equation was estimated by the NLS method. The homogeneity property of variable costs, $a_{13}+a_{14}=1$, was imposed and a_{16} was given the value of 0.22. Initial values of 1.0001, 0.5, 0.6, -0.8 were assigned to the parameters a_{11}, a_{12}, a_{13}, and a_{15} respectively. The obtained estimates after 100 iterations are:

[8] It may be pointed out that nonlinear least squares is a distribution-free method of estimation though for inferential purposes normality is required. Under the assumption of normally distributed disturbances, the NLS estimator yields the same estimates as the maximum likelihood estimates.

$\hat{a}_{11}$ = 2.7318 (53.410)* $\hat{a}_{12}$ = 0.11571*10^{-6} (3.1973)*

$\hat{a}_{13}$ = 0.32178 (3.7227)* $\hat{a}_{14}$ = 1 - $\hat{a}_{13}$ = 0.67822

$\hat{a}_{15}$ = -0.79669 (-23.347)* $\hat{a}_{16}$ = 0.22 (assumed value)

These estimates satisfy all standard theoretical properties. The short-run case of decreasing returns to scale is verified by $\hat{a}_{11}$ >1.

Supply of importables

(2) yis = {pi/[$a_{21}a_{22}$(wr**a_{23})*(pz**a_{24})*(ki**a_{25})*(1+a_{26}*ir)]}
**(1/(a_{21}-1))

This equation was estimated by the NLS method with the restrictions a_{23}+a_{24}=1 and a_{26}=0.1. Initial values of 1.0001, 0.7, 0.7, and -0.8 were assigned to the parameters a_{21}, a_{22}, a_{23}, and a_{25} respectively. The estimates after 100 iterations:

$\hat{a}_{21}$ = 3.1934 (43.135)* $\hat{a}_{22}$ = 0.47946*10^{-5} (4.1264)*

$\hat{a}_{23}$ = 0.4178 (7.6103)* $\hat{a}_{24}$ = 1 - $\hat{a}_{23}$ = 0.5822

$\hat{a}_{25}$ = -1.4291 (-24.504)* $\hat{a}_{26}$ = 0.1 (assumed value)

The estimates also satisfy standard theoretical properties and the short-run case of decreasing returns to scale is verified by $\hat{a}_{21}$ >1.

Supply of nontradables

(3) yns = yns_{t-1}*[(ynd_{t-1}/yns_{t-1})**a_{31}]

$\hat{a}_{31}$ = 1.0446 (7.3058)* R^2 (adjusted) = 0.5101

Demand for imported inputs by the exportable and importable sectors

(4) $zed = (1+a_{16}*ir)a_{14}a_{12}(wr**a_{13})*(ke**a_{15})*(yes**a_{11})/[pz**(1-a_{14})]$

(5) $zid = (1+a_{26}*ir)a_{24}a_{22}(wr**a_{23})*(ki**a_{25})*(yis**a_{21})/[pz**(1-a_{24})]$

The parameters in these equations are the same as those reported above for equations (1) and (2). With the estimated values of the parameters, the unobserved dependent variables zed and zid can be computed.

Demand for imported inputs by the nontradables industries

(6) $znd = a_{41}*yns$

$\hat{a}_{41} = 0.026$ Since no data on znd were available, $\hat{a}_{41}$ was calculated from information about the input-output ratio.[9]

Expenditure on exportables, importables, and nontradables

(7) $yed=\{[b_{11}(logpe-logyyd)+b_{12}(logpi-logyyd)+b_{13}(logpn-logyyd)+b_{14}]/$

$[-1+b_{15}(logpe-logyyd)+b25(logpi-logyyd)+b_{35}(logpn-logyyd)]\}*yyd/pe$

(8) $yid=\{[b_{21}(logpe-logyyd)+b_{22}(logpi-logyyd)+b_{23}(logpn-logyyd)+b_{24}]/$

$[-1+b_{15}(logpe-logyyd)+b_{25}(logpi-logyyd)+b_{35}(logpn-logyyd)]\}*yyd/pi$

(9) $ynd=\{[b_{31}(logpe-logyyd)+b_{32}(logpi-logyyd)+b_{33}(logpn-logyyd)+b_{34}]/$

$[-1+b_{15}(logpe-logyyd)+b_{25}(logpi-logyyd)+b_{35}(logpn-logyyd)]\}*yyd/pn$

[9] The information about input-output ratios in various production sectors was found in "ANALISIS Y PROYECCIONS DEL DESARROLLO ECONOMICO, Vol.V, EL DESARROLLO ECONOMICO DE LA ARGENTINA, Parte 1, CEPAL 1959".

Equations (7), (8), and (9) constitute the three expenditure share equations and hence satisfy certain linear restrictions. Accordingly, equations yed and yid were estimated simultaneously taking into account the equality of some parameters by the NLS method, while the parameters in the equation for ynd were derived from the imposed linear restrictions. The selected initial values for b_{11}, b_{12}, b_{13}, b_{14}, b_{22}, b_{23}, and b_{24} were -0.5, 0.5, 0.5, 0.33 -0.5, 0.5, and 0.33 respectively. The values, after 27 iterations, converged to the following set of estimates:

$\hat{b}_{11} = -0.074143$ (-5.6401)* $\hat{b}_{12} = 0.11964$ (9.1833)*

$\hat{b}_{13} = 0.10889$ (5.0454)* $\hat{b}_{14} = 2.6351$ (4.0794)*

$\hat{b}_{21} = \hat{b}_{12} = 0.11964$ $\hat{b}_{22} = -0.093338$ (-4.3190)*

$\hat{b}_{23} = 0.16889$ (9.2148)* $\hat{b}_{24} = 3.2395$ (6.4609)*

$\hat{b}_{31} = \hat{b}_{13} = 0.10889$ $\hat{b}_{32} = \hat{b}_{23} = 0.16889$

$\hat{b}_{33} = - \hat{b}_{11} - \hat{b}_{12} - \hat{b}_{13} - \hat{b}_{21} - \hat{b}_{22} - \hat{b}_{23} - \hat{b}_{31} - \hat{b}_{32} = -0.06274$

$\hat{b}_{34} = -1 - \hat{b}_{14} - \hat{b}_{24} = -6.8746$

Private expenditure

(10) $ypd = (yd^{**}b_{41})^*(mms^{**}b_{42})^*(ir^{**}b_{43})$

$\hat{b}_{41} = 0.84499$ (22.878)* $\hat{b}_{32} = 0.17386$ (4.2731)*

$\hat{b}_{33} = -0.018552$ (-1.25405) R^2 (adjusted) = 0.6798

Real reported capital flows

(11) $kar_t = c_{11} + c_{12}X_t + c_{13}X_{t-1} + c_{14}X^2_t + c_{15}X^2_{t-1}$

$+ c_{16}X^3_t + c_{17}X^3_{t-1} + c_{18}dum$

where X_t = (IR-IRF-rp-dre)$_t$ and dum is a dummy variable. In the first attempt, estimates of c_{14} and c_{16} were insignificant and the sign of $\hat{c}_{12}$ was incorrect. After dropping the insignificant arguments, we obtained the following results,

$\hat{c}_{11} = 0.54562*10^6$ (5.0247)* $\hat{c}_{12} = 0.36561*10^6$ (4.8710)*

$\hat{c}_{13} = -0.91640*10^6$ (-2.3279)** $\hat{c}_{15} = -0.14761*10^7$ (-6.9005)*

$\hat{c}_{17} = -0.25326*10^6$ (-8.5334)* $\hat{c}_{18} = 8509.6$ (6.3108)*

R^2 (adjusted) = 0.8322

Nominal exchange rate

(12) $ER = ERP + c_{21}*\Delta FF$

$\hat{c}_{21} = -0.16896*10^{-5}$ (-3.2907)* R^2 (adjusted) = 0.2437

Risk premium

(13) $rp = c_{31}*ER*DE/PP*yys$

The coefficient c_{31} could not be estimated due to the fact that data on rp were not available. We assigned a value of unity to c_{31} and computed the data series on rp. This data series was used for estimating other equations. Clearly, other plausible values can be assigned to c_{31} in policy simulations depending on the objectives.

Real government deficit

(14) $df=ged-ta-ty-tx-tz+ir_{t-1}*(DDs_{t-1}/PP)+(ER*DE_{t-1}*IRF_{t-1}/PP)+d_{11}ri$

The coefficient d_{11} measures the Olivera-Tanzi effect. This coefficient was not estimated. Instead, values will be assigned to this coefficient in policy simulations according to variations in the actual inflation rates in different periods.

Real demand for money balances

(15) $mmd = (yys^{**}e_{11})^{*}\exp\{e_{12}^{*}IR+e_{13}^{*}rie\}$

$\hat{e}_{11} = 0.91157$ (298.89)* $\hat{e}_{12} = -0.14729$ (-1.7079)***

$\hat{e}_{13} = -0.010858$ (0.16020) R^2 (adjusted) = 0.1639

Nominal supply of money balances

(16) $MMs = MMs_{t-1}+e_{21}(BP+LO-\Delta DDs+e_{31}DF)$

This equation is left for policy simulation experiments.

Real demand for government bonds

(17) $ddd = (yys^{**}e_{51})^{*}\exp\{e_{52}^{*}IR+e_{53}^{*}rie\}$

$\hat{e}_{51} = 0.22243$ (3.0068)* $\hat{e}_{52} = 9.1090$ (1.9839)***

$\hat{e}_{53} = -1.5792$ (-1.80168)*** R^2 (adjusted) = 0.1036

Nominal supply of government bonds

(18) $DDs = DDs_{t-1}+(1-e_{31})^{*}DF+e_{41}DDs_{t-1}$

This equation is left for the policy simulation experiments.

Nominal interest rate adjustment mechanism

(19) $Y_t = e_{81}X_{1,t} + e_{82}X_{2,t} + e_{83}dum$

where $Y_t = IR_t-(IR_t+IR_{t-1})/2$, $X_{1,t} = (IRF_t+rp_t+dre_t-(IR_t+IR_{t-1})/2)$, $X_{2,t}=\log(MMs_t)-\log(MMs_{t-1})$, and dum is a dummy variable.

$\hat{e}_{81}$ = 0.38437 (7.7241)* $\hat{e}_{82}$ = -0.70406 (-5.1020)*

$\hat{e}_{83}$ = 0.21362 (2.1360)** R^2 (adjusted) = 0.5662

Nominal wage rate

(20) WR = (PPe**f_{11})*exp[f_{12}((yyd-yys)/yys)]

$\hat{f}_{11}$ = 1.0053 (179.58)* $\hat{f}_{12}$ = 1.2206 (1.9343)***

R^2 (adjusted) = 0.9972

Expected inflation rate

(21) rie = g_{21}*dre

$\hat{g}_{21}$ = 0.95726 (21.230)* R^2 (adjusted) = 0.8837

Expected devaluation rate

(22) dre = g_{31}*$(ER/ERP)_{t-1}$+g_{32}(MMs/MMs_{t-1})

$\hat{g}_{31}$ = -1.7685 (-4.7989)* $\hat{g}_{32}$ = 1.7143 (6.7489)*

R^2 (adjusted) = 0.5058

General price index

(23) PP = (PE**h_{11})*(PI**h_{12})*(PN**h_{13})

The coefficients h_{11}, h_{12}, and h_{13} were computed in the process of data construction and are equal to 0.2242, 0.1919, and 0.5839, respectively. Thus, the general price level PP is a Divisa index based on the price indices of exportables (PE), importables (PI), and nontradables (PN). Accordingly, the computed weights sum to unity.

Price index of importables

(24) $PI = (PZ^{**}h_{21})^*[PI_{t-1}^{**}(1-h_{21})]$

$\hat{h}_{21} = 0.43845 \quad (3.4332)^*$ $\qquad R^2$ (adjusted) = 0.6731

Actual price index of nontradables

(25) $PN = PN_{t-1}^*[(PNd_{t-1}/PN_{t-1})^{**}h_{31}]$

$\hat{h}_{31} = 1.8795 \quad (13.762)^*$ $\qquad R^2$ (adjusted) = 0.5567

Mark-up rate for nontradables

(26) $Y_t = h_{41} + h_{42}X_{1,t} + h_{43}X_{2,t}$

where $Y_t = \log(qf_t)$, $X_{1,t} = \log(PPet)$, $X_{2,t} = [(yyd-yys)/yys]_t$.

$\hat{h}_{41} = 0.43467 \quad (21.868)^*$ $\qquad \hat{h}_{42} = 0.43433^*10^{-2} \ (1.8853)^{***}$

$\hat{h}_{43} = 0.70945 \quad (3.8974)^*$ $\qquad R^2$ (adjusted) = 0.2125

Nominal Variable cost in the nontradables sector

(27) VCN = WR*ln/yns+PZ*znd/yns+h_{51}(WR*ln/yns)*IR+h_{52}(PZ*znd/yns)*IR +KN/yns

Since data on VCN were not available, we have to conjecture the coefficients in this equation. With reference to a_{16} = 0.22 in equation (1) and a_{26} = 0.1 in equation (2), we assigned $h_{51}=h_{52}=0.2$.

5. Conclusion

The tentative structural estimation of the CGE model of Argentina served to assess the hypotheses embodied in the original model while at the same time pointing to possible directions for improvement. Meanwhile, confidence in the suitability of the approach and in the plausibility of the underlying hypotheses was supported by the results obtained from a two-sector (tradables and nontradables) model which was related to the original Klein-Ortiz-Rao system - see Wang [1994].

Returning to the current three-sector model, suffice it to say at this point that the next phase of this research project will be devoted to policy simulation experiments, the results of which will be reported by the authors in a separate working paper in the near future.

Appendix

List of Variables

All variables in the theoretical model are listed below. In the list, (x) identifies an exogenous variable and (*) identifies a policy variable. All others are endogenous variables.

Gross Domestic Product Components: Supply and Demand

yes: real supply of exportables

yis: real supply of importables

yns: real supply of nontradables

yed: real expenditure on exportables

yid: real expenditure on importables

ynd: real expenditure on nontradables

ypd: real private expenditure

yd: real disposable income

yyd: total real expenditure

yys: real aggregate supply

Fiscal Sector

try: average income-dependent tax rate (*)

trx: average export tax rate (*)

trz: average import tax rate (*)

trf: average tax rate on yields of foreign financial assets held by domestic residents (*)

ta: real autonomous tax revenue (x)

ty: real output-dependent tax revenue

tx: real export tax revenue

tz: real import tax revenue

tf: real tax on yields of foreign financial assets held by domestic residents

ged: real government expenditure (x)

DF: nominal fiscal deficit

df: real fiscal deficit

External Sector and Balance of Payments

znd: real imported input demand for nontradables

zed: real imported input demand for exportables

zid: real imported input demand for importables

zgr: other real imports in domestic currency (x)

zt: real imports in domestic currency

xt: real exports in domestic currency

bt: real balance of trade in domestic currency

BP: nominal balance of payments in domestic currency

bp: real balance of payments in domestic currency

ca: real current account in domestic currency

ka: real capital account in domestic currency

KAA: nominal net autonomous capital flow in US Dollars (x)

kaa: real net autonomous capital flow in domestic currency (x)

kar: real net reported capital flow in domestic currency

kau: real net unreported capital flow in domestic currency

DE: nominal external debt in US Dollars (x)

FF: nominal official foreign currency reserves in US dollars

rp: risk premium

Financial Variables

MMd: nominal demand for money

mmd: real demand for money

MMs: nominal supply (stock) of money

mms: real supply (stock) of money

MB: nominal monetary base

AM: nominal active money (x)

PM: nominal passive money

LO: nominal central bank loans to depository institutions (x)

DDd: nominal demand for domestic bonds

ddd: real demand for domestic bonds

DDs: nominal supply of domestic debt (x)

dds: real supply (stock) of domestic debt (bonds)

USd: nominal demand for free US Dollars in US currency

usd: real demand for free US Dollars in domestic currency

USs: nominal supply of free US Dollars in US currency

uss: real supply of free US Dollars in domestic currency

DFS: nominal stock of foreign financial assets held by domestic residents

dfs: real stock of foreign financial assets held by domestic residents

kk: aggregate real capital stock (x)

ww: real private wealth

Prices, interest rates, exchange rates and wage rates

PE:	price index of exportables
PI:	price index of importables
PN:	price index of nontradables
PNd:	desired price level of nontradables
qf:	mark-up rate
pe:	relative domestic price of exportables
pi:	relative domestic price of importables
pn:	relative price of nontradables
PZ:	domestic price level of imports
pz:	relative domestic ptice of imports
PEF:	foreign price level of exportables (x)
PZF:	foreign price level of imports (x)
WR:	nominal wage rate
wr:	real wage rate
IR:	nominal interest rate or borrowing cost (x or endogenous)
ir:	real interest rate or borrowing cost
IRF:	nominal foreign interest rate (x)
ER:	nominal exchange rate in pesos per US Dollar (x or endogenous)
ERP:	long run equilibrium parity nominal exchange rate (x)
ri:	rate of inflation
PP:	general price index

Expectation variables

PPe: expected general price level

rie: expected rate of inflation

dre: expected devaluation rate

Miscellaneous Variables

VCN: nominal total short run variable cost for nontradables

VPN: nominal short run production cost for nontradables

VBN: nominal short run borrowing cost for nontradables

vce: real total short run variable cost for exportables

vpe: real short run production cost for exportables

vbe: real short run borrowing cost for exportables

ke: real capital stock for exportables (x)

ki: real capital stock for importables (x)

KN: nominal capital stock for nontradables (x)

ln: employment in the nontradables industries (x)

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