Preliminary. April 1982

# The Real Exchange Rate: Testing the Overshooting Hypothesis in Argentina and Brazil

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This paper presents empirical studies on the determinants of the real exchange rate for both Argentina and Brazil. Hence it is required to combine several separated theories as treated in the literature. Thus, in the analysis, we will consider, those factors stemming from the commercial policies, long run growth and cycles.

The excellent results obtained with the estimated equations reveal the appropriateness of the contemporary developments in the theory of international trade in both fields: pure and macroeconomics. In particular, the Brazilian data indicated that the overshooting is a long run phenomenon, while those for Argentina are suggestive instead of being an instantaneous adjustment.

Section I develops the basic model. The estimated equation for Brazil is presented in Section II. The equations for Argentina, together with a slight modification of the model are found in Section III. Concluding comments are contained in Section IV.

## 1. The Model

Here we draw from the contributions of Dornbusch (1974) and Sjaastad. The home country consumes and produces both Agriculture, A , and Industrial, I , goods - traded

commodities - as well as services, S - nontraded. The country is small so that the relative price of traded goods in the world market is taken as given. Imports of industrial goods are subject to tariffs whose proceeds are reverted to subsidies for the exports of goods of the same sector. There are three sectors with two relative prices which we assume to be perfectly flexible so as to allow the market for services to clear.

The difference between income (Y) and expenditure (E) equals the sum of the excess supplies in every market plus net income from foreign assets, Z :

$$1)\quad Y - E = P_I\,(X_I - C_I) + P_A(X_A - C_A) + P_S\,(X_S - C_S) + Z$$

where $P_i$ $(i = A, I, S)$ is the price in the respective setor, $X_i$ stands for sectorial production and $C_i$ corresponds to the respective consumption. Equilibrium in the nontraded goods sector implies that the excess supply of traded goods, plus net income from abroad (current account surplus), equals the excess of income over expenditure. It is only when income equals expenditure (assets markets equilibrium) that clearing in the nontraded goods sector also implies equilibrium in the current account.

Thus, the empirical model may be reduced to the equilibrium condition in the home goods market. However, provisions must also be given to the equilibrium condition in the assets markets.

The demand for services, D , is a function of the relative prices of services $[p_S \equiv (P_S/P_A)]$, industrial goods $[p_I \equiv (P_I/P_A)]$, and of permanent real income $\bar{y}$ , as follows:

$$2)\qquad D = D\,(p_S\,,\ p_I\,,\ \bar{y}\,)\ .$$

The supply of services, S , is a function of the same set of relative prices, the endowment of capital, K , and labor, L, and the technology, t :

3) $S = S\ (p_S\ ,\ p_I\ /K\ ,\ L\ ,\ t)\ .$

The domestic relative price of industrial goods in terms of agriculture, $p_I$ , is determined by the given world terms of trade $p_I^*$ , and the tariff wedge, $T \equiv 1 + \tau$:

$$p_I \equiv p_I^*\ T\ .$$

Differentiating the equilibrium condition in the nontraded goods sector, $D = S$ , generates,

$$4)\quad \hat{p}_S = -\frac{\varepsilon_{SI} - \eta_{SI}}{\Delta}\ \hat{p}_I + \frac{\eta_{S\bar{y}}\ \gamma - 1}{\Delta}\ \hat{\bar{y}}_S$$

where a $\hat{}$ over a variable indicates its rate of change; $\varepsilon_{SI}$ is the elasticity of substitution in production of services with respect to the relative price of industrial goods; $\eta_{SI}$ is the equivalent elasticity of substitution in consumption; $\eta_{S\bar{y}}$ is the income elasticity of the demand for services; $\gamma$ assumed constant, is the ratio between the long run growth rate of income ($\hat{\bar{y}}$ , permanent income) and the corresponding rate for the service sector, $\hat{\bar{y}}_S$ ; finally $\Delta = (\eta_{SS} + \varepsilon_{SS}) > 0$ .[1]

The degree of substitution or complementarity among goods determines the range of variation in the magnitudes of the coefficients in (4). If services and industrial goods are perfect substitutes, either in production or consumption, the coefficient of $\hat{p}_I$ will be unit, while that of $\hat{\bar{y}}_S$ most likely becomes equal to zero. Conversely, if services and agricultural goods are perfect substitutes, the coefficients of both variables will be zero. A particular case of interest, as we will see later, refers to one of almost independency between services and agricultural goods; here the coefficient of $\hat{p}_I$ will again equal unity, while that of $\hat{\bar{y}}_S$ would be positive and finite[2]. Outside these extreme cases and assuming gross substitution among any pair of goods, the coefficient of $\hat{p}_I$ will be positive but less than unit, while that of $\hat{\bar{y}}_S$ will be positive and finite.

The relative price of services in terms of agricultural goods is equivalent to the relative price of nontraded goods in terms of a traded one. An increase in this relative price means an appreciation in the real exchange rate, independently of whether it comes from either a rise in the price of the nontraded goods or through a fall in the exchange rate[3].

Integration of (4) generates

$$5)\quad \text{Ln}\,\bar{p}_S = \omega_0 + \omega_1\,\text{Ln}\,p_I + \omega_2\,\text{Ln}\,\bar{y}_S\ ,$$

where $\omega_0$ is the constant of integration, while $\omega_1$ and $\omega_2$ correspond with the coefficients of the respective variables in (4); a bar over a variable means its long run value.

Equation (5) reflects the relationship between the variables resulting from the condition of equilibrium in the services markets only. If the economy were permanently in its steady-state equilibrium with the government supplying the additional assets to satisfy the private sector flow excess demand for assets, then Equation (5) would be suitable for estimation[4]. However, this might not be the case , so we need to introduce the disequilibrium condition in the assets markets. We identify a disequilibrium in assets markets by the gap between actual and potential output ($\text{Ln}\,y_S - \text{Ln}\,\bar{y}_S$).

$$(6)\quad \text{Ln}\,\bar{p}_S = \omega_0 + \omega_1\,\text{Ln}\,p_I + \omega_2\,\text{Ln}\,\bar{y}_S + \omega_3\,(\text{Ln}\,y_S - \text{Ln}\,\bar{y}_S).$$

When actual output falls short of its potential level, assets are being accumulated, together with a current account surplus. The accumulation will persist until we reach the desired or steady-state level of assets. At that point the current account achieves balance.

What sign should we expect for $\omega_3$? To answer this question we need to invoke the contemporary developments in the literature on exchange rate determination, which integrates the roles of rational expectations and the assets markets and emphasize the relationship between the behavior of the exchange rate and the current account. With this approach, assets markets determine the exchange rate at a point in time. The current account though, through its effect on net asset positions and therefore on assets markets, determines the path of the exchange rate over time. Important contributions in this field are those by P. Kouri, J. Frenkel and C. Rodriguez, again C. Rodriguez (1980), R. Dornbusch (1975, 1976), R. Dornbusch and S. Fischer, and M. Obstfeld.

For our purposes then, we should expect that a negative output gap is equivalent to assets accumulation and a current account surplus, together with an appreciating exchange rate. Hence, the sign of the coefficient $\omega_3$ should be negative. Moreover, the theoretical models predict overshooting in the exchange rate; thus the absolute value for $\omega_3$ should be greater than unit.

## II. Estimate for Brazil

The empirical study for Brazil covers the sample period for 1955-1980 on an annual basis. Figure 1 plots the series for both relative prices. Before 1970 the relative price of industrial goods $p_I$, was considerably greater than that of services, $p_S$. After that year though, both relative prices are closer to each other, although that for services is now greater than the corresponding one for industry.

In the case of Brazil the best estimate was that with distributed lag, thus implying a partial adjustment


FIGURE 1

Relative Prices in Brazil

model. The results obtained with it for 25 observations are[5]:

$$7)\ \text{Ln } p_{St} = \underset{(-0.83)}{-\ 0.71} + \underset{(2.11)}{0.376}\ \text{Ln } p_{It} + \underset{(2.05)}{0.142}\ \text{Ln } \bar{y}_{St} - \underset{(-2.27)}{0.493}(\text{Lny}_{St} - \text{Ln}\bar{y}_{St})$$

$$+ \underset{(6.07)}{0.625}\ \text{Ln } p_{S(t-1)} \cdot$$

$R^2 = 94.55$ , $\bar{R}^2 = 93.5$ , Durbin h = 0.14 , "t" values between parenthesis.

The Durbin h test does not allow us to reject the null hypothesis of no serial correlation. As a result, OLS estimation can be used. The magnitude of the coefficient of determination as well as the significancy of the coefficients of all the independent variables used indicates the validity of the specification of the model. The constant in this model does not have any meaning and is accepted equal to zero.

The short run elasticity of the relative price of services with respect to the relative price of industry is accepted to be greater than zero and less than unit. That is, in the short run all three goods are gross substitutes. In the long run, however, this elasticity adopts a value exactly equal to unity; which together with the finite value for the trend coefficient, permits us to conclude that services and industry remain substitutes, yet agriculture and services become practically independent. Therefore, in the short run a policy to protect industry which rises its price relative to that of agriculture by 1% will increase the relative price of services about 0,4%; with incidence unevenly distributed between the agriculture and the services sectors. However, the long run effect of that policy is to rise the relative price of nontraded goods by the full amount of protection to industry; which imply full incidence of the tax on agriculture.

The coefficient of the long run income variable is positive as expected and it is suggestive of a value of the

income elasticity of services greater than unity. The 7% permanent annual growth rate for the service sector produced almost a 1% annual real appreciation in the short run, while it did by 2,7% in the long run.

The coefficient of the output gap variable does have the correct negative sign in accordance with the accepted theory. However, for the short run its absolute value is both significantly lower than unit and greater than zero. Accordingly, in the short run there is not an overshooting. This phenomenon has only been observed for the long run when this coefficient reaches a value of -1,31. Thus, a recessionary gap of 1% on the average generated an immediate half percent appreciation in the real exchange rate, while in the long run the appreciation in the order of 1,3%.

## III. Estimates for Argentina

The empirical analysis for Argentina has been done on quarterly bases and covers the period from the first quarter of 1969 through the second quarter of 1981. Figure plots the series for both relative prices. Here we notice that they follow each other very closely. Also the relative price of nontraded services is higher than that of industry both at the beginning and the end of the sample period.

Here we perform the two following estimates: one refers to the full sample period, while the second one refers to a subperiod starting in the second quarter of 1976 onward. The reason is that during most of the latter period a more liberal economic policy was in practice, including general deregulation and opening up the economy in both the goods and capital markets.

In the Argentine case, differing from the Brazilian experience, the model of partial adjustment did not produce good results. The adjustment appears to be immediate instead. A direct consequence of this fact seems to be the need to substitute the variable real income of the service sector by the variable aggregate real income[6]. We use OLS estimates

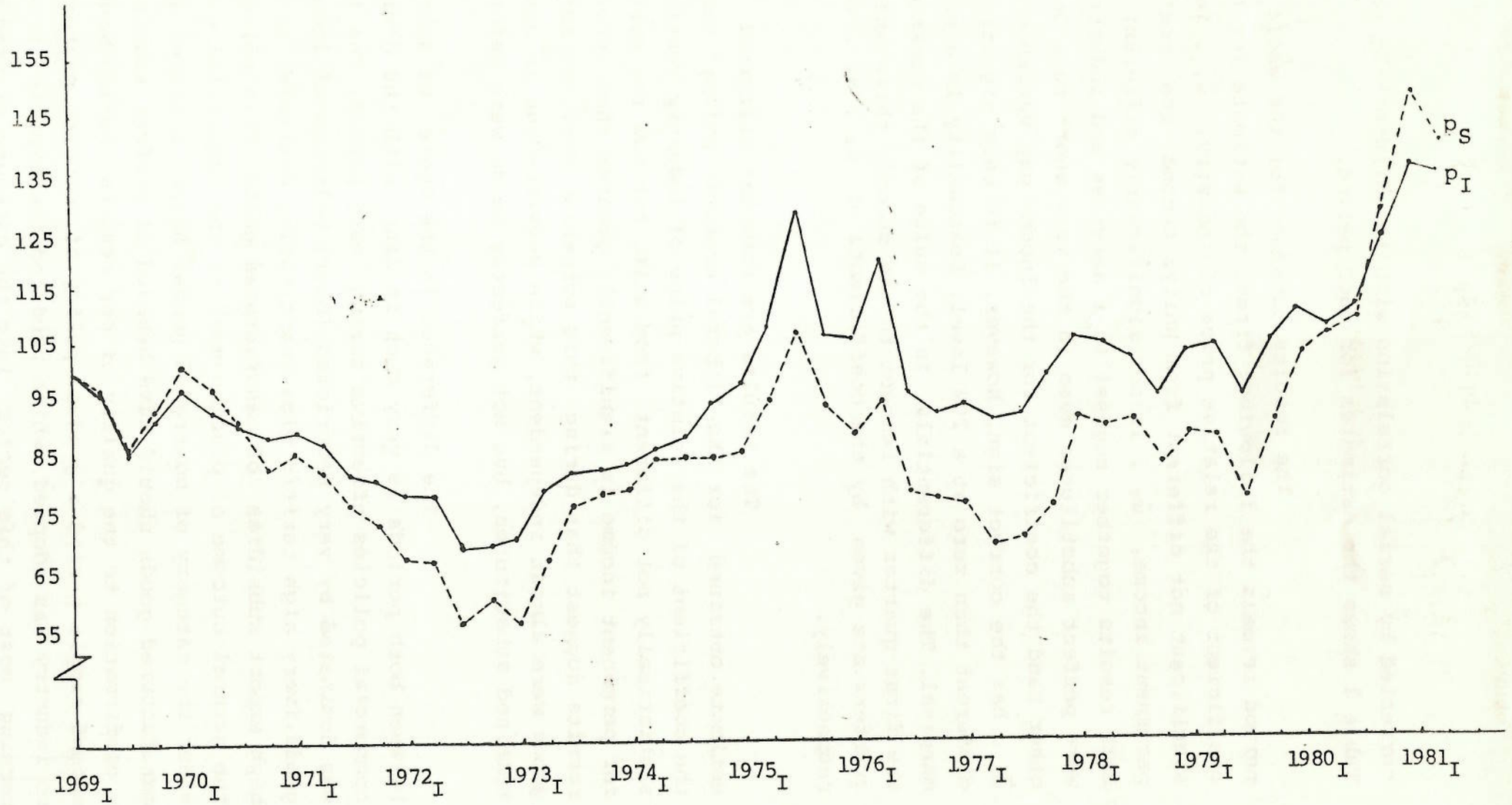


FIGURE 2

Relative Prices in Argentina

corrected by serial correlation with the Hildreth-Lu procedure. Table 1 shows the estimates for each period.

The results obtained for the whole sample period reveals the following: first, the estimate for the coefficient of the relative price of industry, $\tilde{\omega}_1$ , is highly significant not different from unity; second, the coefficient of permanent income, $\tilde{\omega}_2$ , is not significantly different from zero. Both results together suggest that services and industrial goods were perfect substitutes even in the very short run. On the other hand the coefficient for the income gap variable or cycles, $\tilde{\omega}_3$ , has the correct sign, however, it is only significantly different than zero at a 20% level. Seasonality is also very marginal. The differentials in the value of the constant between the first quarter with respect to the second, third and fourth quarters are given by the coefficients of $s_2$ , $s_3$ , and $s_4$ respectively.

The results are somewhat different for the estimate obtained for the "liberal economic policy" subperiod. Here the coefficient of the relative price of industry continues to be statistically not different from unit, but now the coefficient for permanent income is significantly greater than zero. These results suggest that during this subperiod services and agricultural goods were almost independent, while services and industrial goods remained substitutes, but not perfectly so as were before.

The difference in the degree of substitution between both periods is very much in line with the dominant commercial policies effective during each period. The first sample was dominated by very restricted import policies of industrial goods (very high tariffs plus quantitative controls) as well as high export subsidies of manufactured goods. This policy produced the natural outcome of placing most of the industrial goods sector under the category of nontraded goods. Hence, services and manufactured goods should have behaved as perfect substitutes, a confirmation to the quality of our results. During most of the second sample period a gradual policy of reducing protection to industry was adopted, which produced the expected results of turning most of this sector into the category of traded goods.

Table 1

| Sample Period | $\tilde{\omega}_0$ | $\tilde{\omega}_1$ | $\tilde{\omega}_2$ | $\tilde{\omega}_3$ | Seasonality | | | $R^2$ | $\bar{R}^2$ | DW | $\rho$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $S_2$ | $S_3$ | $S_4$ | | | | |
| A.<br>First Quarter 1969 Through Second Quarter 1981.<br>N = 49 | -2.92<br>(-0.75) | 1.005<br>(9.83) | 0.57<br>(0.69) | -0.27<br>(-0.95) | 0.014<br>(0.78) | 0.002<br>(0.13) | 0.01<br>(0.73) | 0.95 | 0.95 | 1.82 | 0.9<br>(14.5) |
| B.<br>Second Quarter 1976 Through Second Quarter 1981.<br>N = 20 | -14.3<br>(-2.4) | 1.09<br>(6.23) | 2.8<br>(2.13) | -0.685<br>(-2.28) | | | | 0.97 | 0.97 | 1.32 | 0.65<br>(3.82) |

"t" values betweeen parenthesis. A ~ indicates estimates of the respective parameters in Equations 6.

In the latter period then, industry and services continuing to be substitutes, were no longer perfect substitutes. At the same time, we can now infer the relationship between services and agricultural goods, which was not possible before, to be almost independent.

Seasonality is not present at all during the estimate for the "liberal" subperiod. With deregulation of the economy, we should expect price flexibility responding to market pressures. Therefore, there are no many reasons to expect seasonality. With a regulated economy instead, price adjustment take place usually at given discrete period of time and in general, price of service were permanent candidates for this policy. Thus, seasonality should have a greater chance under a regulated economy.

The coefficient of the output gap variable is now significantly less than zero, but it is not different than -1. Hence, the hypothesis of overshooting at least for this subperiod can not be rejected.

This estimate generated one statistic not completely satisfactory. This statistic being the DW which falls in the range of indeterminacy. The high degree of substitution between services and industry is responsible for colinearity between the relative price of industry and the income variables in this model; which might also be responsible for the intermediary value adopted by the DW statistic.

Seeking solutions to these problems, we decided to scale down the model from a three sector economy to a two sector one. We explored two alternative ways to do that. The first one is to ignore the industrial sector altogether. Its results are reported in Table 2. The second possibility is to create a composite commodity integrated with services and industry; therefore the dependent variable becomes the relative price of a weighted average of the prices in these two sectors[7]. The results of the corresponding estimates are presented in Table 3.

Table 2

| Sample Period | $\tilde{\omega}_0'$ | $\tilde{\omega}_2'$ | $\tilde{\omega}_3'$ | Seasonality | | | $R^2$ | $\overline{R}^2$ | DW | ρ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $s_2'$ | $s_3'$ | $s_4'$ | | | | |
| A. First Quarter 1969 Through Second Quarter 1981. N = 49 | -10. (-1.44) | 2.96 (2.08) | -1.18 (-2.45) | 0.08 (2.7) | 0.02 (0.8) | 0.03 (1.09) | 0.84 | 0.83 | 1.91 | 0.9 (14.45) |
| B. Second Quarter 1976 Through Second Quarter 1981. N = 20 | -33.3 (-6.2) | 7.71 (7.02) | -1.55 (-3.09) | | | | 0.91 | 0.90 | 1.87 | 0.5 (2.58) |

"t" statistic between parenthesis. The dependent variable is the relative price of services only.

Table 3

| Sample Period | $\tilde{\omega}''_0$ | $\tilde{\omega}''_2$ | $\tilde{\omega}''_3$ | Seasonality $s''_2$ | Seasonality $s''_3$ | Seasonality $s''_4$ | $R^2$ | $\bar{R}^2$ | DW | ρ |
|---|---|---|---|---|---|---|---|---|---|---|
| A. First Quarter 1969 Through Second Quarter 1981. N = 49 | -5.64 (-1.37) | 2.08 (2.47) | -1.09 (-2.49) | 0.08 (2.81) | 0.02 (0.91) | 0.03 (1.06) | 0.84 | 0.83 | 1.92 | 0.85 (11.3) |
| B. Second Quarter 1976 Through Second Quarter 1981 N = 20 | -25.7 (-6.2) | 6.16 (7.25) | -1.27 (-2.97) | | | | 0.9 | 0.9 | 1.84 | 0.45 (2.25) |

"t" values between parenthesis. The dependent variable is the relative price of a weighted average of industry and services.

As expected, the estimates with either one of the last two procedures do not differ statistically. Comparing the magnitudes of the coefficients for the permanent income variable between the two periods, we can conclude that the degree of substitution between agriculture and services, or agricultural versus the compositive commodity service-industry, has declined dramatically during the sample period when a "liberal economy policy" was dominant. This result is in agreement with those reported before in Table 1.

Now it is unambigously accepted to be seasonal variation for the whole sample period, when regulation of the economy was the dominant economic policy. Seasonality is not present during the latter period dominated by deregulation.

With reference to the coefficients of the output gap variable, we notice that all their point estimates are less than -1 (their absolute values increased with respect to the ones obtained in Table 1). Yet none of them are statistically significant less than -1. Only with the B estimate in Table 2 could we accept overshooting at a 20% level. However, we are still left with the contention that instantaneous overshooting (within a quarter) is a plausible event for Argentina.

## IV. Concluding Remarks

Our empirical model generated equivalent results for the behavior of the real exchange rate both for Argentina, during the "liberal economic policy" period, and in Brazil. The only qualification refers to the adjustment coefficient. While in Argentina the models seem to be an instantaneous ones but in Brazil the process of adjustment is considerably more time consuming.

Structural reasons aside, the differential in the speed of adjustments might be a consequence of the higher degree of intervention in the Brazilian economy - exchange, credit, prices and wage controls. This is specially true for the stronger practice of indexation in Brazil as compared with Argentina's

"liberal economic policy" period - full exchange convertibility, quasi full markets flexibility, even in the labor market.

In Brazil all three sectors - services, agriculture and industry - are gross substitutes in the short run, while services and industrial goods, however, remain so in the long run when agriculture and services more likely become almost independent. In Argentina's "liberal economic" period, already in the very short run, services and industry are substitutes, while agriculture and services (or with non agricultural goods in general) are quite independent. These strikingly similar results for both countries would offer some credibility to a stronger variant of the much controversial structuralist hypothesis usually formulated for Latin American countries; namely, that the excess supply of aggregate agricultural output migh be rather price inelastic[8].

Paradoxically, during Argentina's restrictive international trade period, although services and industry were accepted as perfect substitutes; considerable increase in the rate of substitution between agriculture and non agriculture sectors was also shown.

Summarizing, the structuralist hypothesis for the agriculture sector in the semi-industrialized countries seems plausible for the cases of quasi-open-deregulated economies in the short run, and for semi-open-regulated economies in the long run . It seems to be unplausible for the semi-closed economy cases.

With reference to the overshooting hypothesis, this study indicates its acceptance for Brazil only in the long run. For Argentina the results do not permit rejection of the hypothesis of an instantaneous overshooting. In fact the points estimates are suggestive of the possibility of occurence of this phenomenon.

The availability of estimated equations for the real exchange rate is undoubtedly a very important tool for policy decisions. For example, at the time of implementation of a stabilization program, a simple interpretation of the model would

suggest a simultaneous exchange rate appreciation through intervention in the exchange market, together with the introduction of expenditure reducing policies, consistent with the long run equilibrium real exchange rate. This action, however, may interfere in a negative way on the adjustment process underway in the assets markets, which may call for a widening of the output gap.

Another possibility, usually recommended is the inclusion of price-controls of nontraded goods within the stabilization package. This may again interfere with the pace of the equilibrium rate of assets accumulation by speeding it up, which may also call for a reduction in the output gap.

An adjustment through the path resulting exclusively from forces underlying the structure of the economy will generate a higher consumer price index, with a fixed exchange rate system, as compared to a flexible exchange rate system.

Footnotes

* Visiting Professor Graduate Program in Economics, Federal University of Bahia, Brazil. I wish to aknowledge financial support from the Rockefeller Foundation. The Economic Research Institute of the National University of Tucumán and the Center for Macroeconomic Studies for Argentina - CEMA, provided me with the necessary data for the estimates performed for Argentina.

1. $\eta_{SS}$ and $\varepsilon_{SS}$ are respectively the demand and supply elasticities of services with respect to its own relative price, $p_S$ ; $\eta_{SS}$ is defined positive. $\varepsilon_{SI}$ could either be positive when services and industrial goods were complements or negative if substitutes; $\eta_{SI}$ could either be positive when both goods were substitutes or negative if complements.

2. Generally $\eta_{S\bar{y}}$ is assumed greater than unity.

3. The relative price of services in term of agriculture goods is

$$p_S = \frac{P_S}{P_A} = \frac{P_S}{e\, P_A^*} \quad ,$$

where $e$ is the exchange rate and $P_A^*$ is the world price of agriculture goods in foreign currency.

4. Estimates of equivalent equations were done for Colombia, see García García, J. and Marquez-Ruarte, J.; also for Argentina, see Rodríguez, C. (1981). Still, none of them considered in their estimates the long run or trend variable.

5. The partial adjustment is obtained as follows:

$\text{Ln } p_{St} = \text{Ln } p_{S(t-1)} + \alpha[(\text{Ln } \bar{p}_S - \text{Ln } p_{S(t-1)})]$, where $\alpha$ is

the coefficient of adjustment. Replacing $\text{Ln } \bar{p}_S$ from (6) obtain the estimated equation as shown in (7), thus:

$$\text{Ln } p_{S-t} = \alpha\omega_0 + \alpha\omega_1 \text{ Ln } p_I + \alpha\omega_2 \text{ Ln } \bar{y}_S + \alpha\omega_3 (\text{Ln } y_S - \text{Ln } \bar{y}_S) +$$

$$+ (1-\alpha) \text{ Ln } p_{S(t-1)} + u \quad .$$

where $u$ is the error term.

6. Now the coefficient of permanent income will be:

$$\underline{\omega}_2 = \frac{(\eta_{S\bar{y}} - \frac{1}{\gamma})}{\Delta} \quad .$$

7. The weights correspond to the share of each sector on the aggregate for both sectors, base year 1970.

8. The usual hypothesis refers to the supply inelasticity, while we are now restating it in term of <u>excess</u> supply inelasticity (Sunkel).

9. Assuming a value of 1.5 for the income elasticity of the demand for nonagriculture goods, the numerator of $\underline{\tilde{w}}_2''$ in Table 3 would be approximately 0.5. Hence the denominator which equals the excess demand elasticity of nonagriculture with respect to agriculture will be 0.24 for the full period and 0.08 for the "liberal" subperiod. Multiplying these elasticities with the ratio between nonagriculture income and agriculture (6.6 in 1970) generates the respective excess demand elasticities in the agriculture sector, that is -1.5 for the "protective" period versus -0.53 in the "liberal" one.

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