ABSTRACT

This paper develops a reduced form equation for the real exchange rate, or the relative price of nontraded to traded goods. It uses a three sector model: one nontraded, services, and two traded commodities, agriculture and industry. It assumes equilibrium in the nontraded market, and takes into account both the trend in the economy as well as its cycles. The estimates are very suggestive. They allow understanding of the degree of substitution between sectors, as well as to test for temporary effects on the real exchange rate due to disequilibrium between income and absorption.

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1. INTRODUCTION

This paper presents an empirical study on the determinants of the relative price of nontraded to traded goods or the real exchange rate for 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, they permitted to understand the degree of substitution between sectors, hence infer on the incidence of commercial policy. As well as to test for the effects of cycles on the real exchange rate.

Section 2 develops the basic model. The estimated equations are presented in Section 3. The following section discusses the intersectorial relationship. Concluding comments are contained in Section 5.

2. 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 as 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, \(Z\):

\[ Y - E = P_I (X_I - C_I) + P_A (X_A - C_A) + P_S (X_S - C_S) + Z \]

where \(P_i (i = A, I, S)\) is the price in the respective sector, \(X_i\) 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 \([p_S = (P_S/P_A)]\), industrial goods \([p_I = (P_I/P_A)]\), and of permanent real income \(\bar{y}\), as follows:

\[ D = D (p_S, p_I, \bar{y}). \]

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, \(t\):

\[ S = S (p_S, p_I : K, L, t). \]

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 = 1 + \tau:\n
\[ p_I = p_I^* T. \]
Differentiating the equilibrium condition in the nontraded goods sector, \( D = S \), generates,

\[
4) \quad \tilde{p}_S = -\frac{\varepsilon_{SI}}{\Delta} \tilde{p}_I + \frac{\eta_{SI} - \gamma - 1}{\Delta} \tilde{y}_S
\]

where a `` over a variable indicates its rate of change; \( \varepsilon_{SI} \) in the cross elasticity of production of services with respect to the relative price of industrial goods; \( \eta_{SI} \) is the equivalent elasticity of substitution in consumption; \( \eta_{SY} \) is the income elasticity of the demand for services; \( \gamma \) assumed constant, is the ratio between the long run growth rate of income (\( \hat{y} \), permanent income) and the corresponding rate for the service sector, \( \hat{y}_S \); 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 \( \tilde{p}_I \) will be unit, while that of \( \tilde{y}_S \) 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 \( \tilde{p}_I \) will again equal unity, while that of \( \tilde{y}_S \) would be positive and finite. Outside these extreme cases and assuming gross substitution among any pair of goods, the coefficient of \( \tilde{p}_I \) will be positive but less than unit, while that of \( \tilde{y} \) 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.

Integration of (4) generates

\[
5) \quad \ln \tilde{p}_S = \omega_0 + \omega_1 \ln p_I + \omega_2 \ln \tilde{y}_S
\]
where \( w_0 \) is the constant of integration, while \( w_1 \) and \( w_2 \) 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. 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 (\( \ln y_S - \ln \bar{y}_S \)). The latter given by its trend value.

6) \( \ln \bar{p}_S = w_0 + w_1 \ln p_I + w_2 \ln \bar{y}_S + w_3 (\ln y_S - \ln \bar{y}_S) \).

When actual output falls short of its potential level, foreign 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 \( w_3 \)? 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. Fisher, M. Obstfeld, and G. Calvo.

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 \( w_3 \) should be negative.
3. THE ESTIMATE

The empirical study covers the sample period for 1955-1980 on an annual basis. Figure 1 plots the series for both relative prices. Before 1965 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 in 1970 there is a switching point, when the relative price of services become greater than the corresponding one for industry. The data and its sources are presented in the Appendix.

![Figure 1: Relative Prices in Brazil](image)

The best estimates were that with distributed lag, thus implying a partial adjustment model. The results obtained with it for 25 observations are:

7) $\ln P_{St} = -0.71 + 0.376 \ln P_{It} + 0.142 \ln Y_{St} - 0.493 \left( \ln Y_{St} - \bar{Y}_{St} \right) - \ln Y_{St} + 0.625 \ln P_{S(t-1)}$, 

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<td>$P_{S(t-1)}$</td>
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(6.07)
\[ R^2 = 94.55\%, \; \bar{R}^2 = 93.5\%, \; \text{Durbin} \ h = 0.14, \; \text{"}t\text{" values between parenthesis.} \]

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 significance 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 become still closer substitutes, yet agriculture and services become rather 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 long run income variable is identified by the trend in the log of the service sector quantum. Its coefficient is positive as expected and it is suggestive of a value of the income elasticity of services greater than unit. 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 output gap variable is measured by the deviations in the log of the service sector quantum from its own trend value. Its coefficient 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; for the long run this coefficient reaches a value of -1.31. Thus, a reces
tionary gap of 1% on the average generated an immediate half percent appreciation in the real exchange rate, while in the long run the appreciation is in the order of 1.3%.

Still we runned two other estimates by replacing the output gap by two alternative variables. Equation (8) uses the log of the ratio between Expenditure or Absorption (E) and Gross National Product (Y). A positive value for this variable indicates that expenditure is greater than income, which can only occur when the country is diminishing its stock of foreign assets (either or both, decreasing foreign reserves an increasing foreign indebtedness), or equivalently, running a current account deficit, together with a depreciating real exchange rate. Therefore the sign of the coefficient of the absorption-income ratio variable continues to be negative.

Equation (9) substitute the output gap variable by the current account balance as a proportion of income (CC/Y). When it is in a surplus (foreign assets accumulation) the relative price of service rises, hence its coefficient should be positive.

8) \[ \ln P_{St} = 8,6 + 0,55 \ln P_{It} + 0,2 \ln Y - 2,25 \ln \left( \frac{E}{Y} \right)_t + 0,635 \ln P_{S(t-1)} \]
\[ R^2 = 94,7\% \]
\[ R^2 = 93,7\% \]
\[ \text{Durbin } h = 0,90 \]

9) \[ \ln P_{St} = -1,1 + 0,55 \ln P_{It} + 0,15 \ln Y + 0,00021 \left( \frac{CC}{Y} \right)_t + 0,64 \ln P_{S(t-1)} \]
\[ R^2 = 94\% \]
\[ R^2 = 93\% \]
\[ \text{Durbin } h = 0,85 \]

Except for differences in the magnitude of some of the coefficients the results obtained with the three equations are qualitatively similar.
4. INTERSECTORIAL RELATIONSHIP

We learned with this study that the three sectors are gross substitutes in the short run. That is, a rise in the price of anyone of the three commodities will generate excess demand in the markets for each of the other two goods.

Figure 2 illustrates the situation. The units of measurement of each of the three commodities were redefined such as to initially obtain a uniform unit price. Demand and supply curves are drawn for each price of the other two goods. The original curves in the three sectors are labeled with 1. In line with the assumptions we considered both the prices of agriculture (exportables) and manufactures (importables) as exogenously given.

We start from a situation of no distortion and introduce protection to the industrial sector at the rate $t$. The new price of these goods become $T$. A higher price for manufactures generates excess demand in the other two markets, shifting their respective demand and supply curves to the position labeled with 2. The excess demand in the service sector calls for an increase in its price to a level like that given by the ordinate of point $H$. In turn, this higher price for services leads to excess demand in the other two markets by shifting their supply and demand curves to the position labeled with 3. The new short run equilibrium position indicates a rise in the price of industrial goods to $T$, together with a higher level of domestic production and a fall in its consumption. The price of agriculture products remain constant, but the level of production felt while its consumption increased. The price of services also has risen, but in a lower proportion than $T$. Its quantity produced and consumed could either increase or decrease.

In the long run, however, the excess demand in the service sector increases even further to the position labeled $2'$. (Using the results reported in Eq. 7). The rational for the latter may be the following. An initial rise in the relative price of industrial goods, means first an increase in the degree of urbanization, which in a second instance would put higher pressure on the demand for services. A new equilibrium in the service market is established at a price equal to $T$. The still higher price of services induce
additional excess demand in the other two markets shifting their respective demand and supply schedules to the final position labeled by 4.

At the long run equilibrium we depicted a reduction in consumption of industrial commodities and an increase in its domestic production. Agriculture consumption is increased while its production reduced. We also indicate a higher equilibrium of production and consumption of services. Hence, the agriculture sector bears the full incidence of the protection to industry.

As the relative price of agriculture goods becomes sufficiently low, the associated reduction on agriculture production and increases in its consumption becomes of such magnitude, as to place us in the low substitution segment of both: the production possibility frontier and the indifference curve. Hence, we should expect a lower price elasticity of the excess demand for agriculture goods when their relative prices are low.

5. CONCLUDING REMARKS

All these 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 either independents (Eq. 7) or they are complements (Eq. 8 and 9). These results 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 might be rather price inelastic.

The structuralist hypothesis for the agriculture sector seems more a consequence of policies generating lower relative prices for agriculture goods, than a permanent fact of life. The study found that a given rate of protection to industry rank from having a full incidence on the agriculture sector in the long run (Eq. 7); to a greater than proportional incidence (Eq. 8 and 9).

Disequilibrium in assets markets or economic cycles does affect the real sector of the economy through the impact on relative
commodity prices, the effects may be more than proportional in the long run.

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 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**

1 $\eta_{ss}$ and $\varepsilon_{ss}$ are respectively the demand and supply elasticities of services with respect to this 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 From the Slutsky equation we learn the following relationships:

$$-\eta_{ss} + \eta_{si} + \eta_{sa} = 0$$

$$\varepsilon_{ss} + \varepsilon_{si} + \varepsilon_{sa} = 0$$

Substracting the second equation from the first, we obtain a relationship among excess demand elasticities (See, for example, Henderson and Quandt),

$$-(\eta_{ss} + \varepsilon_{ss}) + \eta_{si} - \varepsilon_{si} + \eta_{sa} - \varepsilon_{sa} = 0$$
Then, if service and industrial goods are perfect substitutes either in production ($\varepsilon_{SI} = -\infty$) or consumption ($\eta_{SI} = -\infty$); the Slutsky equation requires respectively, that $\varepsilon_{SS} = \infty$ or $\eta_{SS} = \infty$. Hence, the coefficient of $\bar{p}_I$ will be unit. The one for $\bar{y}_S$ equals zero; since we assume a positive numerator for usually $\eta_{SY}$ is greater than unit.

When service and agriculture goods are perfect substitutes (either $\eta_{SA} = \infty$ or $\varepsilon_{SA} = -\infty$), again $\Delta$ results to be infinite. Then the coefficients of both variables will be zero.

Another possible outcome refers to the case of independency between agricultural and services ($\eta_{SA} = \varepsilon_{SA} = 0$). Here, again the coefficient of $\bar{p}_I$ will be equal to unity.

3 The relative price of services in term of agriculture good is

$$ p_s = \frac{p_s}{p_A} = \frac{p_s}{e \cdot p_A^*}, $$

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.

$$ \ln p_{st} = \ln p_s(t-1) + \alpha[\ln \bar{p}_s - \ln p_s(t-1)] $$

where $\alpha$ is the coefficient of adjustment. Replacing $\ln \bar{p}_s$ from (6) obtain the estimated equation as shown in (7), thus:

$$ \ln p_{s-t} = \alpha \omega_0 + \alpha \omega_1 \ln p_I + \alpha \omega_2 \ln \bar{y}_s + \alpha \omega_3 (\ln \bar{y}_s - \ln \bar{y}_s) + (1-\alpha) \ln p_s(t-1) + u. $$

where $u$ is the error term.

6 The usual hypothesis refers to the supply inelasticity, while we are now restating it in term of exceeded supply inelasticity (Sunkel).
### TABLE 1.A

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**Sources:** Column (1). It is obtained as a geometric mean of the components of the cost of living index at Rio de Janeiro. They are: Personal Services; and Utilities and Urban Transportation.

Columns (2) to (6). Conjuntura Económica.


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