Effects of the exchange rate on the food supply in a model with non-tradables

Juan de Dios Mattos V.,[+] Shoichi Ito[+] and Koichi Usami[++]

[+] Tottori University [++]Yamaguchi University

1. Introduction

The main objective of this analysis is to develop a framework to link the food supply (FS) with the exchange rate using a simple neo-classical structure. The approach employs the real exchange rate as a proxy for macroeconomic policy to explain how the FS reacts to devaluations and emphasizes the role of non-tradables in the determination of per capita FS in four developing countries in South America. Furthermore, the different responses between tradables (exportables and importables) and non-tradables to devaluations, and its consequences on small farmers are discussed. The latter is used to contrast macroeconomic adjustment tools and rural development policies in order to explain contradictory policy objectives that have depressed non-tradables prices, and worked against small farmers. Previous studies neglected the role of non-tradables and assumed that all agricultural products are tradable (Jaeger [6], Lamb [7]). Moreover, the FS as a variable was not studied directly, mostly because of data restrictions.

Schuh [9] was one of the first in studying the agricultural response to movements in the exchange rate. Recent papers stress the importance of trade and exchange rate policy as cornerstones for designing food policy, (Schuh [10], Davis, Thomas and Amposah [2] and Schiff and Valdés [8]). Jaeger [6] and Lamb [7] used explicitly the real exchange rate to assess the impact of government policies on agricultural exports and food production across Sub-Saharan countries.

2. The food supply relation

The FS identity is defined in equation (1), which shows that local production (Q^T), plus imports (Q^M) plus (minus) stock changes (Q^{ST}) and minus exports (Q^X) is equal to total usage inside each country. Local production (Q^T) is divided later into three main groups: Import substitutes (Q^{MS}), total export crops (Q^{XTP}) and non-tradable agricultural items (Q^{NT}), see Eq. (2).

$$Q^T + Q^M + Q^{ST} - Q^X = \text{Total Usage} = PFS \qquad \text{Eq. (1)}$$

3. General neo-classical framework

It is assumed that the country does not affect international prices, that there are three types of goods, importables, exportables and non-tradables, and that the agriculture sector is small compared with the other sectors. Tweeten [11] offers a good description about the effects of devaluations on agricultural import and export markets. Briefly, when the currency gets weaker (depreciation) the price of importables and exportables (measured in local currency) increases. Therefore, quantities of imports decrease and export volumes increase. These

$$\left(Q^{NT} + Q^{XTP} + Q^{MS}\right) + Q^M + Q^{ST} - Q^X = PFS \qquad \text{Eq. (2)}$$
$$\left(Q^{NT} + Q^{ST}\right) + \left(Q^{MS} + Q^M\right) + \left(Q^{XTP} - Q^X\right) = PFS$$

two movements push the FS downwards. However, the effect on the FS is not clear a priori. Eq. (2) tells us that the reaction of NT to exchange rate movements will define the final result on the FS. Derevajan, Lewis and Robinson [3] stress the role of NT as an important feature for the production structure and critic for the success of exchange rate policy schemes in developing countries.

Dornbush [4] describes the devaluation effects on the NT market showing that there is a pressure for higher NT prices and that the trade surplus is unsustainable without policy action. Bruce and Purvis [1] indicate that an alternative and more satisfactory approach than the assumption of fiscal policy is to make demands for tradable and non-tradable goods dependent on total expenditure. Dornbusch [4] using a two-country model found that a currency devaluation lowers the relative price of non-tradables[1].

4. Real Exchange Rate

$$RER = \frac{P_T \cdot e}{P_{NT}} \qquad \text{Eq. (3)}$$

$$RXR = \frac{CPI_{DOM}}{CPI_{USA} \cdot e} \qquad \text{Eq. (4)}$$

Definitions of the "real exchange rate" are mixed in the literature (Edwards [5]). Neoclassical theory defines the real exchange rate (RER) as in equation (3), a price relationship. Finding a good proxy for both prices in equation (3) is not an easy task, especially if we work with groups of products. In this paper we will use the real exchange rate defined by Equation (4), where the CPI_{DOM} is the proxy for non-tradables prices and CPI_{USA} is the proxy for tradables prices (CPI=Consumer Price Index) and e is the official (nominal) exchange rate, average for the period. It is easy to observe that equation (4) is the inverse of equation (3). When e depreciates, the RXR appreciates; by symmetry, when e appreciates the RXR depreciates. In other words, when the RXR rises, exports should fall (negative sign), due to the fact that the e has appreciated.

5. The data, model and results

The primary source of information is FAO's database, only vegetables, grains, oil-crops and other crops were used (livestock, fish and dairy items were left out of the study); therefore, FS becomes PCAS (per capita agriculture supply). Dependent variables are expressed in 1000 metric tons except PCAS which is introduced in the system in Kg. per capita. The RXR was compiled from the IMF statistical yearbook as well as the real GDP per capita, base year 1995=100. Prices in γ are deflated by the CPI, base year 1995=100, compiled from each country's agricultural statistical sources. All series run from 1980 to 1999. Due to the difficulty to identify pure non-tradable, importable and exportable crops, a simple rule was used to define which crop belongs to each group. A crop is exportable, if the $Q^X \geq 0.1Q^T$, if not, the crop is a non-tradable. In the case of importable crops, Q^M has to be at least equal to the domestic production, if smaller the crop is a non-tradable ($Q^M \geq Q^T$).

$$\begin{aligned}
Q_{it}^{T} &= f\left(RXR_t^*, GDP_t^*, Q_{it-1}^{T}, \gamma\right) \\
Q_{it}^{NT} &= f\left(RXR_t^*, GDP_t^*, Q_{it-1}^{NT}, \gamma\right) \\
PCAS_{it} &= f\left(RXR_t^*, GDP_t^*, PCAS_{it-1}, \gamma\right) \\
Q_{it}^{X} &= f\left(RXR_t^*, GDP_t^*, Q_{it-1}^{X}, \gamma\right) \\
Q_{it}^{M} &= f\left(RXR_t^*, GDP_t^*, Q_{it-1}^{M}, \gamma\right) \\
Q_{it}^{MS} &= f\left(RXR_t^*, GDP_t^*, Q_{it-1}^{MS}, \gamma\right) \\
Q_{it}^{XTP} &= f\left(RXR_t^*, GDP_t^*, Q_{it-1}^{XTP}, \gamma\right)
\end{aligned} \qquad \text{Eq. (5)}$$

Based on assumptions in section 2, the relations on equation (5) were developed to estimate the response of FS variables to changes in the exchange rate; the system was estimated for each country with the help of the Seemingly Unrelated Regression (SUR) method. Previous studies did not make differences between tradables and non-tradables and they did not included an independent variable for the FS, moreover; only Jaeger [6] provided country-by-country analysis, but still, in an aggregate form.

As for the variables in Eq. (5), *i* represents Argentina, Bolivia, Brazil and Venezuela, *****, is expected value, *t* is time and γ is any other variable[2)]. The first derivatives respect to RXR are expected to be negative for total production, exports, import substitutes and total export production, that means that after a devaluation, we expect an increase in production (see section 4). For non-tradable items and imports we expect a positive sign, in other words, a decrease in production (consumption) after a devaluation. Moreover, as detailed in footnote 2, own-price elasticities are expected to be positive and income-elasticities to be related with the group characteristics. For example, imports in Bolivia are comprised mostly of wheat, which is expected to have a negative sign[3)]. A lagged dependent variable as an explanatory variable puts the analysis under the Nerlovian-type of model; hence, coefficients represent short-run elasticities. Lamb [7] and Jaeger [6] analyzed Sub-Saharan Africa with single equations, aggregating countries due to data restrictions. Our approach uses system specifications for individual countries.

As Table 1 shows all signs are correct and support the view that exchange rate devaluations improve the trade balance but reduce the PCAS due to the fall in Q^{NT}. All variables are in logarithmic form; therefore, coefficients represent elasticities (see footnote 3). As many as 16 out of 28 coefficients (57%) are significant at the 5% level and 79% of them are significant at the 10%. The fit of model is quite high in average for all countries, only Venezuela presents a low R^2 for the PCAS variable. The PCAS decreases as the currency devaluates in all countries. The effect is stronger for Bolivia and Venezuela, basically mono-importing

Table 1. RXR short run coefficients for agricultural FS variables[1]

	Argentina	Bolivia	Brazil	Venezuela
Total production[2]	-0.067	-0.199	-0.115*	-0.147 a)
	(0.288)	(0.105)	(0.050)	(0.056)
	0.847	0.719	0.939	0.882
Non-tradable items	0.129**	0.509*	0.152	0.214**
	(0.007)	(0.043)	-(0.120)	(0.001)
	0.692	0.727	0.766	0.923
PCAS	0.022 a)	0.682 a)	0.085*	0.501*
	(0.066)	(0.084)	(0.051)	(0.043)
	0.843	0.815	0.467	0.384
Exports	-0.412 a)	-2.390**	-0.24*	-0.44
	(0.078)	(0.004)	(0.049)	(0.114)
	0.644	0.811	0.953	0.809
Imports	0.19	2.772*	0.593*	0.312*
	(0.253)	(0.028)	(0.030)	(0.045)
	0.913	0.547	0.681	0.474
Imports substitutes	-0.848**	-0.537 a)	-0.785**	-0.316 a)
	(0.001)	(0.075)	(0.008)	(0.080)
	0.847	0.437	0.639	0.762
Exp. Total Production	-0.080	-0.473*	-0.354*	-0.058
	(0.317)	(0.050)	(0.028)	(0.126)
	0.795	0.930	0.958	0.847
Number of observations[3]	19(133)	19(129)	19(131)	19(133)
System DF[4]	98	97	94	103

[1] Numbers in parenthesis are probability values. Significance level, a)=10%, *=5%, **=1%. One-tale test.

[2] R^2 Values are reported in the third row for each variable.

[3] The number of observations is reported for equation and total system (balanced for Argentina and Venezuela, and unbalanced for the rest).

4. DF, Degrees of Freedom

countries (wheat). Argentina and Brazil with large and diversified agricultural exports have small PCAS coefficients; also Q^{MS} coefficients are bigger than exports' coefficients, indicating that Q^{MS} receive most of the resources liberated from the Q^{NT}. The response of Q^{NT} is bigger in Bolivia than in the other countries, showing the flexibility of this sector to free resources for the other sectors (basically labor and capital). The small coefficient of Q^{NT} for Argentina is consistent with the relative small size of this group in the Argentinean agriculture. Table 1 also shows that non-tradable crops respond negatively and export crops positively to currency devaluations. Some trade-off between them exists, at least through the RXR. Contrary to Jaeger [6], it seems that tradable crops crowded out non-tradable crops production in the short run. The effect on production for domestic consumption (food) is reduced due to the positive effect of import substitutes to devaluations of the currency. For example, in the case of Bolivia, non-tradable crops decrease by 5% and exports increase by 23.9% for 10% devaluation and in the case of Brazil, for every 10% devaluation, the PCAS falls by 0.85%, even though exports increased by 2.4%. Lamb [7] found a positive response of total production to depreciations of the RER (-0.18) and explicit evidence that export crops and food crops are substitutes in production.

If we assume that the Q^{NT} production represents small farmers output and that large farms and companies manage exports, the results of the devaluation may have had an important income redistribution effect. After devaluations, producers of tradables gain, and producers of Q^{NT} lose. Rural development programs (designed to help small farmers) will increase Q^{NT}, worsening the price relationship, NT/Tradables, everything else constant. In this line of thinking Schuh [10] points out that an important feature of economic growth and development is that large amounts of labor will inevitably have to leave agriculture and that most of that labor will come from the currently small farmers, meaning that promotion of tradable crops seems to be a better idea than promoting non-tradables.

6. Concluding Comments

The Economic theory indicates that devaluations of the exchange rate improve the trade balance, reducing imports and increasing exports, but it does not indicate the effect on the food supply. Analyzing the effect of the RXR and other complementary variables in four South American countries we found that the agricultural variables behave as it is predicted by the theory and that the exchange rate plays an important role on the production decision process. Exports and import substitutes have a stronger response than non-tradable crops to devaluations. Results, however, also show that the income distribution effect might benefit exporters, and that export and import substitutes crops might have crowded out production of non-tradable crops. Producers of non-tradables will face reduction in their relative price (reduction in their income); they may also have to find new products, new sources of income or change their business (migrate). The effects of devaluations on the FS highlight the importance of trade as a source of food to compensate the fall in NT production.

[1)] This model considers that both countries face excess demand and excess supply for their respective exports and imports, this means, the "big country approach".

[2)] The other variables introduced in the system were: 1) For Argentina, taxes on agricultural exports, the beef/petroleum price ratio, time trend, a dummy for the period 1982-1986 (hyperinflation) and the average of agricultural commodities international prices. 2) For Bolivia, a dummy for the period 1981-1985 (hyperinflation), donations of food, international price of wheat and a time trend. 3) For Brazil, a dummy for the period 1984-1989 (inflation), the average of agricultural commodities international prices and a time trend. 4) For Venezuela, a dummy for the period 1988-1992, petroleum price and the international price of wheat.

3) Due to space restrictions the complete set of equations is not presented. However, they are available from the authors upon request.

References

[1] Bruce, N. and Douglas D. Purvis. "The specification and influence of goods and factor markets in open economy macroeconomic models" in Ronald W. Jones and Peter B. Kenen, eds., *Handbook of International Economics Vol. 2*. Amsterdam: Elsevier Science, 1985.

[2] Davis, G. C., C. Thomas and W. A. Amposah. "Globalization and Poverty: Lessons from the theory and practice of food security". *Amer. J. Agr. Econ.* Vol. 83(3), 2001, pp. 714-721.

[3] Derevajan, S., J. Lewis and S. Robinson. "External shocks, purchasing power parity and the equilibrium real exchange rate". *WB Economic Review*. Vol. 7(1), 1993, pp. 46-63.

[4] Dornbush, Rudiger. "Exchange rates and fiscal policy in a popular model of international trade". *American Economic review*. Vol. 65, 1975, pp. 859-871.

[5] Edwards, Sebastian. "Exchange rate misalignment in developing countries". *The World Bank Research Observer*. Vol. 4(1), 1989, pp. 3-21.

[6] Jaeger, William K. "The effects of economic policies on African Agriculture". *World Bank Discussion Papers.* No. 147, 1992.

[7] Lamb, Russell L. "Food crops, exports, and the short-run policy response of agriculture in Africa". *Agriculture Economics*, Vol. 22(3), 2000, pp. 271-298.

[8] Schiff, M. and Valdés A. "Agriculture and the macroeconomy". *The World Bank Policy Research Working Papers Series*, No. 1967, August 1998.

[9] Schuh, Edward. "The exchange rate and U.S. agriculture". *Amer. J. Agr. Econ.* Vol. 56(1), 1974, pp. 1-13.

[10] Schuh, Edward. Edward. *Ensuring access to food: The critical role of income. Constraints and what to do about it*. The Hubert H. Humphrey Institute of Public Affairs. www.hhh.ums.edu/people/geschuh/021400.htm, 2000.

[11] Tweeten, Luther. *Agricultural trade – Principles and Policies*. Boulder, Colorado: West View Press, 1992.