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MEASURING THE EFFECTS OF REAL EXCHANGE RATE POLICIES ON AGRICULTURE

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Measuring the Effects of Real Exchange Rate Policy on Agriculture

ABSTRACT

Many macro policy models assume that changes in the real exchange rate have similar impacts on different production activities within agriculture. This paper discusses the importance of intrasectoral heterogeneity in the degree of tradability and in the characteristics of production functions in estimating effects of real exchange rate changes.

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Introduction

Much of the recent debate on the effects of economy wide policies on agriculture in developing countries has focused on the real exchange rate, and the extent to which sectoral policies or programs can ameliorate these macro effects. This is appropriate - it is clear that wide swings in the real exchange rate can reduce capital formation and output both in the agricultural sector and in the economy as a whole. However, much of this debate in the literature on the effects of macro policy seems to take for granted several stylized facts which upon closer inspection are subject to some important caveats. However, much of this debate in the literature on the effects of macro policy seems to take for granted several stylized facts which upon closer inspection are subject to some important caveats.

A common generalization in studies of real exchange rate bias and agriculture is that all agricultural goods are traded and that the effects on the sector can be identified as those which are presumed to affect traded goods. This is an assumption which is often true, but which is inaccurate for a substantial percentage of agricultural production. Allowance for differences in "tradedness" between agricultural commodities gives rise to a much more complex view of the effects of macro policies and one in which results of given policy initiatives cannot be determined independently of the structure of production. One purpose of this paper is to discuss the determinants of tradedness for agricultural commodities and to generate predictions as to which agricultural commodities are likely to be traded.

Also critical to an analysis of the effects of real exchange rate movements on agriculture is some allowance for differing input requirements across crops. For example, a recent study assumes that all agricultural output is affected similarly by changes in the relative prices of inputs induced by real exchange rate movements. Consider the following:

> " ... by definition, those policies which indirectly affect agriculture have the same net impact on import competing as on exportable commodities, and the listing of indirect protection ... is therefore identical" (Krueger, Schiff and Valdes, 1988, p. 264).

A second purpose of this paper is to show that this assumption can be misleading and that an evaluation of the structure of inputs for different crops is important in an evaluation of the effects of macro policy on agricultural incentives. In many cases, indirect policies do not have the same impact on exportables as compared to importables, nor need this be true even between different crops within these two categories.

One important motivation for this analysis is the fact that differential responses to macro policies may divide along lines of income class or region, since these differences will hinge upon demand propensities for those who consume

certain crops and the structure of production for particular groups of producers. In addition, it is important to consider the time required for resource flows and reallocations when using results based on free trade or other equilibria to guide policy. A typical horizon for policy analysis is 5 to 10 years, a period clearly too short to allow for full adjustment of long standing cultural practices or development of supporting infrastructure for production. Thus, many goods which might be considered traded in a free trade equilibrium will in fact exhibit behavior characteristics of a non-traded good over periods of interest to policymakers. Though measurement of deviations from free trade equilibrium are of interest to economists, policies to remove distortions can have seemingly perverse effects when the end result remains far from a situation of free trade.

Traded Goods, Tradeable Goods and Contestable Markets

The effects of real exchange rate changes on agricultural markets depend on the degree to which agricultural goods are traded. In this discussion a distinction is made between "traded" and "tradeable". In general, the fact that a commodity is tradeable in principle does not mean that it can be regarded as a traded good for the purposes of policy analysis with a medium term perspective. Several factors affect a commodity's degree of tradedness:

(1) **"Natural" Nontradedness** This refers to structural impediments to trade which render a good non-traded at any conceivable price. In some cases, structural impediments may be alleviated by policy over time or may erode as the economy becomes increasingly developed.

The most obvious source of natural nontradedness is transport costs, allowing the classification of goods as traded or non-traded depending upon the relationship between transport costs and the price differential between home production and the world market. There are two characteristics of this relationship which are important to the analysis. First, the designation of goods as traded or non-traded is endogenous, depending on changes both in prices and in transport costs. Second, the range over which a good is non-traded depends on transportation costs as compared to the price differential between world and domestic production. For labor intensive services such as haircuts, the prohibitive level of these costs seems obvious. For most agricultural commodities, transport costs are low compared to the prices of the commodities and these price differentials are correspondingly small.

However, the presence of fixed costs in transportation can have a substantial effect in a situation where necessary infrastructure, both institutional and physical, is lacking. This implies substantial variation in the degree of "tradedness"

of agricultural commodities in different regions of a country depending on the location of consumption and/or production. Those living far from roads in an area where there is little in the way of necessary storage or warehouse space are more likely to be producing or consuming under conditions approximating nontradedness than are people living in a port city. Even in the latter case, physical limitations on import or export capacity can further widen the range over which a good is nontraded. These factors are present to some degree in all countries but are especially important in developing countries. Antle (83) presents evidence that infrastructure development is an important determinant of agricultural productivity, a finding consistent with this argument.

For example, in various West African countries (e.g. Nigeria), the north/south road network is poorly developed, rendering the northern areas more likely to exhibit markets approaching the non-traded category than would southern ones. The costs of providing the necessary transport services are quite large in these cases, meaning that price differentials would have to become quite large for trade to occur. In Southern Africa, landlocked countries may face extremely high transport costs for extended periods. Zimbabwe, Zambia, Botswana, and Malawi are obvious candidates. Similar observations are applicable to the interiors of large countries such as Zaire, or Sudan.

This discussion is related to the concept of contestable markets which states that a market is contested if, in principle, other entrepreneurs would enter to undercut any attempt to extract excessive profits. (See Baumol (82) for discussion). The presence of large fixed costs to production or marketing can cause a market to be noncontested or nontraded. The longer the period over which costs, once incurred, remain sunk (or fixed) in comparison to the time it takes for existing producers to respond by cutting their own prices, the less contested a market will be. Nontradedness is also more likely if the good is perishable or if production requires a certain amount of time regardless of scale. These caveats are of obvious importance in the production of many agricultural commodities, particularly fruits, vegetables, or meats, all of which require time to produce, are perishable, and for which sunk costs as well as fixed costs may be quite important. It is worth emphasizing that it is not enough for prices to rise high enough for a market to become contestable in principle. For a good to be considered traded, this must not only be possible, but it must in fact be the case that a trader has a reasonable chance for a profit over a relatively short term since there is likely to be a fairly high degree of riskiness in many markets. For some products with low value/bulk ratios (e.g., cassava) or with high

requirements for capital investment (e.g. refrigeration for meats or rapid transit facilities for other perishables), the riskiness of such trade is likely to render many markets uncontested.

To summarize, this discussion implies that agricultural commodities are more likely to exhibit the characteristics of non-traded goods: the more poorly developed is supporting transportation infrastructure, the more sunk costs and fixed costs such as refrigeration or warehouses are required, the higher the ratio of bulk to value, the more perishable the commodity, and the more quickly existing sellers can change prices.

(2) Structure of demand - Domestic demand clearly affects the tradedness of commodities since a high level of domestic demand, resulting in a high domestic price, can cause a commodity to be imported while the opposite situation can cause it to be exported. Given a long enough time period, virtually all food is substitutable, within nutritional constraints. However, this is not the case within the time frame envisioned for policy reform programs in many developing countries. On the production side, structural impediments to trade such as poorly developed road networks are unlikely to change substantially, if at all, over such a period. On the demand side, long standing cultural practices in terms of diet and undeveloped marketing systems can greatly reduce the speed and extent of response to macro policy changes. In addition, aggregate measures of agricultural production and food consumption can mask the importance of non-traded commodities for large segments of the population. Groups which produce and/or consume such commodities may in fact constitute a large percentage of the agricultural sector yet may be affected by macro policies in ways quite distinct from those derived from stylized models of real exchange rates and agriculture.

For example, a review of agricultural production and food consumption statistics for Sub-Saharan Africa shows that some important root crops such as cassava are non-traded, with the greater part of production being consumed by subsistence farmers who often have little contact with organized markets. Indeed, the required physical and institutional infrastructure are virtually non-existent in many of the areas where this low value to bulk crop constitutes a staple food. Table 1 shows the share of nontraded root crops in calorie supply for Sub-Saharan African countries. In some countries, e.g., Zaire, cassava and other non-traded root crops provide more than half of the available calorie supply, while in many others it represents a very large fraction. Large though these aggregate figures are, they understate the importance of root crops for some groups, which may rely on these sources for much higher percentages of energy intake than indicated in the table.

(3) **Policy-dependent factors** - "Induced" nontradedness can result from the structure of taxes, subsidies, and quantitative restrictions applying to a given commodity. A recent example of this phenomenon is the decision of Nigeria to ban imports of some important grain crops. This, in effect, rendered all of these crops "nontraded" at least from the point of view of the domestic producer.

While it is common for studies of the indirect protection afforded to agriculture to address the question of how the entire structure of direct trade taxes and restrictions and indirect real exchange rate changes affect incentives, as compared to a hypothetical free trade situation, it is in some ways more interesting to ask how a policy change will affect incentives given the continuation of other interventions. This question relates more closely to the actual situation in developing countries, where reforms are usually pursued one step at a time. Further, it avoids the need to define a hypothetical free trade equilibrium.

The Importance of Input Structure - The "Effective Protection" Effects of Real Exchange Rate Bias*

The previous section argued that measures of indirect policy effects on agricultural incentives may be incorrect since not all agricultural products are traded, nor could they be even in principle within the time frame normally considered for policy analysis. This section shows that even if agricultural products are traded, aggregate measures of the effects of indirect policies affecting the real exchange rate can be misleading because of the effects of differing input structure. Next, the effects of traded inputs on measurement of real exchange rate effects on incentives will be examined in the case of both fixed and flexible input coefficients. The main conclusions are: First, differences in the structure of inputs, particularly traded ones are important. Second, the presence of substitution possibilities has the effect of overstating the degree to which the nominal tariff structure provides protection. (Alternatively, if the overall effect of the real exchange rate bias is determined to be negative, the presence of substitution possibilities will reduce the measured degree of adverse bias.) Second, the degree to which traded inputs are substitutable for the different primary factors has an important role in determining the extent to which changes in output and input prices cause changes in relative outputs of traded versus nontraded goods.

(1) **Intermediate Inputs and Real Exchange Rate Effects** The role of intermediate inputs can be illustrated with an extension of the traded/non-traded goods framework which supports the case for real exchange rate policies. Adding

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* A full derivation of the results presented can be found in Kyle (90).

a traded input to the standard 2 x 2 model where capital is sector specific in the short-run but can be shifted between sectors in the medium to long-run makes it apparent that relationships between real exchange rate changes and increased outputs of tradeable goods become less clear cut in the presence of traded inputs. The prices of the three commodities, X_T, X_N, and X_M (traded, nontraded, and imported intermediate goods respectively) are related to input prices via the following zero profit conditions:

(1) $a_{LT}w + a_{KT}r + a_{MT}P_M = P_T$

(2) $a_{LN}w + a_{KN}r = P_N$

where the a_{ij} coefficients represent input output coefficients, w is the return to labor, r is the return to capital, and it is assumed that changes in the exchange rate affect P_T and P_M equally, but that both prices are also assumed to include policy dependent taxes or subsidies, so that their respective differentials need not be equal in the analysis that follows.

In this context, we can represent a program of trade liberalization or structural adjustment as changes in the relative prices of traded versus non-traded goods. To simplify the algebra, we assume that all changes are relative to changes in P_N so that $dP_N = 0$. Letting a "*" denote relative changes (dx/x), and letting θ_{ij} denote the distribution share of each factor in production, differentiation of (1) and (2) yields:

(3) $\theta_{LT}w^* + \theta_{KT}r^* = P_T^* - \theta_{MT}P_M^*$

(4) $\theta_{LN}w^* + \theta_{KN}r^* = 0$

It is immediately apparent from equation (3) that the extent to which a macro policy such as devaluation affects value added is dependent upon the parameter θ_{MT} and the rate of change of the price of the traded input. The change in value added is equal to the sum of the changes in returns to capital and labor. At one extreme, if $\theta_{MT} = 1$ and $P_M^* = P_T^*$, then value added will not change at all. At the other extreme, if either $\theta_{MT} = 0$ or $P_M^* = 0$, then value added will change to the full extent of the percentage change in the output price.

It is also important to note in passing that it is even possible for a program designed to depreciate the real exchange rate and eliminate subsidies for imported inputs to <u>decrease</u> incentives to produce traded goods if P_M^* is large enough (for a given θ_{MT}) compared to P_T^*. All of these considerations indicate that the use of sectoral averages for the above parameters can produce results that may be very misleading if applied to a particular activity whose input structure is significantly different from the average.

Table 2 presents estimates of the share of tradable inputs θ_{MT} in crop production for selected countries of Latin America and Africa. The figures show that this share varies considerably from crop to crop both within and across countries. In addition, the figures for wheat in Mexico show that there can be considerable variation between different locations in the same country for the same crop.

(2) The Importance of Substitution Effects Changes in relative prices of inputs will in most cases result in changes in the mix of inputs used. Which inputs are substituted for those with higher prices depends on the characteristics of the technology used in production. These technologically determined substitution possibilities together with relative abundance of required inputs (or more generally, factor supply conditions) affect the extent and pace of adjustment to real exchange rate changes. It can be shown (see Kyle (90)) that allowing for substitution in the model above can result in dampening or in extreme cases, elimination of the desired incentive effects of real exchange rate changes in some agricultural subsectors.

The possibility of substitution among inputs in response to changing factor and output prices will in most cases increase the apparent effective change in incentives over that which would occur in the case of fixed coefficients. The intuitive reason for this is that if input coefficients are allowed to vary, the effect is to increase the menu of options available to producers - among these options is the original input mix. So, a producer can either stick with his original situation or, if flexibility allows a lower cost input mix, choose that combination instead. If this results in a smaller input share for a traded input subject to a tariff, apparent effective protection will be greater. In any case the producer will certainly be no worse off and probably better.

Figure 1 illustrates the effects of a real exchange rate with representative iso-price curves. The increase in output price causes a shift outward of the curve for the traded good resulting in a lower r and higher w. If there is no substitution bias toward either capital or labor, (that is, both capital and labor substitute equally well for imported intermediates) then changes in P_M are analogous to Hicks neutral technical change in the sense that the K/L ratio will depend only on the wage rental ratio, and the intermediate input price will determine the level, but not the ratio, of returns to the primary factors. To the extent that the good uses intermediate inputs also subject to price increases, this curve is shifted back toward the origin again, mitigating the initial impact on r and w. The size of these shifts in interest and wage rates will depend on the shapes of the curves for traded and non-traded goods and the direction of the induced

shift; i.e., whether the curve shifts homogeneously toward the origin (when σ_{ML} and σ_{MK}, the elasticities of substitution between the traded intermediate and each of the primary factors, are equal) or whether the shift is biased toward capital or labor.

Figure 2 shows a single iso-price curve and isolates the effects of a rise in the price of the intermediate input. A rise in P_M which leaves K/L unchanged causes a homothetic shift in toward the origin since with a higher P_M and given P_T, w and r must be lower. Biased substitution effects would result in a new equilibrium either above the ray representing "neutral" effects if $\sigma_{MK} > \sigma_{ML}$ or below this ray if the inequality is reversed. Either case represents a situation in which it is inappropriate to use existing technical coefficients to predict the response of capital and labor allocations to policy changes.

Table 3 presents estimates for elasticities of substitution in the agricultural sector for Colombia, the U.S. and Japan. All show that the elasticities of substitution between traded inputs and primary factors differ considerably. In Colombia, machinery was found to be a relatively good substitute for labor in all crops, with estimated elasticities between 1 and 2. In contrast, machinery was found to have very low or even negative elasticities of substitution for land. It is apparent that elasticities of substitution for the U.S. and Japan between primary factors and traded inputs are quite divergent, both between different inputs and across countries, a conclusion supported by Brown and Christensen (81) and Binswanger (74).

The presence of these substitution effects indicate that it is not possible to predict the effects of removal of real exchange rate bias and subsidies on agricultural incentives and outputs without reference to the conditions of production. In addition, it is impossible to say which direction the bias will go without empirical investigation, though the results presented above are suggestive.

Implications for Economic Reform Packages

The analysis above suggests that the effects of reform packages designed to eliminate subsidies and depreciate the real exchange rate may have impacts that vary widely across different sectors or crops. In particular, packages that include a strong element of devaluation together with elimination of subsidies on traded inputs such as fertilizer are candidates for some of the adverse effects outlined in the section above.

To be specific, the following set of conditions would tend to militate against a strong output effect in agriculture from reforms intended to depreciate the real exchange rate and eliminate subsidies:

1. A significant proportion of non-traded agricultural output
2. Factor proportions different from the rest of the economy
3. Removal of large subsidies on traded inputs such as fertilizer which represent a large fraction of input costs
4. Strong substitutability of traded input for factor not intensively used for given crop or sector

For example, suppose that traded agricultural products in a particular country are produced with relatively more labor and traded inputs than are other crops or commodities. Further, as suggested by the elasticity estimates in Tables 2 and 3, assume that fertilizer is a relatively good substitute for land but a relatively poor substitute for labor and that the reform program includes removal of a large subsidy on its use. This sort of situation can result in dampened (or in extreme cases, negative) output response.

The negative effects are likely to be more pronounced following the adoption of a reform package, insofar as traded inputs representing a very large fraction of short-run variable costs, are sharply increased in price or limited in availability. These inputs are precisely those which can be most readily increased to provide a short-run supply response. Even in the absence of legitimate fertility maintenance or other reasons to promote fertilizer use, a relatively cautious pace of reform may well be the best way to promote needed supply increases over the short to medium term.

More generally, the heterogeneity of the agricultural sector both in terms of the structure of production and the response to policy reforms demonstrates that though real exchange rate adjustments are a necessary condition for improved performance they are not a substitute for an agricultural development strategy. Policies and investments tailored to the specific conditions of production are a necessary condition as well, both in the agricultural sector and in the formulation of overall development strategies.

Table 1. Share of Non-traded Roots and Tubers in Total Per Capita Calorie Supply.*

Country	1979-1981 Average
Benin	0.38
Botswana	0.01
Burkina Faso	0.02
Burundi	0.39
Cameroon	0.22
Central African Republic	0.53
Congo	0.48
Gambia	0.01
Ghana	0.37
Guinea	0.20
Ivory Coast	0.28
Kenya	0.09
Lesotho	0.00
Liberia	0.23
Madagascar	0.17
Malawi	0.00
Mali	0.02
Mauritania	0.00
Mozambique	0.40
Niger	0.04
Nigeria	0.26
Rwanda	0.49
Sao Tome and Principe	0.14
Senegal	0.00
Sierra Leone	0.05
Somalia	0.01
Sudan	0.02
Swaziland	0.02
Tanzania	0.31
Togo	0.37
Uganda	0.18
Zaire	0.59
Zambia	0.05
Zimbabwe	0.01

* Includes cassava, yams, sweet potatoes, taro. Total calories excludes alcohol. Some zero entries in countries with non-zero consumption result from existence of small amounts of trade.

Table 2. Share of Tradable Inputs in Value of Production.

Country/Agricultural Products	Percent
Ecuador	
Wheat	18
Barley	35
Potatoes	35
Dairying	24
Mexico	
Wheat(Sonora)	33
Wheat(Tlaxcala)	43
Kenya	
Export Crops	14
Cereals	34
Milling	6
Other Domestic Crops	30
Zimbabwe	
Wheat	31
Maize	31
Soybeans	39
Groundnuts	48
Cotton	22
Tobacco	10

Sources: Byerlee, 1985; Byerlee and Longmire, 1985; Sharpley, 1988 and Morris, 1988.

Table 3. Estimates of Allen Partial Elasticities in Colombian, United States and Japanese Agriculture.

	Parameters			
	Machinery/Labor	Land/Labor	Machinery/Land	Land/Fertilizer
Colombia				
Rice	1.4	.79	-.34	---
Cotton	1.9	-.02	-.13	---
Corn	1.4	.79	-.66	---
SSS*	1.3	.55	.13	---
Wheat & Barley	1.1	.44	.04	---
U. S. (1880-1925)	.191	.191	.191	.777
Japan (1880-1940)	.029	.239	.239	.093

* Aggregate of sesame, sorghum and soybean.

Source: Thirsk, 1974 and Hayami and Ruttan, 1985.

Figure 1.

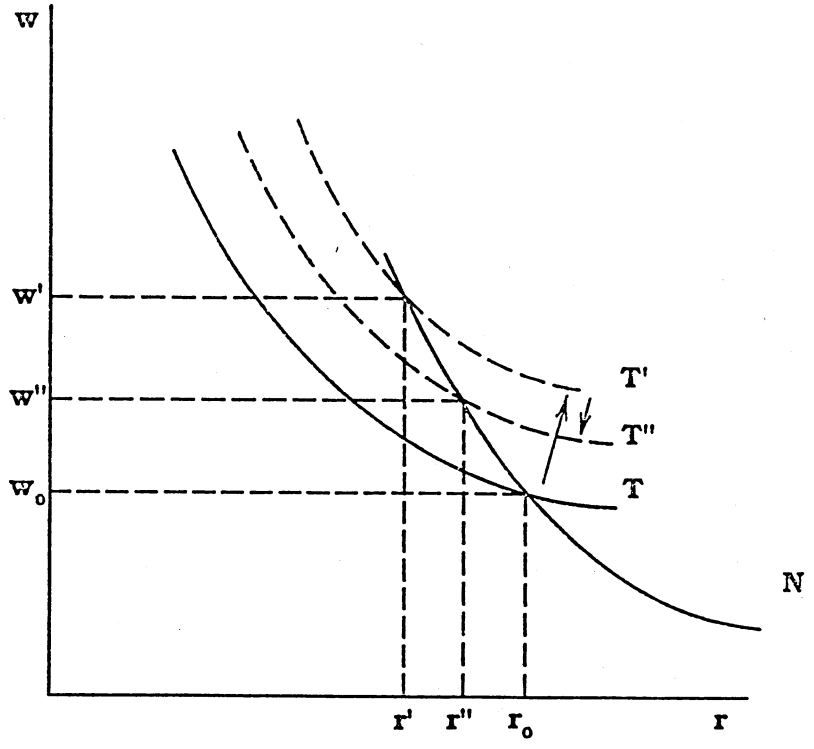
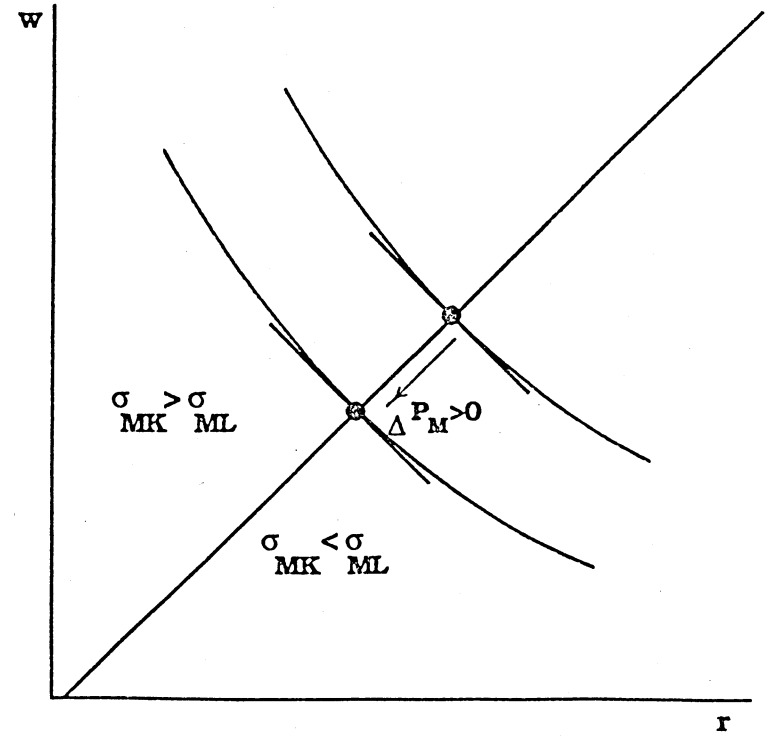


Figure 2.



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