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### EFFECTS OF AN EXCHANGE RATE CHANGE ON AGRICULTURAL TRADE

By William E. Kost\*

A theoretical model is reviewed and used to evaluate the effects of currency devaluation or revaluation on production, consumption, trade, and price in both exporting and importing countries. The model is applied to the effects of devaluation on the agricultural sector, when supply and demand are inelastic. Based on the analysis, devaluation will have only a small impact on agricultural trade. What effect there is will be primarily on price rather than quantity.

Keywords: exchange rates, devaluation, commodity trade, export supply, import demand.

#### BACKGROUND

Most writers of literature on devaluation, revaluation, and exchange rate policy take a macroeconomic approach. Generally, they view exchange rate policy in the context of balance-of-payments adjustment. Currency devaluations or revaluations are considered as to their effect on total exports and imports and the impact of such changes on the balance-of-payments position of the country. For example, see Kindleberger (5, pp. 253-309, 569-587) for a good discussion of the Marshall-Lerner condition and the absorption theory.<sup>1</sup> Economists have given substantially less thought to the price and quantity effect of exchange rate policy on a particular agricultural commodity. Though discussion of economic impacts of U.S. devaluations in agricultural literature over the past few years has focused on commodity impacts, not balance-of-payments impacts, it has tended to rely on a macroeconomic theory base. This missapplication of theory has led many people to conclude that the exchange rate is an important structural variable that has been omitted from any analyses of the agricultural situation. They have also come to believe that the dollar devaluations contributed significantly to the increases in foreign demand for U.S. agricultural products (1; 2, pp. 18-19; 3, p. 2; 4; 6, pp. 1, 11-12; 8, pp. 3, 7). After one has looked at the relevant microeconomic international trade theory, these conclusions are, at their worst, wrong or, at their best, quite misleading as to the magnitude of the effects we can expect in agriculture when the exchange rate changes.

The purpose of this article is to review the theoretical framework that can be used to assess the trade impact of devaluation or revaluation—on any commodity or any subsector of a country's economy. It traces the effects of changes in an exchange rate on commodity production, consumption, trade levels, and prices for any two trading partners. The theoretical model is used to analyze the possible effects of a devaluation on the agricultural sector of the two economies.

For purposes of exposition, the following simplifying conditions are assumed: (1) the model consists of a two-country world (or one country-rest of the world), (2) competitive economic systems exist in both countries so that a competitive equilibrium position will be reached, (3) a single homogeneous commodity is traded, (4) there are no transport costs, (5) no trade barriers exist, and (6) the market for the single homogeneous commodity can be specified by a single, downwardsloping demand function and a single, upward-sloping supply function for each country. Implications of relaxing these restrictions will be discussed later.

### DEVALUATION

#### Case I: Effects of Devaluation by Exporter

Figure 1 shows the domestic supply and demand curves and equilibrium price of a given commodity for two countries. For the moment, assume that prices in both countries are in the same currency units. Use of this assumption temporarily ignores the exchange rate question.<sup>2</sup> Trade will take place if the price is different in the two countries. As the price rises in the exporting country, the domestic quantity supplied increases, and the domestic quantity demanded decreases, making more of the commodity available for export. Concurrently, as the price falls in the importing country, its domestic quantity demanded increases, the domestic quantity supplied decreases, and the importing country becomes more reliant on imports. Equilibrium is reached when prices are equal in the two countries and when the amount available for export from one country equals the amount the other country desires to import.

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<sup>&</sup>lt;sup>1</sup> Italicized numbers in parentheses refer to items in References at the end of this article.

<sup>&</sup>lt;sup>2</sup> One could assume either an exchange ratio of 1:1 or that the price variables are measured in terms of a single world price.



These trading relationships are summarized in the center panel of the figure. The export supply curve (ES) shows the various quantities of the commodity that will be supplied to the importing country by the exporting country at different price levels. Only when the price rises above the isolation equilibrium price will there be any of the commodity available for export. At any price above this isolation equilibrium price, the amount available for export will equal the difference between the quantity supplied and the quantity demanded.

The import demand curve (ID) shows the various quantities of the commodity that will be demanded from the exporting country by the importing country at different price levels. Only when the price falls below the isolation equilibrium price will there be any demand that cannot be satisfied from the domestic supply. At any price below this isolation equilibrium price, the amount the importing country desires to import will equal the difference between the quantity demanded and the quantity supplied.

Trade equilibrium is reached at that point where export supply equals import demand. The trade equilibrium price will be higher than the isolation equilibrium price in the exporting country and lower than the isolation equilibrium price in the importing country.<sup>3</sup> The point between these two prices at which the trade equilibrium price will settle depends on the relative elasticities of the export supply and import demand curves. The more elastic the export supply curve is, relative to the import demand curve, the closer the equilibrium trade price will be to the isolation equilibrium price level in the exporting country. Conversely, the more elastic the import demand curve is, relative to the export supply curve, the closer the equilibrium trade price will be to the isolation equilibrium price level in the importing country.

The elasticity of the export supply and import demand curves is a function of the underlying domestic supply and demand curves. The more elastic the domestic supply and demand curves, the more elastic the export supply and import demand curves will be. It can also be shown that the import demand curve will never be less elastic than the domestic demand curve underlying it and that the export supply curve will never be less elastic than the domestic supply curve underlying it. For a more rigorous exposition of these elasticity relationships, see the appendix.

To this point, the analysis has not been based on the concept of the exchange rate. An exchange rate is the number of units of one country's currency that are exchangeable for one unit of another country's currency. An international transaction can be viewed as having two parts: (1) the purchase of the currency of the exporting country and (2) the purchase of goods from the exporting country with this currency.4 The exchange rate can be represented in the analysis of figure 1 by comparing the scales on the vertical axes of the left- and right-hand panels of the figure. The ratio of one scale to the other represents the exchange rate between the two countries. It, however, does not explain why one currency exchanges for another at a particular rate. The price for money (the exchange rate) can be represented in the figure through an appropriate setting of the vertical scales of the leftand right-hand panels. Any fluctuation in the money market will change the relationship of the vertical scales.

<sup>&</sup>lt;sup>3</sup>There are two exceptions to this statement. When the export supply curve is infinitely elastic, the trade equilibrium price will be the same as the exporting country's price in the isolation case. Conversely, when the import demand curve is infinitely elastic, the trade equilibrium price will be the same as the importing country's price in the isolation case.

<sup>&</sup>lt;sup>4</sup>The importing country could purchase the goods directly with its own currency; however, somewhere along this chain of transaction, a currency transaction will occur. The important point to recognize is that any international transaction involves both a goods transaction and a currency transaction.

From the viewpoint of the exporting country, its devaluation can be expressed by changing the scale on the vertical axis of the importing country's graph. One unit of the exporter's currency will now buy less units of the importer's currency than before the devaluation occurred. Thus, in the figure, a devaluation implies a stretching out of the vertical axis on the importing country's graph. Figure 2 shows a 50-percent devaluation of the exporting country's currency; that is, from 1=11 to 1=11.

### FIGURE 2 EFFECT OF 50 PERCENT DEVALUATION BY EXPORTING COUNTRY ON THE IMPORTING COUNTRY'S CURRENCY



This change of the price scale (with no change in the quantity scale) will cause a "shift" in both the demand and supply curves for the importing country. Since the devaluation causes a stretching out of the price axis, the demand curve will "shift" up from its previous position. It will pivot up and to the right at the point where the original demand curve crosses the quantity axis. Since the devaluation is expressed as a percentage change, the shift in the demand curve will not be a parallel one. It will show a larger vertical shift at the higher price levels than at the lower ones (fig. 3).<sup>5</sup>

Devaluation will cause the supply curve to pivot at the quantity point where price equals zero. When the supply curve cuts the price axis, the whole supply curve will shift up. This shift will not be a parallel one. It represents a constant percentage change; there will be a

<sup>5</sup> There is a constant percentage difference between the two demand curves, however.

### FIGURE 3 EFFECT OF DEVALUATION BY EXPORTING COUNTRY ON DEMAND OF IMPORTER



larger vertical distance between the two supply curves at the higher price levels than at the lower price levels (fig. 4).

From the point of view of the exporting country which devalues, the importing country appears to have

### FIGURE 4 EFFECT OF DEVALUATION BY EXPORTING COUNTRY ON SUPPLY OF IMPORTER



simultaneously increased demand and decreased supply. What seem to be shifts in the supply and demand curves for the importing country will result in an actual increase (shift to the right) in the import demand curve (fig. 5). The rotation in the import demand curve is illustrated in the center panel of figure 5. There will be a greater vertical difference between the curves for predevaluation and the curves for post-devaluation import demand, the higher the trade price level. This shift also represents a constant percentage change.

A second way of looking at currency devaluation by the exporter is to consider that the importing country with any given amount of its currency can now purchase more units of the exporter's currency. Thus, the importer can, at any given price level, purchase more of the exporter's goods. Consequently, import demand for the exporter's product has increased.

A third way of viewing the devaluation is to see it as making the price of the import goods cheaper to the importing country, relative to the price of the same goods produced domestically, than before the devaluation occurred. With a cheaper relative price for the imported goods, there will be a shift away from purchases of domestic products toward imports.

Whichever of these three ways one views a devaluation, the result is the same—an increase in import demand. Such an increase will cause an expansion in the quantity exported as well as a rise in the price (expressed in the exporter's currency units). This higher price will stimulate production in the exporting country, thus increasing the quantity supplied; and it will dampen consumption, leading to a decrease in the quantity demanded. Thus, the exporting country, receiving a higher price for its exportable goods, will produce more, consume less, and export more (fig. 5).

From the importer's viewpoint, since imports are

**FIGURE 5** 

cheaper after the devaluation, the quantity demanded will rise. With the lower price, more goods will be consumed and less will be produced domestically. This increased demand in the importing country translates into a rise in the price in the exporting country. The higher price will somewhat dampen the increased demand effect already outlined. The net effect will be to lower the price in the importing country, raise it in the exporting country, and increase the volume of trade.<sup>6</sup>

The apparent shift in the supply and demand curves in the importing country, and the resulting shift in the import demand curve, each equal the percentage change in the exchange rate. Thus, there is an upper limit on how much the prices and quantities traded can change. The maximum amount of the price rise for the traded goods will be by the same percentage as the amount of the devaluation. This maximum price rise will occur only when the export supply curve is perfectly inelastic and the impact of the full shift of the import demand curve is absorbed by the price change. The maximum amount of increase in the quantity traded, also the same percentage as the amount of the devaluation, will occur only if the export supply curve is perfectly elastic. Only then can the full effect of an import demand curve shift be reflected in a quantity change. Any time the export supply curve is less than perfectly elastic or less than perfectly inelastic, devaluation by an exporting country will increase both the price and quantity of its exported goods. Each of these changes, however, will represent a smaller percentage increase than that for the devaluation.

#### <sup>6</sup> It must be kept in mind that the before and after foreign demand and supply curves are based on different price axes. For a more detailed exposition of this point, see the appendix.



## Case II: Effects of Devaluation

A devaluation by the importing country means that it must now give up a larger amount of its currency than before to purchase the same amount of the exporting country's currency (see fig. 6 for effects). From the importer's viewpoint, the effective price it must pay for imports is raised, and quantity of imports demanded will be less. As the effective price goes up, quantity supplied domestically will rise and quantity demanded will fall. From the importer's viewpoint, it is paying a higher price for the imported product, importing less, producing more domestically, and consuming less than before the devaluation.

In terms of the exporter's currency, the decrease in imports leads to a drop in the price of the goods the country exports.<sup>7</sup> This reduced price leads to an increase in the quantity demanded and a decrease in the quantity supplied.

### REVALUATION

## Case III: Effects of Revaluation by the Exporter

Exchange rate revaluation by the exporting country means that the importing country can now purchase fewer units of the exporter's currency.<sup>8</sup> Thus, the importer can also buy fewer goods than before. Lowered purchase at the same price implies a decrease in import

<sup>8</sup>To visualize this case of revaluation, interchange the "before" and "after" labels and change the direction of the arrows in figure 5. Purchase of fewer units shrinks the price axis scale. demand. Within the exporting country, both the level of exports and the price will drop. As a result, quantity consumed domestically will rise while production falls. For the importer, the higher price—in terms of the importer's currency—produces a drop in consumption, a rise in production, and a decline in imports.

### Case IV: Effects of Revaluation by the Importer

Revaluation by the importing country means that the importer can now give up a smaller amount of its currency than before to purchase the same amount of the exporting country's currency.9 Thus, price to the importer falls, and quantity imported rises as movement occurs down the import demand curve of the importing country. Such a movement results from an increase in the export supply curve. This lower price in the importing country will increase its consumption, decrease its production, and raise the level of imports. Within the exporting country, the higher price of the goods-in terms of the exporter's currency-induces a fall in consumption, a rise in production, and an increase in exports. Exports rise even with the higher price in the exporting country because the price is lower in terms of the importing country's price, not higher.

## IMPLICATIONS FOR AGRICULTURAL TRADE

The impacts of exchange rate changes on trade and prices—for both agricultural and other commodities depend on the magnitude of the exchange rate change

### FIGURE 6 EFFECT OF DEVALUATION BY IMPORTING COUNTRY ON EQUILIBRIUM TRADE PATTERN FOR IMPORTS



<sup>&</sup>lt;sup>7</sup>The price change shown in figure 6 does represent a price decrease. See appendix.

<sup>&</sup>lt;sup>9</sup>To visualize this case of revaluation, interchange the "before" and "after" labels and change the direction of the arrows in figure 6. Purchase of fewer units shrinks the price axis scale.

and the elasticities of the export supply and import demand curves. The extent of the exchange rate change determines the magnitude of the shift in the import demand curve. The elasticity of the export supply curve determines the impact of a shift in the import demand curve on the equilibrium trade price and the quantity exported. As the export supply curve becomes more elastic, the quantity traded will increase and the price rise will decrease, for any given shift in the import demand curve. This export supply elasticity depends on the domestic supply elasticity, the elasticity of demand in the exporting country, and the relative importance of the export sector.

The effect on imports of a change in the exchange rate is similar. This impact is a function of the magnitude of the exchange rate change and the elasticity of the import demand curve. The extent of the devaluation determines the amount of the shift in the export supply curve. The import demand elasticity determines the price and quantity effects resulting from the shift. The more elastic the import demand curve, the larger the quantity effect and the smaller the price effect. The import demand elasticity is a function of the domestic supply elasticity, the demand elasticity, and the relative importance of the import sector.

The elasticity of both supply and demand is very low, particularly in the short run, for U.S. agricultural products. This characteristic is especially true when we consider agricultural products relative to industrial products. Consequently, a devaluation would generate relatively larger changes in price than in quantity traded for agricultural products than for industrial goods. Also because of the extreme inelasticity of the agricultural market, it is very likely that the effect on agricultural prices will be larger than the effect on quantity. Thus, to the degree that the agricultural sector is inelastic and the industrial sector elastic, one could conclude that a devaluation would be relatively inflationary within the agricultural sector. Similarly, in the industrial sector, a devaluation would cause a relatively larger quantity impact and thus reduce unemployment more than it would in the agricultural sector. However, upper bounds to these impacts would be set by the extent of the devaluation. Generally, devaluations entail small percentage changes in the exchange rate.

One cannot determine, based on the foregoing analysis, the contribution of agricultural trade to the improvement of a country's net balance of trade (and therefore the balance of payments) when it devalues. For exports, selling more agricultural products at a higher price will improve the country's balance of trade. Changes in imports, however, will cause a deterioration. When the import demand curve is inelastic for a devaluing importer, the rise in price more than offsets the decline in quantity imported. The result is an increase in total expenditures for the goods. For a large net exporter of agricultural products, the effects on exports will probably outweigh those on imports; the net result would be some improvement in the balance of trade.

However, one cannot look to agriculture for the major contribution to improvements in the balance of payments through devaluation. The rest of the economy, where we can more reasonably expect the export supply and import demand curves to be elastic, is more likely to be the primary source of improvement. If the devaluing country's import demand curve is relatively elastic, devaluation will reduce total outlays for imports. More exports will be sold at higher prices. Thus, both the export and import sectors will contribute to improvement of the balance of payments.

Generally, each developed country has a viable trade sector other than agriculture. Not all developing countries do. Those that do not must rely on their ability to remain large net exporters of agricultural products—if devaluation is to improve their balance-of-payments position.

The reasoning to this point has assumed that a free trade world exists. To the extent that one does not, the trade impacts resulting from a devaluation will be lessened. Any barrier that insulates a domestic market from the effects of changing relative prices will restrict the amount by which the export supply and import demands curves shift. Examples of barriers would be a variable levy system like that of the European Economic Community, a quota, or a restrictive trade licensing scheme.

Another assumption used in the analysis has been that the devaluing country does not have government controlled stocks which might be used to stabilize the market. If, for example, a devaluing country wanted to stabilize domestic prices, it could, through an active stocks manipulation policy, sell supplies from the government stockpile. This increase in supply would dampen any devaluation-induced price rise. For exports, such an action would shift the export supply curve down to the right. This increased supply would hold prices down and, at the same time, make more available for the export market. The quantity exported would increase from what the level might otherwise have been. This same shift in the export supply curve would occur for imports. Here, the result would be to offset some of the shift in the export supply curve that was due to the devaluation. The quantity imported would not decline as much as otherwise. Thus, an active stocks policy could similarly moderate the devaluation effects on trade.

In summary, we can only expect a small impact on agricultural trade as a result of a change in exchange rates.<sup>10</sup> And what effect there is will be primarily on price rather than quantity. Any change in price or quantity traded will be limited by the percentage change in

<sup>&</sup>lt;sup>10</sup>See "The Impact of Revaluation on U.S. Agricultural Exports" in this issue, for an attempt to isolate empirically the impact of exchange rate changes on agricultural exports.

the exchange rate. To the extent that the export supply and import demand curves are not perfectly elastic or perfectly inelastic and conditions exist that restrict the free flow of goods internationally, the impact on agricultural commodity trade will be less than this maximum. These conclusions suggest that recent U.S. devaluations had little effect on U.S. trade of agricultural products.

$$\eta_{\rm D} = \frac{d[f_1({\rm P})]}{d{\rm P}} \cdot \frac{{\rm P}}{{\rm Q}_{\rm D}}$$
$$\eta_{\rm S} = \frac{d[f_2({\rm P})]}{d{\rm P}} \cdot \frac{{\rm P}}{{\rm Q}_{\rm S}}$$

We can substitute these definitions into the import demand curve elasticity equation:

$$\eta_{\rm ID} = \frac{\eta_{\rm D} Q_{\rm D} - \eta_{\rm S} Q_{\rm S}}{Q_{\rm D} - Q_{\rm S}}$$

This equation shows that import demand elasticity is a function of domestic demand and supply elasticity and the relative importance of the trade sector in the economy. We can see that (1) the more elastic the demand curve, the more elastic the import demand curve; (2) the more elastic the supply curve, the more elastic the import demand curve; (3) the larger the trade sector, the more inelastic the import demand curve; and (4) the import demand curve will be more elastic than the demand curve, except when there is no domestic production. When there is no output domestically, the elasticity of the import demand curve equals the elasticity of demand.

Similarly, the elasticity of the export supply curve is:

$$\eta_{\rm ES} = \frac{\eta_{\rm S} Q_{\rm S} - \eta_{\rm D} Q_{\rm D}}{Q_{\rm S} - Q_{\rm D}}$$

In this equation, the elasticity of export supply appears as a function of the domestic supply elasticity, the demand elasticity and the relative importance of the trade sector in the economy. It follows that (1) the more elastic the supply curve, the more elastic the export supply curve; (2) the more elastic the demand curve, the more elastic the export supply curve; (3) the larger the trade sector, the more inelastic the export supply curve; and (4) the export supply curve will always be more elastic than the supply curve, except when there is no domestic demand.

### DEVALUATION INDUCED PRICE CHANGES IN THE FOREIGN COUNTRY

Figure 7 reproduces the importer segment of figure 5. Since only the price axis changed between these "before" and "after" curves, the following relationships hold:

$$P_a = P_c$$
,  $P_d = P_b$ ,  $P_a > P_d$ , and  $P_c > P_b$ .

The total demand curve for a commodity and the domestic supply curve for that commodity are defined by the following two equations:

$$Q_{D} = f_{1}(P) \text{ where } \frac{d[f_{1}(P)]}{dP} < 0 \text{ and}$$
$$Q_{S} = f_{2}(P) \text{ where } \frac{d[f_{2}(P)]}{dP} > 0$$

The quantity of the commodity that will be demanded from the exporting country by the importing country, the import demand quantity, is defined as:

$$Q_{\text{ID}} = Q_{\text{D}} - Q_{\text{S}} = f_1(\text{P}) - f_2(\text{P})$$
$$\frac{dQ_{\text{ID}}}{d\text{P}} = \frac{d[f_1(\text{P})]}{d\text{P}} - \frac{d[f_2(\text{P})]}{d\text{P}}$$

The elasticity of the import demand curve is defined as:

$$\eta_{\rm ID} = \frac{dQ_{\rm ID}}{dP} \cdot \frac{P}{Q_{\rm ID}} = \left[ \frac{d[f_1(P)]}{dP} - \frac{d[f_2(P)]}{dP} \right] \cdot \frac{P}{Q_{\rm ID}}$$

$$\frac{d[f_1(\mathbf{P})]}{d\mathbf{P}} \cdot \mathbf{P} - \frac{d[f_2(\mathbf{P})]}{d\mathbf{P}} \cdot \mathbf{P}$$

$$\frac{\left[\frac{d[f_1(P)]}{dP} \cdot \frac{PQ_D}{Q_D}\right] - \left[\frac{d[f_2(P)]}{dP} \cdot \frac{PQ_S}{Q_S}\right]}{Q_D - Q_S}$$

Since the elasticity of demand and the domestic elasticity of supply are defined as:

If these statements are true, then  $P_b < P_a$ . Thus, devaluation by the exporting country lowers the importing country's price (defined in terms of the importing country's currency). This same type of analysis can be applied to the foreign country graphs in figure 6.

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### FIGURE 7 EFFECT OF DEVALUATION BY EXPORTING COUNTRY ON IMPORTING COUNTRY



106