

EXCHANGE RATES AND AGRICULTURE: A LITERATURE REVIEW

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Economists have long recognized the importance of exchange rates' influence on trade. Over the last couple of years agricultural producers have been more sensitive and interested in the role of exchange rates in commodity prices. The strong dollar is seen as a major culprit in low farm prices. Given the concerns of farmers it seems appropriate to review the literature on the importance of exchange rates in affecting prices. This working paper is taken largely from the work of Kristinek (2001) that examined the impact of exchange rates on the North American cattle industry.

Economic Theory

In today's world with a rapidly increasing global economy and constantly changing international trade laws and technology, the exchange rate plays a role in valuing farm production and equipment. For many years, the role of exchange rates as an integral part of agricultural economics was overlooked. The seminal work on the role of exchange rates in agricultural trade was that of Edward Schuh. In 1974, he argued that the overvalued dollar caused the decline in agricultural exports due to their relative expense in other countries. The overvalued dollar led to depressed prices and lower farm profits, causing an undervaluation of farm resources and oversupply of output. Schuh called attention to the relationship between the exchange rate and agriculture

product and factor markets. Schuh's view was that while many variables affect agriculture, the exchange rate plays a role in all aspects of agriculture.

Grennes (1975) commented on Schuh's classic article and stated that exchange rate policy may alter distribution of income between countries and between producers and consumers in the U.S. He claimed that since most agricultural export commodities were subsidized and the subsidies are positively correlated with the degree of overvaluation, the subsidy offsets the overvaluation and eliminates any need for an exchange rate policy.

Schuh (1975) found that the high point of subsidies in the 1963-1973 period was in the 1963-1964 fiscal year, whereas the overvaluation of the dollar didn't hit its peak until the 1971, making him believe that there was not much correlation between the magnitude of the subsidies and the degree of overvaluation.

In 1984, Schuh again blamed changes in imports and exports on changes in the value of the dollar. The result of the shift to flexible exchange rates was of great significance because of the emergence of well-integrated international capital markets. Changes in monetary policy induced international capital flows, which in turn caused changes in the value of the dollar. These changes in the value of the dollar had an impact on the level of imports and exports. The net result of these changes was that agriculture (and other export-oriented industries) must bear the majority of the burden caused by changes in monetary and fiscal policies.

Orden (2000) suggested that Schuh's classic article overstates the macroeconomic argument. The process of revising price support policy to accommodate

a strong dollar occurred about the time that the dollar depreciated. This devaluation restored U.S. exports, decreased excess stocks, and contributed to allowing the easing of acreage supply controls, which was fortunate for agriculture. Exchange rate movements create a difference in foreign and domestic prices of a single good, and monetary shocks have non-neutral effects that explain some of the variability in agricultural prices. Macroeconomic conditions often play a large role in domestic agricultural policies and therefore a role in world market competitiveness and trade relations. Orden stated that these structural policy implications of exchange rate movements coupled with their direct effect on markets are why exchange rates are important to agriculture.

Figure 2-1 contains the basic economics of the effect of exchange rate movements on an exporting country. The four-panel diagram contains the U.S. as an exporter on the left panel, trade on the second panel, exchange rates on the third panel, and the rest of the world to the far right panel. A stronger dollar increases the relative price of the product in the rest of the world, decreasing demand for and reducing exports from the U.S.

In Figure 2-1, point Q_t is the original quantity traded before the appreciation of the U.S. dollar, and P is the price of the good at this quantity traded. The strengthening of the dollar is illustrated by a downward shift in the exchange rate line (1:1), effectively depreciating the importer currency. After shifting the currency line, begin at the equilibrium of the import market, point B, and move left until reaching the original currency line at point C. Take that line down to the new currency line, point D. Continue left from point D to the U.S. price axis. This line is the new price level for the

exporter, increasing quantity demanded by J and decreasing quantity supplied by K in the export country's market. At point E, where the new price intersects the trade price axis, the new Excess Demand line is drawn by connecting point E to the intercept point on the horizontal axis of the original ED. Point F is the new quantity traded, with a decrease in the amount of L. From point F, a line is drawn back to the new currency line (point G) up to point H on the 1:1 line and to the right through the importer supply and demand axis. This shown that the impact of the currency appreciation in the export market is a decrease in quantity demanded and an increase in quantity supplied in the amount of M.

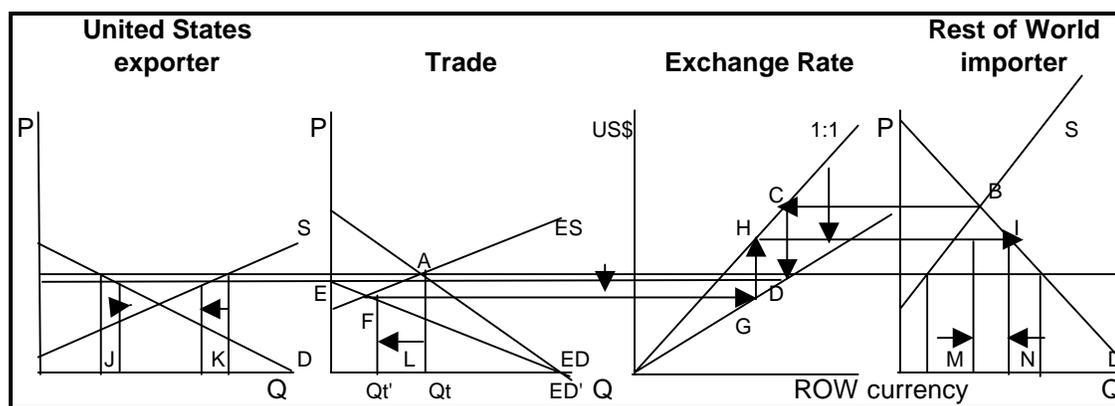


Figure 2-1. The Impact of Exporter Currency Appreciation on Trade.

It is important to remember that the U.S. is not just an exporter, but a producer and importer of some commodities as well. Beef is one of these commodities, as well as lamb. A stronger dollar would have the effect of increasing imports and decreasing exports.

The Economic Research Service (ERS) released a report in 2001 on exchange rate indexes and U.S. agricultural trade. The value of the dollar has increased 42 percent relative to the currencies of U.S. competitors over the last several years, making U.S. producers less competitive in world markets. The exchange rate has historically accounted for 25 percent of the change in U.S. agricultural export value and in the last five years has become a handicap for U.S. agricultural exports. These exchange rate indices can be used to assess the competitiveness of U.S. agricultural products.

Empirical Research

Research on exchange rate impact has yielded varying results. Some research has found that exchange rates play a relatively miniscule role in the U.S. price of commodities. Kost (1976) reviewed the theoretical framework used to assess the trade impact of a devaluation or appreciation of a country's currency on any commodity or subsector of a country's economy. He traces the effects of changes in exchange rates on commodity production, consumption, trade levels, and price for any two trading partners. Kost first examined the effects of a devaluation of the exporter's currency, which has the same effects as an of the appreciation of the importer's currency. Either of these actions cause an increase in quantity exported and an increase in price in exporter country, which causes an increase in production and decrease in consumption in the exporting country. The importing country will demand more, consume more, and produce less because their price decreases. Overall, the quantity traded increases. With an appreciation of exporter currency or depreciation of the importer currency, the importing country reduces import demand, increases production, and decreases

consumption. In the exporting country, prices increase, exports decrease, consumption increases, and production decreases.

Kost points out that there is an upper limit on how much price and quantity can change in response to an exchange rate change. The maximum that price and quantity can change is by the same percentage of the exchange rate change, and this price maximum would only occur if the export supply curve is perfectly inelastic and quantity maximum only if export supply curve is perfectly elastic. The impacts of an exchange rate change on imports and exports depend on the magnitude of the exchange rate change. Kost expects only a small impact on agricultural trade as a result of a change in exchange rates and what effect there is will be on price rather than quantity.

On the same note, Vellianitis-Fidas (1976) tested the hypothesis that exchange rate changes have a significant effect on the demand for U.S. agricultural exports. Two steps were taken to test this hypothesis: first, a cross-sectional study using stepwise ordinary least squares (OLS) of demand for U.S. agricultural exports (namely, wheat, corn, and soybeans) by major U.S. trading partners in 1971-1973 and second, past exchange rate changes in other countries were examined to determine if changes in these rates explained variations in imports over time, both from the U.S. and the world in the period 1954-1969. Both of these steps supported the hypothesis that special characteristics of the agricultural sector negate the effect of exchange rate changes in demand for U.S. agricultural exports. For the OLS step, exchange rate changes, per capita income growth, population growth, CPI, foreign supplies, expected export quantities for the U.S. and the rest of world (ROW), and the actual export quantities of

both the U.S. and the ROW. In this step, exchange rate was not significant in the wheat equation and not important in the corn and soybean equations. Almost none of the variation in changes in quantities exported for 1971 to 1972 and 1972 to 1973 is explained by the variation in the exchange rates.

These changes can be examined on the basis of value of good traded. The U.S. did not export relatively more or less to countries whose currencies changed the most versus the dollar. Value consists of quantity and price together, wheat price was stable from January 1971 through August 1971, then in July 1972, it began to increase. U.S. Gulf export price per bushel of hard winter wheat increased from \$1.76 to \$2.95 in July 1973 and hit \$5.44 by the end of 1973. Soybean prices were stable until November 1972 and began to increase while corn prices decreased January 1971 to October 1971 and then stabilized and increased in September to November 1972 to \$1.50/bushel to \$2.83 in mid-December 1973. Even allowing for a lagged relationship, these significant price increases suggest that the devaluations of August 1971 and February 1973 were not instrumental in the increase in domestic price since the price increases were greater than both of the official devaluations.

Vellianitis-Fidas continued her 1976 work by studying 1960-mid-1969 period using twenty countries that had devalued or revalued their currencies at least once during this period and wheat, corn, cotton, tobacco, and oilseeds. Two nonparametric tests were used to summarize results of each country's equation. The first test involved testing, at the five-percent level, that the majority of countries did not have significant t-stats for the exchange rate dummy variable. The second test involved ranking the t-stats

using a U-test. The first test found that countries didn't significantly change level of imports from the U.S. after their change in exchange rates. Cotton imports seemed more likely to be affected by exchange rates and wheat imports seemed to be less affected by exchange rates than the rest of the commodities. A change in U.S. exchange rates or a change in major importer or minor importer exchange rates did not significantly affect their respective agricultural trades. The author noted that Kost (1976) only expected a small shift in demand caused by exchange rate changes and explained this by saying that the maximum amount of the shift equals the amount of the devaluation (or appreciation) of the currency. The trade weighted exchange rate indicates maximum price changes for wheat and corn that were less than the amount of U.S. dollar devaluation versus gold. Another part of her explanation included the fact that there are institutional factors that prevent the full impact of the devaluation such as the European Community policies such as a variable levy. Changes in import quantity demanded by countries who experience a devaluation is small or zero in the long run because the shift in the supply curve was small and /or demand for imports were fairly inelastic. Changes in value due to exchange rate changes are small as well, as shown by the time series analysis. If changes in value and quantity are small, and value equals quantity times price, then it serves that the change in price must be small as well. The degree to which exchange rate changes impact exports and imports balances on two pivotal factors: the elasticities of supply and demand. The inelasticity of supply and demand in the agricultural sector suggested that exchange rate changes do not greatly impact agricultural trade. In sum,

Kost and Vellianitis-Fidas agree: the U.S. devaluations of the dollar were not the cause of high U.S. prices in 1972-1973.

Johnson, Grennes, and Thursby (1977) compared the impact of exchange rate versus the impact of foreign commercial policy in the pricing of U.S. wheat. Using a deterministic short run forecasting model examining the international pricing of wheat, they determined that foreign commercial policy, created to insulate consumers from increasing prices, was more influential in their domestic price of wheat than U.S. policy. They found that a devaluation of the dollar had a positive impact on domestic wheat prices by way of increased export demand and in turn lower domestic supplies. In addition, there was some indication that distortions in U.S. shipping policy were on equal footing with the devaluation of the dollar in influencing wheat price.

Chambers and Just (1979) noted that while some research found that exchange rates play a role in agricultural exports, still others found that the exchange rate has relatively small impact on the agriculture sector of the economy. They critiqued the treatment of exchange rates in agricultural trade models. Their findings were clear: the approach to dealing with the exchange rate in agricultural models at that time was overly restrictive in the specification of the exchange rate variable in empirical agricultural trade models. Machlup (1980) argued that at one level of policy making, it is the lagged relationship between exchange rates and sales that is important to understand. Although actual shipments are important for this group of policy makers, they presumably reflect an additional set of lags and complications because of logistical issues such as weather,

capacity, et cetera. This complicating set of lags is then of interest to analysts studying actual shipments of commodities.

Collins, Meyers, and Bredahl (1980) used a simple analytical method to analyze the impact of multiple exchange rate changes, rates of inflation, and trade restrictions on real U.S. commodity prices. Their study included two parts: (1) an expression for short run U.S. commodity price changes caused by both nominal exchange rate changes and exchange rate changes adjusted for differential exchange rates and (2) calculated annual changes in U.S. prices of wheat, corn, soybeans, and cotton attributed to exchange rate changes and inflation rates in 1971-1977. They compared these estimated changes with observed changes in prices in order to determine how small or large the exchange rate impact was on U.S. agriculture. The authors noted that there were some other issues involved. The size of the exchange rate impact depends on crop, year, country, governmental influence in markets, elasticities, measured price variables, alternative prices considered, and the definition of exchange rate effect. They concluded that if the exchange rate changes reflect only differential rates of inflation then under free trade, nominal commodity prices change but the underlying supply and demand do not. If the exchange rate is fixed, differential inflation rates cause supply and demand changes, and as the use of nominal price insulation policies increase, the impact of inflation and exchange rate changes on U.S. export demand and real commodity prices increase significantly.

Chambers (1981) performed simple regressions to test causality for four hypotheses: (1) money supply does not “cause” agricultural exports, (2) money supply

does not “cause” agricultural imports, (3) the interest rate does not “cause” agricultural exports, and (4) the interest rate does not “cause” agricultural imports. The idea of “cause” is described by Granger and others, and is caused by a time delay. Using monthly data for 1973-mid-1980, Chambers found some evidence of a causal relationship between money supply and agricultural imports and exports, while there was little evidence of a causal relationship between the interest rate and agricultural exports and imports. He then tested the hypothesis that money supply did not “cause” the level of wheat exports for the period of 1892-1952 and found that there is some limited evidence of causality in this instance as well. Chambers’ findings were important and were consistent with other findings as well, that the money supply/value of the dollar plays some role in the levels of agricultural trade.

In 1981, Chambers and Just addressed the exchange rate issue. They performed a dynamic econometric analysis, using three stage least squares (3SLS), on the wheat, corn, and soybean markets. They made an effort to develop a model that allows the exchange rate impacts to show in both the domestic and foreign sector of U.S. agriculture. Their findings were that exports and agricultural prices are more sensitive to fluctuations in the exchange rate than domestic factors, although they could still be considered responsive. These sensitivities and responses were much more dramatic in the short run than the long run, even though the long run adjustments were still considered significant. Chambers and Just again addressed exchange rate issues in 1982. Using a three-block recursive model, they found U.S. credit-supply fluctuations led to substantial long run agricultural sector impacts. The first block is a model of the wheat,

corn, and soybean markets using three stage least squares and quarterly data from 1969-1977; the second block is aggregate exports estimated by Zellner's seemingly unrelated regression; and the third block, a reduced-form model of exchange rate determination based on ordinary least squares. One of their observations was that most exchange rate-export studies use actual shipments rather than sales. In addition, Chambers and Just explained how expansive monetary (M2) policy decreases the dollar exchange rate, making crop exports more attractive on world markets. This increases crop exports and supports U.S. crop prices from added exports. The competitive position of the U.S.'s agricultural sector was worsened by an appreciation of the exchange rate.

More recent studies also cite the exchange rate as an important factor determining agricultural exports. Chambers (1984) developed a theoretical model that compared the short-run impact on the agricultural sector versus non-agricultural sector that changes in monetary policy brought about. The financial sector was represented in the model by a portfolio balance model, with two countries. Each country has liabilities that yield no return, bonds or securities in the domestic currency that yield the domestic interest rate, and bonds and securities issued in the foreign country that yield a return of the foreign country's interest rate. Portfolio composition depends on the value of nominal wealth domestically, which is based on the exchange rate. Commodity production is represented by a two commodity, three factor model: the agricultural and the non-agricultural commodity and agriculture specific, mobile, and non-agricultural specific factors. The production function gave constant returns to scale. The prices of agricultural commodities are Hicksian flex-price while the non-agricultural commodities

are Hicksian fix-price, in both countries. This means that the price of agricultural commodities in the short run is determined by the interaction of supply and demand while the price of non-agricultural commodities must adjust to supply and demand pressures in the long run to maintain full employment of factors. It is also assumed in this model that agricultural commodities are exported by the domestic country. Vector autoregression (VAR) is used to examine the issues brought up by this model, specifically, that a short run open market depresses the agricultural sector. He found that a restrictive monetary policy or any development impacting the competitive position of a country's currency may more adversely influence the competitive position of an export-oriented industry (such as agriculture), implying lower agricultural prices relative to the rest of the economy, (non-agricultural industry) as well as lower farm incomes and returns.

Numerous researchers have examined the influence of exchange rate movements on agricultural trade (prices, supplies, and demands), but disagreement persists on the magnitude of the effects (ERS 1984). The appreciation of the dollar has had an adverse impact on U.S. agricultural trade while the depreciation of the dollar in the 1970's aided the increase of U.S. agricultural exports. Commodity prices tend to be affected equally by a change in exchange rate, taking into account cross-price effects (Longmire and Morey, 1983). In the long run, commodity prices tend to move together in response to an exchange rate change because commodities can be substituted for one another in both supply and demand. Longmire and Morey developed a model that isolates the exchange rate effect on wheat, corn, and soybeans, noting that the dollar appreciation in the early

eighties caused a decrease in exports of three billion dollars in 1981-1982. The dollar depreciation of the 1970's, which bottomed out at a depreciation of 30 percent lower against foreign currencies, gave U.S. agriculture its best year ever in exports. Wheat, corn, and soybeans all experienced a decrease in exports and an increase in stocks with a real appreciation of the dollar.

Bessler used a vector autoregressive model (VAR) to test the causal relationship from money to agricultural prices using monthly data for money supply, agricultural prices, and industrial prices in Brazil for the period of 1964-1981. Bessler rejected Cairnes' theory that agricultural prices adjust faster to money supply shocks than industrial prices. However, Devadoss and Meyers (1987) found results consistent with Cairnes' theory that agricultural prices adjust more quickly than industrial prices. The impulse responses were positive and significantly different from zero at all periods. Devadoss and Meyers found these results using monthly money supply, farm product price index, and industrial product price index from 1960-1985. Because a change in money supply will cause a change in exchange rates, the two previous studies are important as they both attempt to prove that agricultural prices are more sensitive to monetary policy changes, and in turn, could be sensitive to exchange rates.

Paarlberg, et al. (1994) detail the economic theory behind the impact of exchange rates on prices, production, and consumption. The authors report the research of other studies that have measured the effects of exchange rate movements on agriculture. The theoretical constructs and research results confirm that exchange rates are an important factor in determining prices, supplies, and demands. Tweeten (1992) also reviews the

economic theory behind the impacts of exchange rate changes and various studies on exchange rates. He explains the impact of an appreciation of an exporter's currency is to raise the price of the good in the importing country. This, in his graphical analysis, is illustrated by the rotation of the excess supply curve, which decreases export quantities supplied at any given price. However, some disagreement persists on the magnitude of different effects between different commodities.

Batten and Belongia (1984) provided empirical support for the "exchange rates don't matter" position. Batten and Belongia argue that the real stimulus for export demand comes from income enhancements in importing countries.

Rausser, Chalfant, Love, and Stamoulis (1986) simulated the impact of subsidy and taxes on wheat, feed grains, corn, and livestock using quarterly data from 1984-1986 and using a short-run model. In their analysis, they found that exports play a major role in transmitting monetary and fiscal policy to the agricultural sector. Wheat is more sensitive than feed grains to exchange rate movements since more of it is exported than used domestically. Rausser et.al. found that long-run agricultural policy played a larger role in resource allocation decisions than did macroeconomic policies and external events and that agricultural policy must be adjusted for macroeconomic developments or fail.

In continuing with studies on exchange rates, when looking at a changing monetary policy, Batten and Belongia found that neither monetary policy nor a government deficit impacted the value of the dollar. They considered the statement that "the real value of the dollar has contributed to the reduced volume of U.S. farm exports

since 1981.” Batten and Belongia considered the relevant concerns of the exchange rate issue to be the magnitude of its effect on the identification of policy variables that could be used to decrease the dollar value if this were a desirable policy objective. The answer to this normative question was not clear. Batten and Belongia’s primary focus was determination of factors that affect changes in real exchange rate. They failed to discover any evidence that monetary policy or budget deficits have had effects on the real value of the dollar. They inferred from these inconclusive results that attributions of the decline in farm exports to monetary policy or the deficit are difficult to support empirically.

Schwartz (1986) compared the effects of changes in exchange rate (and other macroeconomic variables) in a simple competitive versus a noncompetitive market for wheat. In the simple competitive case and under a floating exchange rate, a change in exchange rate in one country will cause a short run adjustment in price, output, trade, market share of exports and export volume for two countries competing with one another. The country that experiences depreciation in currency value will see a decrease in exports and the other country will see an increase in exports. The more the exchange rate fluctuates, the more variable short-run changes in domestic prices and trade shares are. In looking at a non-competitive market, Schwartz states the following limitation: exporters have to have market shares large enough to effect price. There are three outcomes possible with a change in exchange rate: (1) traders cooperate and price exceeds marginal cost, (2) with more traders, output and price will be closer to competitive position, and (3) there is no cooperation between traders, leading to price

wars and prices that may fall below marginal cost. The possibility exists for large traders (i.e., the exporters) to use stockholding policies to control some of the effects of exchange rate moves. There is a lower chance that competitors will cooperate if exchange rates are more variable, which increases the chance that trade and price variability will worsen as they shift from periods of cooperation to non-cooperation.

Exchange rate changes can affect terms of trade and international competitiveness as long as they affect relative prices between traded and non-traded goods. Grigsby and Arnade (1986) examined the consequences of Argentina as a competitor country for grain export markets using its distorted exchange rate policy. A policy such as this can cause a divergence between comparative advantage and competitiveness. This “distortion” policy was that Argentina utilized a different exchange rate for its commodity exports than the actual “official” exchange rate for other foreign transactions. Using a trader’s revenue maximization objective function, the Argentine peso was devalued relative to the U.S. dollar. This caused an increase in quantity supplied, and a decrease in quantity demanded. The size of the domestic price increase was dependent on supply and demand elasticities in the short run. Argentina adjusted its exchange rates as part of a pricing policy to keep domestic prices constant when increased prices in domestic market for basic commodities fueled inflation. This policy allowed Argentina to change export prices without changing signals to producers, since there was no domestic price change. This policy can also enhance the size of world demand shocks on export price and increase or decrease the competitiveness of Argentina’s grain exports depending on the government’s goals and level of adjusted

exchange rate. This exchange rate policy affected price competitiveness without changing signals to producers or comparative advantage. Since producers received no price signals, this could also cause a long run increase in productivity.

Pagoulatos had responses to several papers published in 1986. He noted limitations in the specification of the real exchange rate equation, use of *ex post* real interest rate, and simultaneity problems in Batten and Belongia. Grigsby and Arnade reminded him (and us) that the U.S. exchange rate is not the only one relevant to U.S. agriculture but did not test hypothesis with data from Argentina for a more complete assessment. Pagoulatos said that Schwartz took a step towards developing a useful conceptual framework relative to the effects of exchange rate changes on agricultural exports and prices in an imperfect world market structure.

Orden (1986) also comments on Batten and Belongia, Schwartz, and Grigsby and Arnade. He suggested that Batten and Belongia's empirical analysis fell short in clarifying the effects of macroeconomic policies on international capital and commodity markets. Their work lacked data from earlier periods, needed examination of money growth considerations, and relied too heavily on the purchasing power parity approach. In addition, the magnitude and persistence of policy and non-policy factors was ignored. Orden continues his attack on Schwartz, citing that her explanation highlights the facts that the framework of analysis applied to exchange rate impacts on agriculture is oversimplified. She does, however, make some interesting points: exchange rate movements made market intervention schemes difficult to enforce and intervention can insulate markets from exogenous shocks. Orden goes on to say the Grigsby and

Arnade's work was too general and the central role assigned to the revenue maximization function of traders/strictly concave marketing possibility frontiers were misleading. He felt that they should have emphasized that policy induced distortions may keep a country from being competitive in world markets despite its comparative advantage instead of placing the focus on the difference between competitiveness and comparative advantage based on short run effects on consumption versus determination of the level of supply.

Bessler and Babula (1987) considered the empirical lagged relationship among the real trade-weighted exchange rate and cash prices, export sales, and shipments of wheat from a forecasting perspective. They report mixed results when comparing forecasts from four-variable vector autoregressions to those of univariate autoregressions. Bessler and Babula conclude that forecasts of wheat sales are not improved by including the exchange rate as an explanatory variable. However, they did find that "wheat prices responds substantially to shocks in real exchange rates" (p. 406).

Orden and Fackler (1989) specified a nonrecursive structurally identified vector autoregressive (VAR) model of oil prices, supply, and demand for aggregate output, money supply and demand, international effects (represented through exchange rates), and agricultural prices. A shock in monetary policy first caused money and output increases, followed by the dollar devaluation, then the overall price level rose slowly. They concluded that monetary shocks raised real agricultural prices for about one year. Empirical estimates also led to the conclusion that monetary policy shocks had not been

the dominant source of agricultural price instability. These results subsequently paralleled in studies focused on monetary effects on exchange rates.

Bradshaw and Orden (1990) tested the Granger Causality of exchange rates on agricultural prices and exports. The hypothesis was: if exchange rate mattered, it would help predict subsequent export sales. They examined the impact of the real agricultural trade-weighted exchange rate for monthly forecasts of real cash prices and export sales volumes of wheat, corn, and soybeans by comparing out-of-sample forecasting performance of univariate models to bivariate models that included exchange rates to test the impact of magnitude and timing of macroeconomic impacts on agriculture. Citing the poor forecasting performance of econometric models that account for macroeconomic variables, they attempted, in terms of forecasting, to more completely evaluate macroeconomic variables. Bradshaw and Orden found that their best bivariate model outperformed the best univariate models in statistically significant ways, but they would not have found this result if they had limited their research among models to those specified with a common lag structure. Model specification and the choice between in sample and out of sample tests are important in determining if Granger Causality is detected from the exchange rate to prices and exports sales of wheat, corn and soybeans. However, results indicate that while it's more difficult to detect Granger causality from the exchange rate to flexible agricultural prices than Granger Causality to export sales volume, some role for the exchange rate in predicting agricultural prices exists.

Robertson and Orden (1990) examined quarterly data for money, agricultural prices, and manufacturing prices for 1963-1987 in New Zealand. They found that

agricultural prices respond more quickly than manufacturing prices to a shock in money supply. Impulse response functions were compared for vector autoregression (VAR) and vector error correction (VEC). The VEC response functions to money supply shocks were more plausible than that of the VAR. As with previously cited literature, this work did not deal with exchange rates per se, but helps highlight the importance of monetary policy on agricultural prices and in turn, on agricultural competitiveness in world markets.

In 1991, Fuller, Capps, Bello, and Shafer specified a simultaneous equation model of the spring onion sector with the model containing six behavioral equations and an identity while drawing on the classical two-country trade paradigm. The model includes each country's excess demand and supply function and variables relating to exchange rate, the real tariff, and a U.S. policy variable for the 1976-1985 period. They concluded, among other things, that the devaluation of the peso encouraged onion imports from Mexico, especially when the peso was allowed to float versus the U.S. dollar.

Denbaly and Torgerson (1992) used a cointegration methodology that links the long run relationship between relative wheat price and its determinants with a short run dynamic equation, known as an error correction model (ECM). An ECM accounts for the dynamics of price adjustments and treats all variables as endogenous. Error correction is based on the error or difference between variables. They estimated wheat price elasticity with respect to exchange rate of -1.27 , equal to the level reported by Chambers and Just in 1981. This elasticity means that expansionary monetary policy

disproportionately benefits wheat producers, relative to non-commodity sectors, in the short run and tight monetary policy hurts wheat producers in the short run.

Henry, et al. (1993) performed a time series analysis on the effects of government policies on the U.S. beef cattle industry. While their study did not include exchange rates, their methodology is important for this thesis. Using a Bayesian VAR time series model with quarterly data on cattle on feed, cattle slaughtered, beef imports, total cattle inventories of feeder cattle, price of slaughtered cattle, price of corn, price of utility cows, and an index of retail prices for beef substitutes and disposable income from the 1960-1986 period, they shocked three different parts of the beef cattle sector and studied the impulse response functions. First, they shocked the number of cattle slaughtered to represent the increase in dairy cows slaughtered as the impact of the Dairy Termination Program (DTP). Since this time series reacts with the other series in the VAR, the shock can be traced through to other variables. They found a relatively modest impact of DTP on cow and beef prices after the shock. Next, corn prices were shocked to represent a change in policy in corn price supports. They noted that a strong dollar and high support prices coupled with economic conditions in other countries led to a decrease in U.S. exports. A shock to decrease corn prices would cause a long-run decrease in beef prices and the benefits to consumers would be passed on in about two years. On the other hand, a significant increase in corn prices causes an unexpected immediate response, that of an increase in cattle inventories. It takes three quarters for beef price to fall and approximately ten quarters for inventory reductions to take place. Lastly, Henry, Peterson, Bessler, and Farris used their models to indicate changes in the

beef import quota. A decrease in imports caused a relatively small reaction, whereas an increase in imports caused a price decrease and feeder cattle price recovered more quickly than beef price. Changes in beef imports affect cattle price in the short and intermediate run.

Babula, Ruppel, and Bessler (1995) found no cointegration between exchange rates, price, sales, and shipments in regard to United States corn exports. Short-run connections between exchange rates, price, sales, and shipments found support in the research, and while it appears that the exchange rate does not influence exports, it does impact corn price, similar to the results found for wheat in Bessler and Babula. Estimates attained using both structural econometric models and time series methods have found varying degrees of exchange rate impacts on agricultural prices and quantity traded. The Mexican peso devaluation was cited by Anderson (1995) as one reason for increased Mexican cattle movements to the U.S. However, exchange rate changes were part of an overall economic crisis coupled with a severe drought that sent a “flood” of Mexican cattle North.

Dorfman and Lastrapes (1996) disaggregated U.S. agricultural data into crop and livestock data and used interest rate, output, prices received by farmers, total livestock and products and total crops, real energy price, real exchange rate, and money supply for the months from February 1952 to November 1993. Three different activities were included: (1) the disaggregation of agricultural data into crop and livestock data, (2) theory based impulse response functions, and (3) a Bayesian approach to model specification. These were used to test the responses of agricultural prices to money

supply shocks. Real crop and livestock price responses suggested short- to medium-run benefits to both sectors from expansionary monetary policy, which is consistent with the findings of Chambers, Devadoss and Meyers, Orden and Fackler, and Rausser, et. Al. Short-run agriculture benefits from expansionary monetary policies. Crop prices have a very small initial positive response to money supply shocks but gradually rise and take longer to fully adjust than livestock prices, which exhibit strong positive response to the same shocks.

Anderson, Mintert, and Brester (1998) continued the work on exchange rates by discussing how exchange rates might be one of the more important changes in U.S.-Canada livestock trade. In the early-to-mid 1990's, the weakening of the Canadian dollar versus the U.S. dollar encouraged increased fed cattle movement to the U.S. The availability of feed as well as changes in Canadian grain policy have fostered growth in the Canadian cattle feeding industry. In terms of Mexican exports, there was a six hundred fifty thousand head increase in 1995 attributed in part to the devaluation of the peso during Mexico's financial crisis. Anderson, Mintert, and Brester also discussed how changes in industry structure and how the lowering of trade barriers played a role in this increase of cattle movements.

Espinoza-Arellano, Fuller, and Malaga (1998) sought to determine the primary economic forces influencing Mexico's competitiveness in the U.S. winter melon market, consisting of cantaloupe, honeydew, and watermelon. Price linkage equations were used to link retail and farm level prices in the U.S., Mexico, and Caribbean Nations. The price transmission equations included tariffs and exchange rates. Per capita melon

demand was calculated as a function of own-retail price, other melon prices and per capita income. Supply equations were estimated with an acreage and yield equation. Mexican and Caribbean prices were specified as a function of U.S. prices, real exchange rate, and applicable tariffs for the December to May periods of 1970-1994. Three stage least squares was used to estimate 70 model parameters in nineteen equations and then the model was validated using in-sample simulation. A baseline was created in order to compare results across scenarios. The results show that the effect of the 1994-1995 peso devaluation had important short run affect on Mexican melon exports to the U.S. Watermelon, honeydew, and cantaloupe exports increased 36, 18, and 4 percent, respectively relative to the baseline, due to the peso devaluation. As a result, Mexico's share of U.S. watermelon, honeydew, and cantaloupe imports increased by 11, 7, and 2 percent, respectively. In their conclusion, Espinoza-Arellano, Fuller, and Malaga found that "exchange rates do have an important effect on trade, in particular, the weakening of the peso (exporter's currency) increases export opportunities in the short run" (p. 505).

Barichello, Pearson, and Selim (1998) constructed a series of partial budgets to in order to examine anticipated the impact of Indonesia's currency devaluation on agricultural profits and potential exports for different commodities. The authors used up to date farm cost and revenue data in conjunction with the Policy Analysis Matrix Approach. They adjusted output prices to 1998 values for traded and non-traded outputs and inputs. Results show that the commodities used: rice, corn, soybeans, sugar, dairy, crude palm oil, and cashew nuts become more export competitive with the depreciation. However, export response as calculated will be overstated in some instances due to

additional constraints on export response in agriculture, namely the competition across traded agricultural goods for common inputs (such as land). All export commodities became more profitable initially, but after the general equilibrium effect of rising land prices, only some remain profitable. In addition, some of these commodities may not have been exported previously, meaning there could be issues in product quality, grading, storage, and transportation to be figured out, causing a delay in export response.

Barichello asked in 1999, “What is the impact of dramatic exchange rate movement and economic collapse on imports and exports?” He answered this question using the Asian financial crisis, specifically Indonesia’s crisis, as an example. The Indonesian Rupiah lost eighty percent of its value from June 1997 to March 1999, hitting a low point of an eighty-five percent loss of value in July/August of 1998. Traded good prices increased 3.7 times or 270 percent relative to the March 1997 exchange rate. Prices increased approximately three times for both imports and exports, which would drive down import demand faster than export demand, if production expansion were involved. Regarding exports and given the time pattern of the depreciation, the 1998 pattern of exports is consistent with moderate growth in exports in response to the depreciation. Imports, excluding rice, responded quickly and rapidly to the exchange rate changes, except in the last half of 1998 when imports increased unexpectedly. Barichello drew the conclusion that following currency devaluation, imports experienced a brief and significant decrease while exports displayed an erratic, delayed, and unpredictable increase in agricultural exports and production. These changes in exports were also stretched out more in time than expected.

Kapombe and Colyer (1999) used a multiple equation structural time series model as the theoretical framework for supply and demand equations to analyze U.S. broiler exports. Using quarterly data from 1970-1995 for U.S. broiler production, demand, inputs, exports, meat prices, and annual values for broiler import equations for Japan, Hong Kong, Canada, and Mexico. The results of estimating U.S. broiler import demand equations indicate that Japanese demand for U.S. broiler exports were negatively influenced by the exchange rate: a one percent increase in the yen-U.S. dollar exchange rate will cause a .96 percent decrease in import demand. Hong Kong import demand is negatively influenced by the exchange rate: a one percent increase in Hong Kong-U.S. exchange rate will decrease import demand .56 percent. Mexican broiler demand is also negatively influenced by the exchange rate, as a one percent increase in the peso-dollar exchange rate will result in a 0.58 percent decrease in import demand. Kapombe and Colyer find the U.S. broiler market to be very sensitive to changes in real exchange rate and trade distorting policies.

Lamb (2000) estimates supply functions for total agricultural output, food crops, and export crops in fourteen African countries in the period of 1975-1999. The concept that a country's exports depend on its exchange rate is examined in this work. Lamb finds that the exchange rate has "a persistent, robust and negative" relationship between the exchange rate and aggregate agricultural output in markets where food crops and export crops are substitutes in production in the short run. The decision between producing food crops or export crops is based on the value of the currency, that is, an overvalued currency makes exports more expensive to other countries and imports less

expensive while an undervalued currency makes exports cheaper to other countries and imports more expensive. When a currency is undervalued, export crops are likely to be produced at a time when imports are expensive, leading to the risk of reduced stocks of domestic food.

The consideration of graphical models is important in this review as well, as they offer an alternative to regression-based or other procedures for model specification. Akleman, Bessler, and Burton (1999) used Tetrad II, a software package, to create directed graphs of the relationships between variables in the U.S. corn market: exchange rates, corn price, corn export sales, and corn export shipments. Using figure 2-2 as an example, A directed graph is an ordered triple $\langle V, M, E \rangle$ where V is a non-empty set of variables (A, B, and C is Figure 2-1), M is a non-empty set of marks (arrows), and E is a set of ordered pairs (A and B or B and C). Each member of E is called an edge. In other words, a directed graph, at a basic level, is a picture representing the causal flow among a set of variables. In Figure 2-2, A caused B, and both A and B cause C. It is possible to find a relationship between variables in a directed graph but not know the direction of causality. A directed graph can be used to indicate Granger Causality. Granger Causality is when one variable is related to another, but doesn't necessarily cause the other variable.

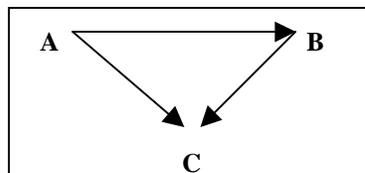


Figure 2-2. An Example of a Directed Graph

In Akleman, Bessler, and Burton, at a five percent level of significance, exchange rates do not cause export sales and shipments. At higher levels of significance, specifically the ten percent level, some support was given to the notion that changes in exchange rates cause changes in corn price and/or corn export sales.

In 2000, the Economic Research Service (ERS) reported that since 1995, the exchange rate competitiveness of U.S. agricultural exports has declined eighteen percent. In other words, the dollar's higher export-weighted exchange value has raised U.S. farm prices eighteen percent in the previous 5 years. ERS went on to conclude that since 1995, the exchange rate for U.S. bulk exports is up by nearly twenty percent. In another report, ERS documented the international financial crisis that began in July 1997 and struck Thailand, Indonesia, South Korea, Russia, Brazil, and other South American Countries. This crisis led to depreciated currencies, decreased economic growth, and higher interest rates, depressing global commodity prices, which decreased U.S. agricultural exports. U.S. agricultural exports value experienced a 23 percent decrease in real terms, for the period from fiscal 1997 to fiscal 1999. USDA analysis blames oversupplies for this decrease, however, the U.S. as a non-crisis exporter experienced a four percent increase in economic growth, a one percent decrease in interest rates, decreased producer prices, increased production, increased consumption, decreased exports and increased imports (p. 5) due to the crisis, which included significant depreciations of crisis countries' currencies.

Westhoff (2001) makes mention of potential policies to protect agricultural producers from the volatility caused by exchange rates. The strengthening of the U.S.

dollar makes its goods more expensive to other countries, and this plays a role in the depressed U.S. agricultural markets. Currently tariff rate quotas (TRQ) and marketing loans help to mitigate some of these negative effects, however, TRQ's are to be decreased, by order of the World Trade Commission and neither policy applies to the beef and cattle industry directly. Westhoff discusses several policy options to protect U.S. agricultural producers from exchange rate caused income risk, but there is no "best option" and many of them will become increasingly difficult to defend and protect in an increasingly open world market.

There is also a need to discuss the differences between nominal, real, and trade weighted exchange rates. According to the Economic Research Service (2001), nominal exchange rates are those observed and are a result of the market and other forces out of our control. Real exchange rates are nominal rates adjusted for inflation. Trade-weighted exchange rates are calculated with a trade-weight index. These indices are constructed by multiplying the average trade weight of a country in U.S. exports, exports to the world, and U.S. imports. These weights are average dollar shares of U.S. exports, exports to the world, and U.S. imports for the relevant commodity. The current exchange rate for each country (in units per dollar) is then adjusted by taking the ratio of the same period CPI in the U.S. to the country in question. The percent change from the base period is then multiplied by the weight. These weighted changes are summed into a total, which is the "real" index.

Summary

Edward Schuh started considerable debate when he stated that the exchange rate plays a large role in agriculture. There have been numerous theoretical arguments made and empirical analyses done; yet there still seems to be no absolute solution to the questions of exchange rate's role in agriculture and especially agricultural trade. The raw theory agrees: exchange rates do play a role in prices and in turn, trade. However, the basic theory leaves out quantitative measures such as elasticities of supply and demand and the magnitude of the change. These things have been examined empirically, but it seems that there is little agreement on the best method by which to measure exchange rate influence. One of the main issues is not whether or not exchange rates play a role in pricing, but just how large that role is and what other macroeconomic variables may influence agricultural prices and trade in a similar way. Table 2-1 is a summary of the empirical research relevant to the exchange rate issue. It contains information on authors, commodities, methods, and the role of the exchange rate. The role of exchange rates is expressed as a relative scale from important to unimportant. These descriptions are provided to give an idea of the varying opinions on the impact of exchange rates on agriculture.

Table 2-1. Summary of the Literature Relevant to the Exchange Rate-Agricultural Trade Issue

Author	Commodity	Method	Exchange Rate Role
Johnson, Grennes, and Thursby	Wheat	Deterministic short run forecasting model	somewhat important
Chambers and Just (1979)	General agriculture	Critique of exchange rate treatment	overly restricted in models
Collins, Myers, and Bredahl	Wheat, corn, soybeans, cotton	Simple analytic method	important
Chambers (1981)	Agricultural imports, exports, prices, and wheat	Simple regression	play a role
Chambers and Just (1981)	Wheat, corn, soybean	Dynamic three stage least squares	Important in the short run
Chambers and Just (1982)	Wheat, corn, and soybeans	Three stage least squares and ordinary least squares	important
Chambers(1984)	Agricultural vs. non agricultural sector	Vector autoregression	important
Longmire and Morey	Wheat, corn, and soybeans		important
Bessler	Brazilian ag prices	Vector autoregression	not important
Devadoss and Meyers	Agricultural prices	Vector autoregression	important
Paarlberg, Webb, Morey, and Sharples			very important
Tweeten	General agriculture	Theoretical model	very important
Batten and Belongia (1984)			not important
Rausser, Chalfant, Love, and Stamoulis	Wheat, feed grains, corn, livestock	Short run simulation model	play a role
Batten and Belongia (1986)	General agricultural commodities	Standard expression for export determination	Inconclusive
Bessler and Babula	Wheat	4 variable VAR and univariate AR	not very important
Orden and Fackler	General agricultural prices	nonrecursive structurally identified model	play a role
Bradshaw and Orden	Wheat, corn, and soybeans	Compare Bivariate to Univariate models in terms of forecasting ability	important
Robertson and Orden	Agricultural prices	Vector autoregression and Vector Error Correction	Monetary policy important
Fuller, Capps, Bello, and Shafer	Onions	Simultaneous equation model	plays a role
Henry, Peterson, Bessler, and Farris	Beef cattle	Time series based on Bayesian VAR	N/A

Table 2-1 continued

Author	Commodity	Method	Exchange Rate Role
Babula, Ruppel, and Bessler	Corn	Both structural econometric models and time series methods	not important
Dorfman and Lastrapes	Disaggregated agricultural data	Standard macroeconomic model with impulse responses	Prices react to monetary policy
Anderson, Mintert, and Brester	Livestock (Cattle and Hogs)		plays a role
Espinoza-Arellano, Fuller, and Malaga	Cantaloupe, honeydew, and watermelon	Three stage least squares	important, in short run
Barichello, Pearson, and Selim	Rice, corn, soybeans, sugar, dairy, crude palm oil, and cashew nuts	A series of partial budgets	important
Barichello	Agricultural exports, excluding rice		important
Kapombe and Colyer	Broilers	Multiple equation structural time series model	important
Lamb	Food crops and export crops	Two-stage least squares	important
Akleman, Bessler, and Burton	Corn	Directed graphs	might be important
Vellianitis-Fidas	General Agriculture	Ordinary Least Squares and Time Series	not important in 1972-73

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