EXCHANGE RATE REGIMES IN MODELS OF AGRICULTURAL EXPORTS

By

JAMES MARSHALL GLECKLER

Bachelor of Arts
University of Tulsa
Tulsa, Oklahoma
1974

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1977

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Thesis Approved:

James E. Osborn
Thesis Adviser

David M. Henneberry

Luther G. Tweeten

Harold V. Love

Norman N. Durham
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

For almost two decades the prosperity of the Agricultural Sector in the United States has been closely associated with exports of farm products. The boom years of the 1970's were times of rapidly expanding U.S. agricultural trade. The United States' market share in world trade of many commodities rose substantially, as did prices and profitability on American farms. Over seventy percent of U.S. soybeans and nearly sixty percent of American wheat were destined for overseas markets. As market shares and export sales of U.S. farm products fell in the early 1980's, so did commodity prices and production profits.

The dollar exchange rate has been at the center of the discussion of agricultural trade and farming sector prosperity (Chapter II). Many agricultural economists have theorized that the value of the dollar is central to agricultural prosperity in this country. Soon after the devaluations of the early 1970's, Schuh (1974) presented a widely-acclaimed analysis of American agriculture after World War II which drew special attention to the value of the dollar during this period. His analysis included a review of the usual "closed economy" explanation of American investment in technology which shifted supply and lowered domestic prices. Price supports designed to improve faltering incomes among farmers resulted in commodity surpluses, which were controlled in part by land set-asides. Schuh claimed that an important omitted variable in this analysis is the value of the dollar. His analysis points out that the dollar was over-valued relative to its market exchange rate from about the time of the Korean War until it was revalued in the 1970's. As a result of this over-valuation, the advantages of the technological revolution in agricultural production were transferred primarily to the consumers since the exchange rate discouraged exports of farm products. The dollar's exchange rate helped over-value U.S. land and labor.

According to Schuh, U.S. products were placed in a noncompetitive position in world markets. Lower prices and shrinking profits provided additional incentives to adapt to the new technology, and innovations were incorporated in production practices at a faster rate than would have been otherwise. The cycle kept worsening the chances for farm sector prosperity. The revaluation and eventual floating of the dollar in the early 1970's ended this policy-imposed isolation of the agricultural sector and over-valuation of its resources relative to those in other countries. The result was a dramatic rise in U.S. exports, prices and farm prosperity.

Events in the remainder of the 1970's and the 1980's have strengthened Schuh's claim that the exchange rate is an important factor in agricultural exports and farm prosperity. As the value of the dollar began its rise about 1980, U.S. market shares of world trade began to fall along with farm prices. The dominant issue with regard to the exchange rate in 1988 is, with a significant decrease in the strength of the dollar since early 1985, will U.S. agricultural exports respond and prices of farm commodities rise? Properly specified empirical models of U.S. agricultural exports can help answer these questions.

The role of exchange rates as a variable in models of agricultural exports has changed significantly over the last fifteen years (Chapter II). Early in the period agricultural trade models used the nominal exchange rate as a variable.

Later specifications called for an accounting of the relative importance of trade. As a consequence, exchange rates were trade-weighted to reflect the specific mix of countries to which commodities are exported. A further improvement occurred when the relative inflation in trading countries was taken into account and a real exchange rate variable used in trade models. This study attempts to measure the importance of yet another modification of the exchange rate. The modification takes into account the regime in which the exchange rate is determined in the importing country.

The exchange regime refers to the market structure in which the exchange rate is determined. The exchange rate regime is a government policy variable. In this respect, it is an institutional variable. Since a government may fix its currency's value, or allow that value to be determined by market forces, the regime is a critical factor in determining how quickly developments in the currency markets are translated into exchange rate changes and price and income effects.

Exchange rate regimes are often broken down into three categories depending upon the degree of control over the currency's value exercised by the government. Some governments peg the value of their currency to another currency or a composite currency value. Other countries allow the value of their currency to be determined by the forces of demand and supply. In between the two extremes are governments which allow their currency's value to fluctuate in a fixed range but will manage its value if the rate exceeds the imposed limits.

In the 1980's, twenty percent of U.S. agricultural exports have gone to countries with pegged exchange rates, twenty-eight percent of these exports have gone to floating exchange regime countries and fifty-two percent have gone to countries with managed exchange rates. If there is significant explanatory power among the different exchange rate regimes, a model which incorporates the regime in the exchange rate variable will be a superior predictor of the effects of recent exchange rate movements. Such a model will be able to more accurately forecast agricultural exports and indicate the timing of a recovery in the agricultural sector. In addition, the significant contribution of exchange regime to the model would indicate the possibility of governments affecting trade by the foreign exchange marketing policy which they choose.

In this regard, a problem statement in the form of a question would be, "Do government policies with respect to foreign exchange market structure affect imports of U.S. grain?" In an attempt to scientifically investigate this problem, previous studies of agricultural trade and the exchange rate are reviewed in Chapter II. In Chapter III, the theories of exchange rate determination and agricultural trade are presented. In addition, a discussion of the possible effects of different exchange regimes on trade using deductive methodology is presented. This reasoning arrives at conclusions which are testable using inductive techniques. Chapter IV contains a theoretical model specified in such a way as to allow empirical testing of the deductive conclusions using inductive statistical inference. A formal null hypothesis and alternative hypothesis are presented as well. Results of the statistical inference are contained in Chapter V and conclusions in Chapter VI.

CHAPTER II

LITERATURE REVIEW

A search of the agricultural economics literature produced no studies dealing specifically with the effect of different exchange rate regimes on agricultural trade. There has been considerable study of the effect of an exchange rate variable in agricultural trade models since the dollar devaluations of the early 1970's. This study draws heavily on the theory and methodology of these earlier investigations in studying exchange rate regimes and their possible effect on agricultural trade. As a consequence, this chapter will focus on the theoretical and empirical contributions concerning exchange rates and agricultural trade. A table containing the trade equations of the empirical studies reviewed here is presented at the end of the chapter.

Shortly after the devaluation of the dollar in 1973, Schuh (1974) laid the major theoretical foundation for the empirical studies of trade and exchange rates which were to follow. Schuh's deductive analysis theorized the exchange rate's effect on the agricultural sector in the 1950's and 1960's. During most of this period Schuh argues that the dollar was over-valued. This led to uncompetitively high world prices for U.S. commodities, chronically low farm prices and depressed farm income. Policies that tried to relieve the situation naturally caused oversupply. Schuh maintained that the revaluation of the dollar in 1971-2 made U.S. farm products more competitive on world markets, and the change in exchange rates was a major factor in price, stocks and farm income improvements.

Fletcher, Just, and Schmitz (FJS) in 1976 investigated the impact of exchange rates and other factors on North American wheat export demand. Using trade and exchange rate theory, they modeled North American wheat exports as a function of U.S. wheat price, foreign wheat production, importer affluence, the U.S. - importer exchange rate, importer population and Australian (a competitor's) wheat production. The use of the exchange rate as a separate variable in the export equation was justified on the grounds that the effect on export demand of a change in the exchange rate is likely different than the effect of a change in price alone. The former has more of an income effect, especially where more than the one commodity is traded between the two countries.

The empirical model specified by FJS combined U.S. and Canadian exports because of the high degree of correlation between prices and other factors. North American exports to four distinct regions were estimated. Because of the simultaneity present in the theoretical export equation, two additional internal equations (disappearance and carryover) and an identity were specified. The system was then estimated using 2SLS, 3SLS, and OLS. Empirical findings from the study supported Schuh's claim that exchange rates were an important factor in agricultural trade and wheat prices.

In the same year as the FJS work (1976), Vellianitis-Fidas (V-F) presented empirical results which contradicted Schuh's theory and the FJS findings. V-F used a multi-commodity time series model of import demand with the trade volume being regressed only on the U.S. dollar exchange rate. The results of her empirical tests indicate that the exchange rate is not a significant variable in explaining agricultural trade in the commodities modeled. The model specification with exchange rate as the only regressor has been criticized by later researchers.

Johnson, Grennes and Thursby (1977) modeled wheat trade using a spatial equilibrium model consisting of six endogenous trading partners and an exogenous rest of world (row). Policies among the trading partners were expressed as differences in price and included in the model. Their estimates showed exchange rates to be of minor consequence in determining trade flows compared with the influence of trade policies among the partners.

Konandreas, Bushnell and Green (KBG) added more empirical evidence to the growing debate on the effects of exchange rates on agricultural trade in 1978. KBG argued that export demand for U.S. wheat is the aggregate of individual countries' import demands. With this in mind, their model had wheat exports as a function of the importing country's wheat price, U.S. wheat price, world wheat price, the price of a substitute for wheat (rice) and the income in the importing country. In the regression equation itself, KBG exclude several price variables on the basis of high correlation, and they make a strong case for including the exogenous variables U.S. concessional exports, and last period exports.

The KBG empirical model in each of five regions regresses wheat exports on effective U.S. price, last periods exports, U.S. concessional exports, importer production of wheat and importer income. There are no separate exchange rate regressors in their empirical model. The price and income variables incorporate the exchange rate, and KBG calculate elasticities for both prices and exchange rates concluding that exchange rates have substantial impacts on agricultural exports in general, and wheat in particular.

Chambers and Just in 1979 presented an extensive review and criticism of theoretical specifications up to that time. They pointed out that the standard theoretical model used in examining the impact of exchange rates on agricultural trade during the 1970's consists of a simple two-country excess supply-excess demand model:

$$ED_j = f(P_2)$$
$$ES_i = g(P_1)$$
$$ED_j = ES_i = Q,$$

where ED is the excess demand in the j^{th} importing country, ES is the excess supply in the i^{th} exporting country, Q is the quantity traded, P_2 is the price in the importing country and P_1 is the price in the exporting country. In the absence of transportation costs and trade barriers, the law of one price holds:

$$P_2 = P_1 e,$$

where e is the exchange rate.

In expanding this theoretical model to a more general specification, Chambers and Just point out that under neoclassical consumer theory, excess demand as a function of only one price assumes that the cross price effects of all other goods is zero. Demand functions derived by maximizing individual utility functions subject to budget constraints are a function of the commodity price, all other prices and income. Therefore, the proper theoretical specification of excess demand and supply functions should be,

$$ED_j = f(\gamma,Y)$$
$$ES_i = g(\sigma),$$

where γ and σ are vectors of prices, and Y represents a measure of national income in the importing country. Even with a more general specification the law of one price will still hold:

$\gamma = \sigma e.$

Chambers and Just emphasize two important implications for empirical work using the more general theoretical model. First, they cite other theoreticians who have made a strong case for including the exchange rate as a variable separate from the price regressors in trade models. This specification is justified on the basis of different reactions by buyers to price moves and exchange rate moves. The second implication for empirical work is a method for dealing with the prices of all other goods in the specification of the model. A hypothesized two stage budgeting process on the part of consumers allows a simplification to the price of the good in question, an index of all other traded goods, and an index of nontraded goods as the price regressors in the empirical trade model. The only model approaching such a specification is the one designed by Fletcher, Just and Schmitz (1976). Chambers and Just note that this study found exchange rates to be an important factor in agricultural trade flows.

In 1981 Chambers and Just presented an elaborate empirical study which tested their deductive hypotheses of two years before. The dynamic econometric model used quarterly data from 1969 to 1977 and consisted of fifteen equations, three of which were identities. The recursive system was divided into equations which explained disappearance, inventories, exports and production for corn, wheat and soybeans. The data were expressed in per capita form and 3SLS was used to estimate the parameters. As advocated in their theoretical paper, this model included a separate exchange rate regressor in the export equations. The exchange rate was expressed in terms of the International Monetary Fund's Special Drawing Rights (SDR). Additional independent variables in the per capita wheat export equation were own-deflated wheat price, the EC threshold price for wheat imports, stocks of wheat in exporting countries, P.L. 480 shipments, the lagged dependant variable, and seasonal variables. The findings of this study confirmed the significant impacts of exchange rates on export volumes, especially with respect to corn exports. Exchange rates had the least significance in the wheat export equation.

In 1984, as a part of a paper about exchange rate behavior and agricultural exports, Batten and Belongia presented an extremely simple, single equation aggregate export model. Using quarterly data, their empirical model regressed the volume of U.S. agricultural exports on the trade-weighted index of foreign real GNP, a deflated price index of U.S. agricultural exports and the real trade-weighted index of the dollar. All variables were expressed in natural log form. The data, from 1971 to 1984, contained not only the export expansion years in the 1970's, but the years of declining exports in the 1980's. The most outstanding characteristic of this model other than its simplicity is the R^2 of .94, which exceeds the proportional explanatory power of most previous models. The export elasticity of the exchange rate was estimated to be -.71, which agrees with theory, but the impact on exports of the exchange rate regressor was significantly less than that of foreign GNP, which led Batten and Belongia to conclude that importer affluence is the main factor which affects agricultural exports, not the exchange rate.

In 1985, Henneberry published a paper in which he raised the possibility of institutional constraints, specifically exchange rate regimes, having an effect on trade which is distinct from the price and income effects measured in previous models of agricultural exports. The exchange rate is the price of the dollar in terms of another currency. Often the dollar exchange rate is expressed in terms of an index of many other currencies. The exchange regime is particular to a country and a matter of government policy (thus, an institutional parameter). The regime is the market structure in which the exchange rate for the domestic currency is determined. Institutional considerations determine the extent (or timing) to which the markets are allowed to operate in determining the price of the domestic currency. Exchange regimes are grouped into three categories: floating, limited flexibility and pegged. Henneberry was particularly interested in the pegged regimes because over twenty percent of American agricultural exports go to countries with pegged exchange rates. Pegged currencies do adjust to market forces, but the adjustments are sporadic, extreme and usually unexpected. Agents operating in such markets face less short term fluctuation but greater risks of unexpected revaluation in the long run. His suggestion at the time was to develop an agricultural trade-weighted exchange rate that would take into account the high proportion of fixed exchange rates.

In a 1987 article, Henneberry, Drabenstott, and Henneberry (HDH) estimated U.S. wheat trade with a single equation model which included an exchange rate variable. The quarterly volume of U.S. wheat exports from 1973 to 1986 was regressed on the real trade-weighted GDP of wheat importers, the deflated U.S. wheat export price, the real trade-weighted exchange rate for wheat exports, the real price of Australian wheat, the deflated world price of rice, and the production of wheat in the rest of the world. In estimating the model, natural logs of all variables and OLS techniques were used. The estimation resulted in an R^2 of .43, which is not high but it is similar in explaining power with earlier empirical results of quarterly wheat export models. The relative strengths of the estimated coefficients seem to confirm the findings that own price and importing country income factors have more influence on wheat exports than the exchange rate. HDH emphasize that the influence of pegged exchange rate regimes among U.S. wheat importers may significantly weaken the effect of exchange rates.

Another recent study by Bessler and Babula (1987) tested the relevance of exchange rates in export models by statistical methods rather than on a theoretical basis. Since there is still considerable controversy over the inclusion of a separate exchange rate variable, Bessler and Babula explored the question using various formulations of the trade-weighted exchange rate, wheat price, wheat export sales and wheat export shipments. The different formulations were used to make out-of-sample forecasts and the prediction error for each was measured. Sales and actual shipments were differentiated because of the additional lags and complications involved with shipments (logistics, etc.) over a relatively simple negotiated sale. Their findings with regard to exchange rates were that wheat sales and shipments could be forecast as well or even better by leaving exchange rates out of the model specification.

In their 1988 empirical study, Childs and Hammig used a model with simultaneous equations for five commodities to test the hypothesis that the exchange rate is the key explanatory variable affecting the level of farm exports. Their partial equilibrium trade model had a separate block of recursive equations for each commodity. The dependent variables in each block were domestic price, domestic production, ending inventory, domestic consumption, and export volume for the commodity. Exports in the last equation were regressed on the real domestic price, the real trade-weighted exchange rate, the deflated gross domestic product of the importing countries, and in the case of grains, the population of livestock in the importing countries. Most variables were expressed in per capita figures and the time series was in annual periods. Some of the estimated equations had low R^2 and their estimated coefficients had unusual signs such as positive price and negative income coefficients. Childs and Hammig had conclusions similar to those of Batten and Belongia, finding that exchange rates matter much less than do variables representing importing country income.

No studies undertaken to examine the impact of exchange rate regimes in models of agricultural exports were found in the agricultural economics literature.

TABLE I

TRADE EQUATIONS OF THE EMPIRICAL STUDIES

Fletcher, Just, Schmitz. (1976)
3 equation model of North American wheat exports, annual data:
$X = f(P, Q_i/K_i, Y_i/K_i, ER, Qaus/Kaus)$

Konandreas, Bushnell, Green. (1978)
Single equation model of U.S. wheat exports, annual data:
$X = f(X_{t-1}, P, Xcons, Q_i/K_i)$

Chambers and Just. (1981)
5 equation model of three U.S. export commodities, quarterly data:
$X/K = f(P, ERsdr, Pec, Qrow, Xcons, X/K_{t-1})$

Batten and Belongia. (1984)
Single equation of aggregated U.S. agricultural exports, quarterly data:
$X = f(P, Y_i, ER)$

Henneberry, Drabenstott and Henneberry. (1987)
Single equation of U.S. wheat exports, quarterly data:
$X = f(P, ER, Y_i, Paus, Pric, Qrow)$

Childs and Hammig. (1988)
3 equation model of five U.S. commodities, annual data:
$X = f(P, ER, Y_i, K_{ls})$

CHAPTER III

THEORY

Exchange Rate Behavior

According to the theories of open economy macroeconomics, the exchange rate can have profound effects on trade. With prices in the U.S. and other countries stable or nearly so, a significant devaluation of the dollar against the yen would lower the foreign price of American grain by the proportional amount of the devaluation. This could all happen in a matter of days. During the same period, the dollar might surge upward with respect to the peso on news of economic problems in Mexico. The magnitude of this surge would be reflected in the peso price of U.S. commodities sold in Mexico and the demand for these commodities would fall accordingly. Thus, price effects underlie the theoretical statements of exchange rate impacts on trade, but there are different measures of the exchange rate and not all affect trade like the examples above. For this reason it is appropriate to outline the composition and behavior of exchange rates.

The exchange rate (E) in this discussion will be in terms of foreign currency per dollar of domestic currency. Consequently, when the dollar is said to 'strengthen', E will increase.

In a floating exchange regime, the exchange rate will be determined by market forces. Demand and supply of dollars and of the foreign currency will determine the value of the foreign currency per dollar at any given moment. In an unhindered market, the demand and supply of currencies is determined by trade in goods and in financial investments. Demand for goods or investments produces a demand for the currency with which to buy them.

Two theories have been advanced to describe exchange rate behavior. The older of these theories is the purchasing power parity theory (PPP). PPP has been shown to accurately model the exchange rate between countries in the long run and is based on the relationship between domestic and foreign price levels. Purchasing power parity expressed mathematically is,

$$P^* = EP \tag{1}$$

where P^* is the foreign price level, E is the exchange rate in foreign currency per dollar, and P is domestic prices. According to PPP, over the long run E equates the market assets in the two economies. After dividing both sides of equation (1) by P^* it becomes evident that,

$$1 = EP/P^* \tag{2}$$

So long as PPP holds, the exchange rate times the domestic price level divided by the foreign price level will equal one. Obviously, when there is not parity in price levels and the exchange rate, this relationship will not equal one. Equation (2) can be modified to reflect non-parity by substituting the variable Q for the parity value of one,

$$Q = EP/P^* \tag{3}$$

Q is referred to as the real exchange rate and is equal to one so long as PPP holds. The importance of Q is that it influences trade. (E may or may not influence trade: As long as the parity of equation (1) holds, changes in E do not influence trade). When Q falls, there is a decline in the strength of the domestic currency not attributable to the relative prices in each economy. Dollars become less expensive for foreign importers of American grain to buy. The trading partner's currency costs more dollars to buy, and although the foreign good prices may remain constant, the goods become more expensive in dollars. U.S. grain's real price falls in the importing country and foreign import real prices rise in the U.S. Both of these effects act to shift demand toward domestic products. Thus, the real exchange rate (Q) operates independently from price levels in the respective countries to produce price effects.

Two factors operate to influence the real exchange rate (Q). These factors are structural changes in the economy and capital market fluctuations. Structural changes in the economy are long term shifts relative to two partners in things like technology, population and natural resources. Short run changes in Q can also occur. Almost as rapidly as interest rates can change, Q can change. This relationship is outlined in the second theory of exchange rate behavior, the uncovered interest parity model (UIP). Because of electronic capital transfers world-wide, there is a considerable arbitrage in capital markets of many countries. Investment capital is shifted between assets in markets internationally. Among other things, investors seek the highest return on their investment. Open economy theory assumes that interest rates represent an appropriate rate of return on investments. Equilibrium in the capital market can be expressed as,

$$i = i^* \quad (4)$$

where i is the domestic interest rate and i^* is the foreign or world interest rate. According to the UIP model, a rise in domestic interest rates above the world rate will invite an in-flow of investments large enough to influence the real exchange rate and eventually interest rates. Demand for dollars to purchase the higher yielding assets would bid up the dollar's value. Q, the real exchange rate, would rise in this case. The rise in Q, independent of the price levels in the two countries, will shift demand away from U.S. commodities. This shift acts to reduce interest rates (IS curve shifting left along LM curve).

Modifying equation (3) by solving for E, the nominal exchange rate can be expressed as,

$$E = QP^*/P \tag{5}$$

Expressing proportional changes in all variables, (5) becomes,

$$E = \hat{Q} + (\hat{P}^* - \hat{P}) \tag{6}$$

where the ^ over each variable indicates proportional change. From equation (6) it can be seen that the market determined nominal exchange rate has both price and real exchange rate factors influencing it. Since the real exchange rate is the only variable affecting trade, Q is of interest in specifying models of agricultural trade. The real exchange rate in this and other studies of agricultural exports is calculated according to equation (3) above.

Trade Models

Chambers and Just (1979) in their outline of agricultural trade theory point out that the usual examination of the impact of exchange rates on trade is based upon the standard excess supply--excess demand model. Konandreas, Bushnell and Green (1978) have explained that total export demand for U.S. commodities is the aggregate of individual country import demands. Most empirical work examining exchange rate effects on trade has concentrated on estimation of import demand (excess demand) relationships.

Paarlberg, Webb, Morey and Sharples include a conceptualization of trade and policy issues in their 1984 publication. Many of the graphical descriptions below draw on their work. A graphical representation of a world market where the U.S. is a "large country" is presented in Figure 1. This would be the situation when U.S. stocks are low and pricing policy is ineffective in supporting U.S. producer prices (world price is above the loan rate) as was the case in much of the 1970's. Figure 2 illustrates the world market when stocks are high and the loan rate supports the U.S. price, which has been the case in much of the 1980's. X in both cases is the quantity of U.S. trade in the commodity, a term of central importance (the dependant variable) in our model.

Figure 3 and Figure 4 illustrate the U.S. domestic market from which the excess supply curves of Figures 1 and 2 are derived. Both Figures 3 and 4 contain totally inelastic supply curves representing a fixed production of the commodity in a single production period. A shift of the supply curve in Figure 3 from S to S' might be a result of weather patterns, government production controls or price in the previous period. A shift of the supply curve in Figure 4 might result from either of these factors, or be caused by a change in the target price for the commodity. TP and LR are the target price and loan rate respectively in Figure 4. As drawn in this graph, the intersection of the long run supply curve (Slr) and the target price determines the quantity produced. The production response to TP in Figure 4 is illustrated as falling from S to S'.

Figures 5 and 6 illustrate changes in domestic demand. The demand function in Figure 5 is simply an aggregate of individual demands in the U.S. economy. This demand is derived from consumer utility maximization subject to a budget constraint and is therefore a function of, among other things, the price of the commodity, all other prices, and the nation's income. Shifts in the demand curve result from changes in factors other than the commodity price. An increase in demand possibly resulting from an increase in the price of substitutes (D to D') is illustrated in Figure 5. In Figure 6, the negatively sloped portion of the demand curve is a function of the same variables as the curve in Figure 5, but the totally elastic portion of this curve is a function of government policy, namely the U.S. loan rate to farmers. Changes in the loan rate shift this portion of the curve. A decrease in demand resulting from a drop in the loan rate is illustrated in Figure 6.

Shifts in the domestic supply and demand functions bring about shifts in the excess supply curve in the world market. Excess supply is zero at the equilibrium price of the exporting country. Changes in the domestic equilibrium price will change the intercept of the excess supply function. Other things being equal, this will change the trade volume (X to X') for the commodity as is shown in Figures 7 and 8. Consequently, shifts in excess supply can be traced to changes in the exporter's economy which shift the domestic supply and demand curves. The excess supply shifts in Figures 7 and 8 correspond to the demand shifts in Figures 5 and 6 respectively.

The excess demand function is the same in Figures 1, 2, 7 and 8. It can be thought of as the demand above the domestic price in a single importing country, or the aggregate of such excess demands in a group of countries (the rest of the world or a subset of the rest of the world). As was pointed out above, estimating excess demand is of central importance to many of the previous studies of agricultural trade.

The internal situation in the importing country or countries is shown in Figure 9. As in the exporting country case (Figure 3), shifts in the supply curve from period to period are a function of variables such as weather, price in the previous period and government policy. The demand function is derived from the solution to consumer's utility maximization problem subject to a budget constraint, and is therefore a function of the commodity price, the price of all other goods, and individual incomes. Importer demand shifts when these other prices and when income changes.

Shifts in the importers' supply and demand functions bring about shifts in the excess demand curve of the world market. Changes in the domestic equilibrium price will change the intercept of the excess demand function. Other things being equal, this will change the trade volume for the commodity. A fall in the domestic price is illustrated in Figures 10 and 11. In both cases the shift in excess demand results in an equilibrium trade volume (X') which is less than that traded before the importing country shock occurred.

Theory would indicate that own price increases will have a negative effect on the import quantity demanded of an ordinary commodity. Increases in the price of substitutes for the commodity, all else being equal, should shift demand toward the commodity. If the commodity is a normal good, an increase in importer income should increase demand. If the commodity is inferior, an increase in income will decrease demand.

A devaluation of the dollar, which has been the case since early 1985, is depicted in Figure 12. The price in the world market is in U.S. dollars. A depreciation of the dollar will allow each unit of the importer's currency to buy more dollars and therefore more U.S. commodity. The greater the price, the greater the devaluation's impact on foreign currency buying power, thus the rotation of importer excess demand. In Figure 12, the U.S. is assumed to be the sole exporter. If there were competing exporters with currencies independent of the dollar, the excess supply curve would also rotate. The devaluation illustrates an increase in trade from X to X'.

Exchange Regimes

The exchange rate regime of the country or countries importing U.S. commodities has yet to be considered in models of export demand and agricultural trade. When the exchange rate variable is included in a model of trade, the price and income effects of exchange rates are accounted for, but the model implicitly assumes that economic agents under different regimes act uniformly in their demand for a commodity. As Henneberry (1985) has pointed out, import buyers in countries with pegged exchange rates face less short term price fluctuation but greater risk of unexpected revaluation in the long run. The resulting market instability means that agents dealing with pegged exchange rates may shift demand away from imports and toward domestic production or domestic substitutes in order to avoid this instability. This is especially relevant when considering that it may be six months between the time a sale is negotiated and the actual payment and delivery are completed.

A closer examination of the conditions to which import buyers are exposed because of exchange regime may reveal behavioral distortions. The examination will focus on the distinctions between buyers with a floating exchange rate and buyers whose currency is pegged. Figure 13 illustrates the relationship between two currencies that might occur over a certain time period. Two relationships are graphed, one indicating the relative market value of the currencies if they were allowed to 'float', and the other graph indicating the relationship if the importer fixed the exchange rate with respect to the exporter's currency. The exchange rates are shown to be equal under both regimes at certain times (where the lines intersect). Two substantial devaluations of the importer currency are also shown on the pegged graph.

Figure 13 contains a graph of a pegged exchange rate over time when the importer's currency is pegged to that of the exporter. Figure 14 illustrates a pegged exchange rate relationship when the peg is not to the exporter's currency. In this case, during the periods between devaluations, the graph (curving line) reflects the relationship between the exporter's currency and the peg currency (i.e. SDR, French Franc, etc. with respect to the dollar). The effects are the same as those in Figure 13 near a time of devaluation. At time t_1 in both Figures the pegged regime importer's currency is overvalued. Then comes a drastic devaluation where price and income effects are massive, and at time t_2, the importer currency is undervalued. Figure 14 serves to illustrate that the relationships discussed below are representative of any situation where exchange rates are pegged, and not just the case where the importer currency is pegged to the dollar.

Contrasting the price effects on imports will point to possible distortions in the behavior of buyers from one regime with respect to buyers from another. In Figure 13 the pegged import buyer is in a more favorable position at point A (time t_1) than the buyer with a floating currency at A'. The degree of over-valuation of the pegged currency at that point is reflected in the distance between A and A'. Since the pegged currency is over-valued, it will buy more of the exporter's currency, and consequently, more of the exporter's commodities for a given unit of pegged currency. This is like a price break on the commodities and demand would be shifted toward imports at point A. If over-valuation is apparent to the importing country buyers, and a devaluation is expected, this knowledge may be an additional motivation to buy while the price is low. At a later time corresponding to B and B', it can be seen that the pegged currency is under-valued when compared with the market or floating rate. At this time, pegged regime buyers would be discouraged from importing. At time t_2 the price of the exporter's currency is unusually high and there are no bargains in imports as long as the pegged currency is under-valued.

The net effect of these types of pegged exchange rate distortions on buying behavior depends mostly on the length of these periods and the magnitude of over- and under-valuation.

Another contrast between the two regimes that may have even more impact on the behavior of buyers, is the risk to which they are exposed, especially considering the nature of sales of traded commodities. International grain transactions are usually a matter of long-standing relationships between traders and trading countries, and of contracts which are negotiated months in advance of shipment and delivery. Although floating exchange rates do fluctuate, the changes are far more gradual than the revaluations of pegged regimes (Figure 13). A gradual adjustment in exchange rates allows for gradual adjustments in contractual arrangements. Abrupt adjustments mean contractual risk in buying and additional expense in shifting to different sources for import commodities. This is where an important behavioral distortion may occur. If it is more expensive and risky to buy foreign commodities, the importing countries will shift demand away from imports and toward domestic production. Such a shift in demand is probably the major overall effect that pegged exchange rates have on trade.

These conclusions have some support in the work of previous studies. Juster and Wachtel in a 1972 study found that price uncertainty during periods of inflation, whether anticipated or unanticipated, led consumers to buy less. Simple price uncertainty was shown to diminish demand. Import buyers are consumers of traded commodities and can face extreme price uncertainty when revaluations periodically occur.

Chambers and Just in their 1979 paper make an even greater case for sensitivity to exchange rate changes.

> . . . there is further reason to believe that exchange movements should be differentiated from market price movements. Orcutt, in a classic paper, has hypothesized that economic agents react more quickly to exchange rate fluctuations than to market price changes in a world characterized by fixed exchange rates (pegged). When exchange rates are inflexible, consumers perceive a devaluation or revaluation as being more permanent than short-term price changes. Also, in this case, exchange rate movements usually involve much larger percentage changes than market price fluctuations taking place in a similar short time interval. On the basis of these two points, it would not be surprising if adjustment to exchange rate changes in a fixed rate system was faster than to market price changes.

Chambers and Just's claim of increased sensitivity to exchange rate fluctuations in fixed or pegged systems, would lead to the conclusion that buyers will also avoid exchange rate risk to an even greater extent than simple price risk.

If the exchange rate regime does in fact make a difference in the behavior of buyers of U.S. export commodities, the demand functions for a good should vary depending on the regime under which purchases of that good were made. As was pointed out above, it should make no difference to which medium the currency is pegged.

If the theorized shift in demand away from imports among pegged exchange rate importers is significant, estimates of models which distinguish between regimes will be different than those which do not. In addition, comparisons of pegged and floating importers will reveal an insensitivity to those variables which normally cause import demand to increase. Price and exchange rate changes, for instance, can be expected to have less of an effect on demand for U.S. grain among pegged importers. These deductive conclusions or hypotheses concerning the effects of government exchange regime decisions will be empirically tested in the next chapter.

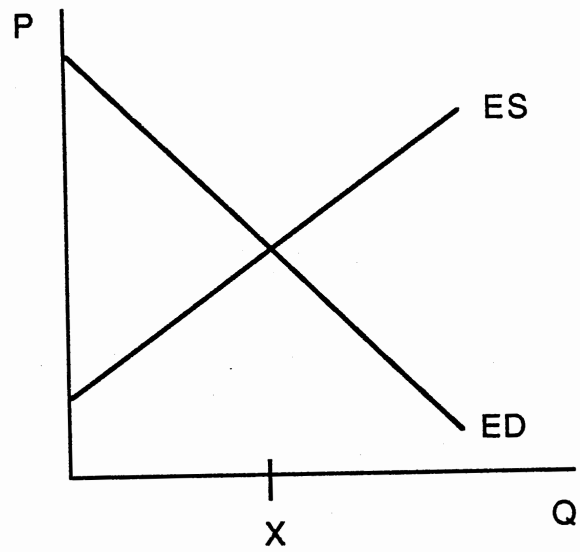

Figure 1. World Trade 1970's

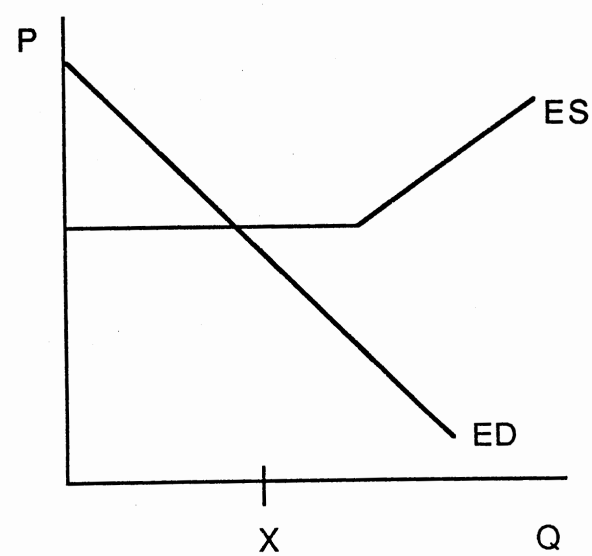

Figure 2. World Trade 1980's

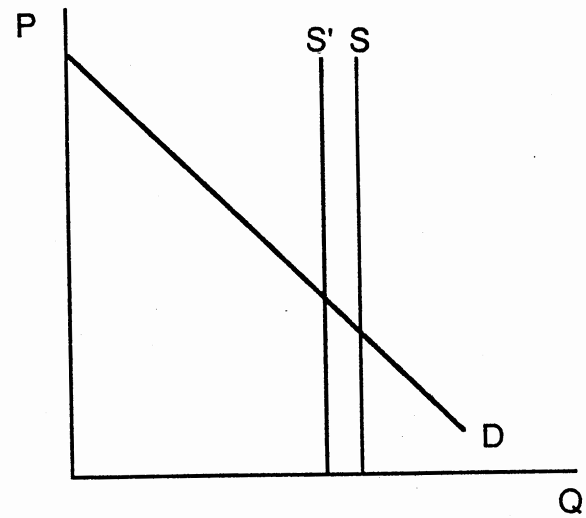

Figure 3. U.S. Agriculture 1970's

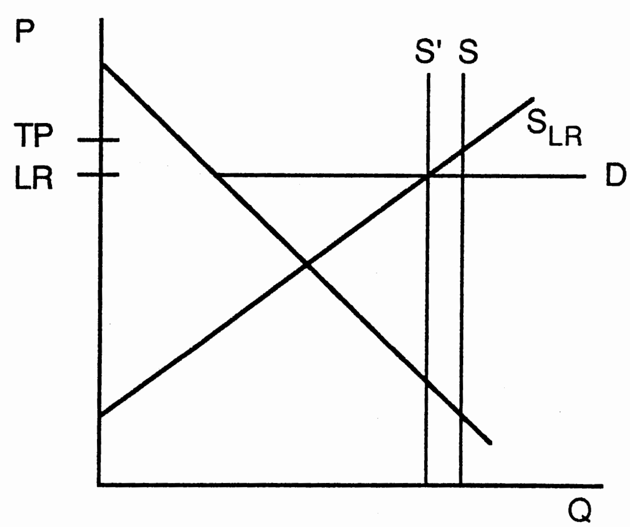

Figure 4. U.S. Agriculture 1980's

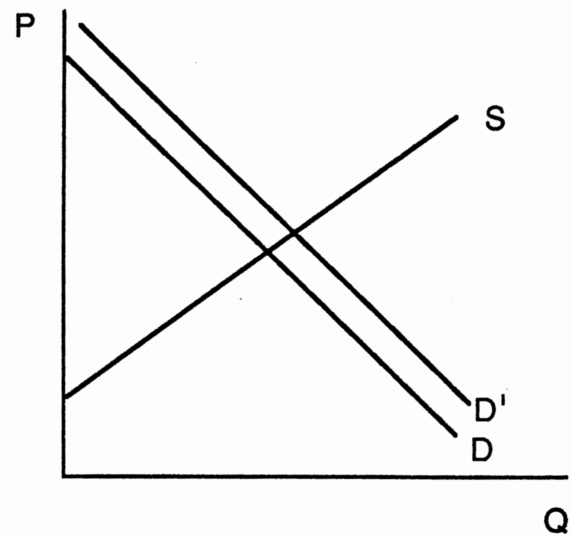

Figure 5. U.S. Demand Shift 1970's

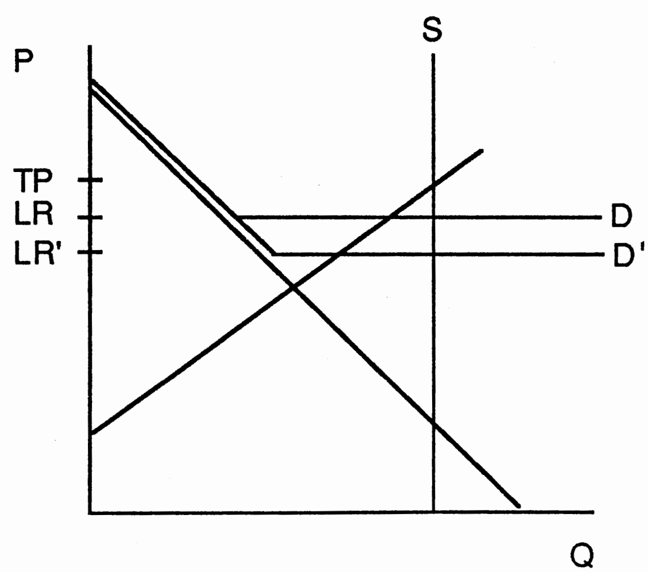

Figure 6. U.S. Demand Shift 1980's

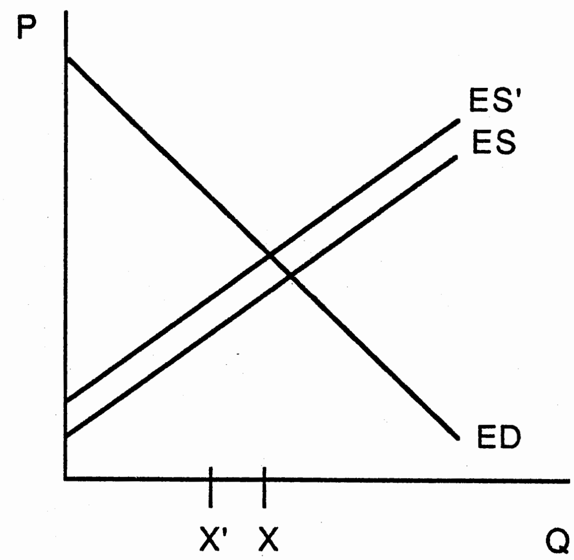

Figure 7. World Excess Supply Shift 1970's

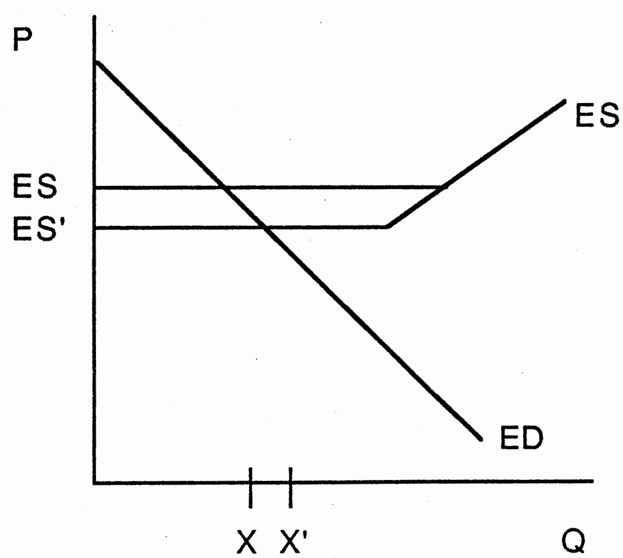

Figure 8. World Excess Supply Shift 1980's

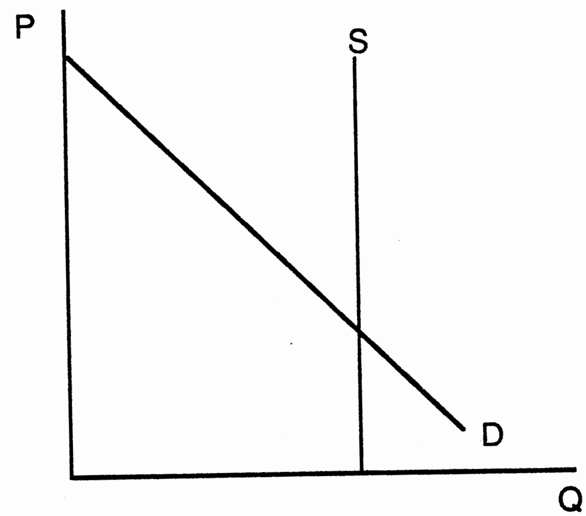

Figure 9. Importer Supply Shift

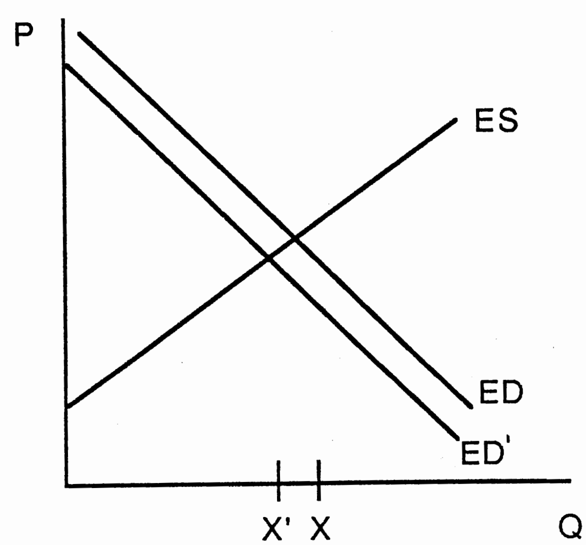

Figure 10. World Excess Demand
Shift 1970's

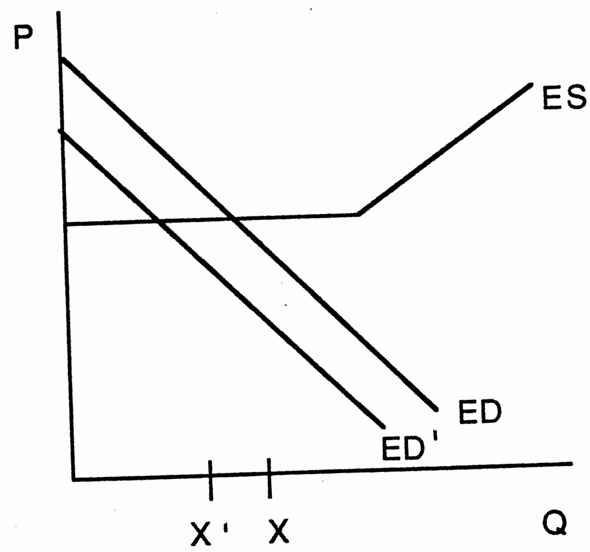

Figure 11. World Excess Demand
Shift 1980's

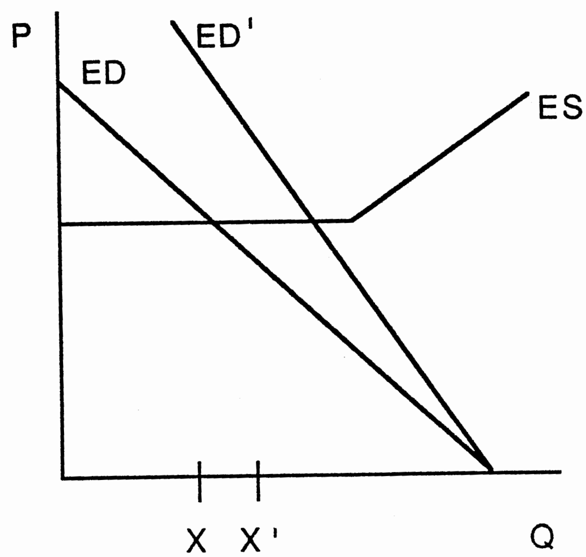

Figure 12. U.S. Currency Devaluation

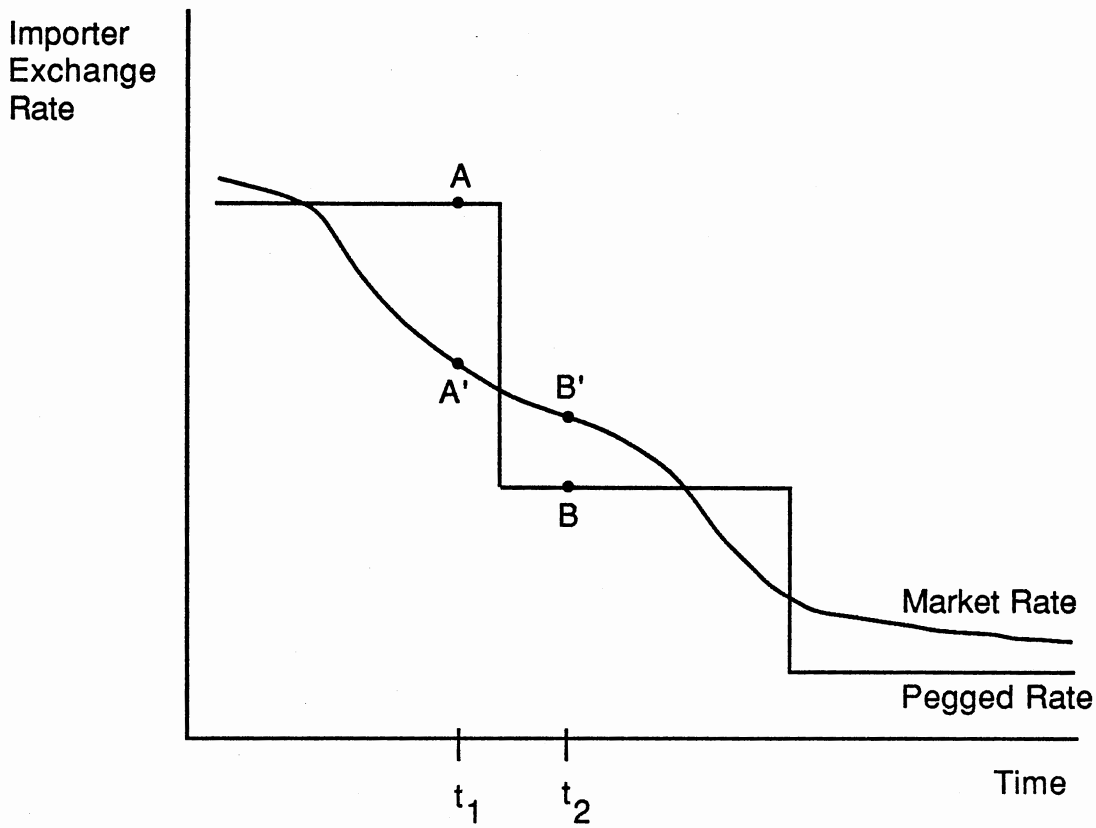

Figure 13. Pegged and Floating Exchange Rate Behavior

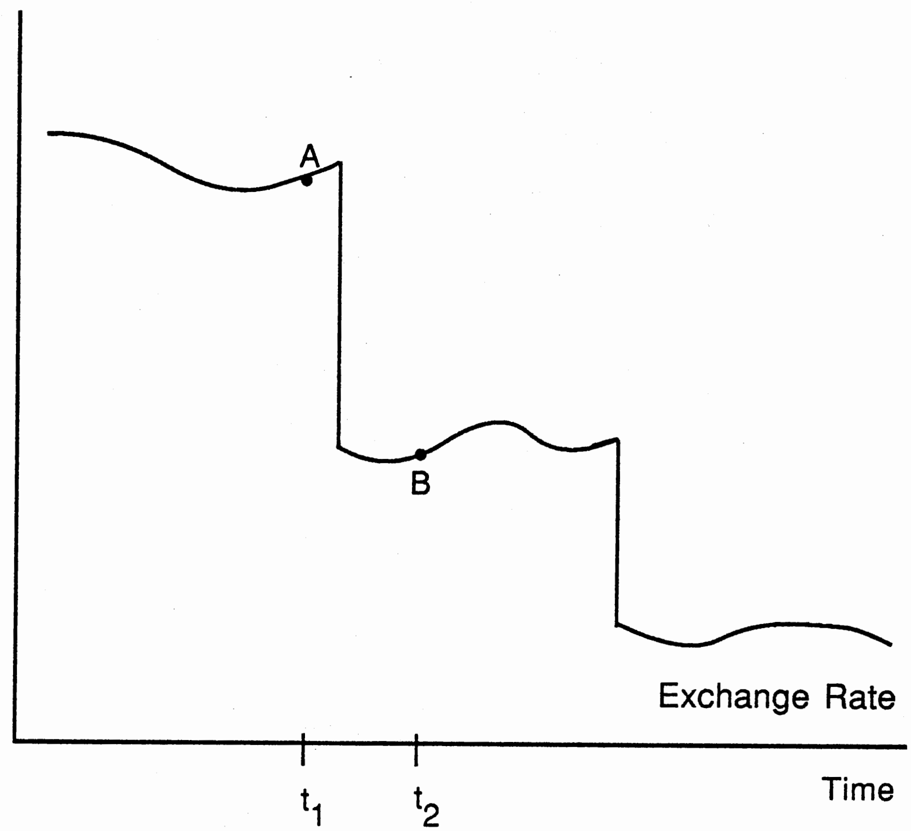

Figure 14. Devaluation and a Third Currency Peg

CHAPTER IV

METHODOLOGY AND DATA

The problem was stated in Chapter I in the form of the question, Do government policies with respect to foreign exchange market structure affect imports of U.S. grains? This study uses an experimentalist or econometric methodology which integrates deductive theorizing with inductive testing. The theory justifying inclusion of an exchange regime variable in a model of U.S. agricultural exports was developed in Chapter III. The present chapter (IV) specifies those conclusions in a model which can be estimated empirically. The purpose of the model specification is to enable a testing of the theory using statistical inference.

In this study, U.S. food and feed grain exports are modeled as a function of a deflated U.S. export price, the trade-weighted real exchange rate, a trade-weighted income variable for the importing countries and a one period lag of the dependant variable. The price variable is the value of exports divided by the volume. This unit value is deflated by the U.S. consumer price index. In mathematical terms, the single equation export model is,

$X_t = f(P/CPIus, RERtw, GDP/CPIim, X_{t-1})$, or, using less complicated variables,

$$X_t = \alpha + \beta_1 P_t + \beta_2 ER_t + \beta_3 Y_t + \beta_4 X_{t-1} + U_t \qquad (1)$$

where P/CPI is the U.S. export price (unit value) divided by the U.S. consumer price index, RER is the trade-weighted real exchange rate index, and GDP/CPI is the trade-weighted gross domestic product index over the consumer price index for the importing countries and X_{t-1} is the previous period export volume. Ut is the error term. A further discussion of the selection of independent variables for inclusion in the model is in the Conclusions Chapter (VI).

Trade-weighting the exchange rate and income variables involves combining the data from each importing country according to the proportion of the total exports purchased by a country. The weight for a particular country is its import volume divided by the total imports of all countries in that period. This weighting factor is multiplied times the country's exchange rate and income values and the product added to the weighted values from all other countries. Consequently, a country's contribution to the variable value in any period depends on its contribution to the dependent variable. A detailed discussion of the formulation of data for the study is contained in Appendix A.

The one period lag of export volumes takes into consideration the institutional setting of trade between countries. Contractual obligations and negotiated agreements between trading partners may prevent buyers from switching to alternative sources of grain in one period. This setting is an a priori reason for structuring a model so that it conforms to the partial adjustment theory of demand behavior. Precedent has been set in this regard by the specifications of Konandreas, Bushnell and Green (1978) and Chambers and Just (1981). Partial adjustment theory, as outlined by Kennedy (1985), claims that for every set of conditions which an importer of grains faces, there is a desired level of grain which the buyer would import. In terms of the above model, for every combination of price, exchange rate, and domestic income there is a desired level of grain imports. When viewed from an export demand perspective, the combination of exogenous variables produces a desired level of exports of U.S. grain (X^*). According to the partial adjustment theory, if inertia, imperfect information and rigidity are taken into account, the desired level of exports will not be the actual level for that period. This is the case because of buying habits on the part of importers. In addition, importers are never certain whether recent changes in these independent variables are temporary or permanent. Most importantly, contractual arrangements and trade agreements are not quickly or easily changed on the basis of price, exchange rate or income shifts.

Partial adjustment theory claims that actual exports, or the observed X, is some constant proportion of the difference between the present and the desired export volume. The cost of rapid adjustment brings about this proportional behavior. Expressed mathematically,

$X_t - X_{t-1}$ = actual adjustment, and

$X^*_t - X_{t-1}$ = desired adjustment,

where X^*_t is the desired level of exports considering the exogenous conditions in time t. If σ is the coefficient of adjustment, representing the proportion of change made toward the desired level of exports, the relationship between actual and desired adjustments is

$$X_t - X_{t-1} = \sigma(X^*_t - X_{t-1}).$$

The desired volume of exports (X^*) is not known, but σ 's value can be determined. According to partial adjustment theory, the export model is,

$$X_t = \sigma\alpha + \sigma\beta_1 P_t + \sigma\beta_2 ER_t + \sigma\beta_3 Y_t + (1-\sigma) X_{t-1} + \sigma U_t.$$

Since the coefficient of the lagged dependent variable is $(1-\sigma)$, σ is easily calculated. If the coefficient of adjustment is one, the desired level of exports is achieved in one observation period. Adjustment to the independent variable values is instantaneous. If the coefficient of adjustment is zero, no adjustment toward the desired level is made. The independent variable values are ignored and buying behavior focuses on last period's volumes.

The export demand model with a lagged dependent variable (X_{t-1} as a regressor) is an autoregressive equation. Autoregressive models violate the stochastic regressor assumption of classical linear regression. The noncontemporaneous correlation between the lagged dependent variable and the disturbance terms results in biased coefficient estimators in an ordinary least squares (OLS) output. The OLS coefficients are consistent and, since there is little that can be done in small samples to correct the problem, they are normally adopted as the most appropriate estimators (Kennedy, 1985).

Equation (1) above is referred to as the restricted model in this study. It does not include any variables to account for differences in exchange rate regimes. Exchange rate regime will be included as a qualitative variable like gender or season, rather than a continuous variable like price. The reason for including exchange rate as a qualitative or discontinuous variable is that the exchange regime of countries is categorized by the International Monetary Fund (IMF) as pegged, managed or floating. If the actual degree of control over the exchange market were reported, then a continuous variable could be used. Using IMF data necessitates discontinuous values which can be included in an export model by using dummy variables. Since the dummy variables account for the exchange regime of a group of importers, their inclusion changes equation (1) to the unrestricted model.

In structuring the observations for an unrestricted model, variables can be considered for different groups of countries depending on the exchange rate regime specified in those countries. Consequently, the data for any one period (year) were broken into three parts, one for those countries with managed exchange rates, one for those countries with floating exchange rates and one for the countries with pegged exchange rates. In this way each year has three observations. This is similar to previous studies where export flows were broken down into several regions of the world. Here we have three groups of countries, each with a common regime. The Konandreas, Bushnell and Green (1978) model grouped countries according to region.

In the restricted model shown above, all observations were included in the estimation without regard to the group to which they belong. Estimates of the parameter coefficients and other information such as the error sum of squares can be obtained using ordinary least squares (OLS). The error sum of squares (sum of squared residuals) for the restricted model (ESSr) is important to this study. The error sum of squares is used in the statistical inference.

The actual inclusion of exchange rate regime variables completes the model to be estimated. The equation which accounts for changes in exports depending on exchange rate regime is referred to as the unrestricted model. Because regime is a qualitative variable, dummy variables are used to account for changes in regime among the regressors. The unrestricted model is presented in mathematical form below:

$$X = \alpha + \beta_1 D_1 + \beta_2 D_3 + \beta_3 P + \beta_4 ER + \beta_5 Y + \beta_6 XL + \beta_7 P^*D_1 + \beta_8 P^*D_3 \\ + \beta_9 ER^*D_1 + \beta_{10} ER^*D_3 + \beta_{11} Y^*D_1 + \beta_{12} Y^*D_3 + \beta_{13} XL^*D_1 \\ + \beta_{14} XL^*D_3 + U_t ,$$

where the continuous regressors are as defined in the restricted model and the D-variables are zero-one dummy regressors. XL is the one period lag of the dependant variable. D_1 was one if the observation is from a group of managed regime countries, and zero otherwise. D_2 was one if the observation is from a group of floating regime countries and zero otherwise. And D_3 was one if the observation is from a group of pegged regime countries and zero otherwise. It will be noted that the D_2 dummy variable has been dropped from the equation, which is the usual practice to avoid perfect multicollinearity (the dummy variable trap).

The dummy variables act to include and eliminate appropriate independent variables in the model depending on the exchange rate regime associated with that observation. The intercept as well as the slope of the regression function will vary with the respective regime. Slope in this discussion refers to changes in the dependant variable with respect to an individual explanatory variable, all other variables held constant. The intercept of the function associated with floating regime countries is α. The intercept of the export function associated with managed regimes is $\alpha+\beta_1$. The intercept of the function associated with pegged regimes is $\alpha+\beta_2$. The slope coefficient of the real exchange rate regressor for countries with floating exchange rate regimes is β_4. The slope parameter of the ER term in the function associated with pegged regimes is $\beta_4+\beta_{10}$. The slope parameter of the ER variable associated with managed regimes is $\beta_4+\beta_9$. The slopes of the other regressors with respect to the different regimes are calculated in a similar manner. Likewise, estimates of these parameters are calculated from the $\hat{\beta}$ and $\hat{\alpha}$ coefficients of the OLS output. Estimation of the unrestricted model yields an error sum of squares (ESSu) as the estimation of the restricted model did.

The inclusion of a discontinuous exchange rate variable in the model of agricultural exports is now complete. The error sum of squares from the estimation of this unrestricted model will be compared with the error sum of squares from an estimation of the model which does not include a regime variable (restricted model) in calculating an F statistic. This inference procedure was developed by Chow (1960) and is further outlined below. If this study was dealing with a continuous regime regressor, the t statistic of the estimated coefficient on that variable would allow an inference with a given level of probability as to the impact of regimes on trade. The F statistic allows the same type of inference to be made regarding the discontinuous variable. The hypotheses about the discontinuous regime variable are similar to those of a continuous variable as well, only an F statistic is used, and instead of the null hypothesis concluding the coefficient is zero, the null conclusion would be that there is no significant difference in the restricted and unrestricted estimations. Stated quantitatively,

$$H_o: F = 0 \qquad\qquad H\alpha: F > 0,$$

where H_o is the null hypothesis, $H\alpha$ is the alternative hypothesis and F is the true population parameter. If H_o is concluded, the regime should not be considered a part of the export model. If we fail to reject the alternative hypothesis, regime may be considered part of the model. Statistical inference permits an estimation of the risk (the probability) of being wrong in failing to reject the alternative hypothesis (type I error).

The test to compare the statistical similarity between regressions was developed and reported by Chow in 1960. It is often referred to as the Chow test of structural stability, because it measures the statistical similarity between structural regression equations. The Chow procedure is further illuminated by Maddala (1977) and Ray (1988). The F^* statistic is calculated by taking the difference between the ESSu and the ESSr, dividing this difference by the number of restrictions imposed by the restricted model, and dividing that quotient by the estimated variance of the unrestricted model (S^2). The number of restrictions imposed by the model is the number of regressors in the unrestricted model minus the number in the restricted model (which is ten in this case). In formula notation,

$$F^* = \frac{(ESSr - ESSu)/10}{S^2}$$

Conclusions concerning the structural stability test are made by comparing F^* with a table F value at the appropriate level of statistical significance. The F^* statistic measures the difference in explaining power of the two models. If there was not a significant difference in explaining power, F^* would not be significantly different than zero and the null hypothesis can not be rejected.

The Chow test of structural stability can also be conducted without the use of the dummy variable equation described above. The observations for each of the regimes can be grouped and estimated separately using the same structural form (regressors) as the restricted model. In this method the restricted model is identical to equation (1) above, but the unrestricted model is the set of three estimations of export equations for the different regimes. The ESSu value is the sum of the error sum of squares from all three unrestricted estimations.

Economic theory does not dictate the functional form that an export model should take, and the structural models were estimated using various functional forms. The functional form with the best fit (highest R^2) was selected for the test and for parameter estimations.

Annual data for the dependent variable and the price variable were gathered from the USDA's Foreign Agricultural Trade of the United States and Situation and Outlook Yearbooks for wheat and feeds. In addition, data for the trade weighted real exchange rate and importer income variables were collected from the IMF's International Financial Statistics. The dependent variable, export volume from the U.S. to a particular importing country, includes both food and feed grain exports. All data were gathered by country, trade weighted and then grouped according to exchange rate regime. Appendix 1 includes a detailed description of the data collection and aggregation from the above sources, as well as a table of the data sets used to run the regressions.

CHAPTER V

RESULTS

Although the several variations of natural logarithmic and semi-logarithmic functional forms were tried, they proved to be no better in predicting food and feed grain exports than the linear form. Consequently, the results reported below are based on the linear data sets given in Appendix B.

Results of the ordinary least squares (OLS) regression of U.S. grain exports on U.S. grain prices, trade weighted real exchange rate, trade weighted importer income and the last period's exports for the restricted model are reported in Table II. The restricted regression uses the fifteen observations (1972-86) from each regime group without distinguishing as to exchange regime. All forty-five observations are used in estimating the restricted equation.

The OLS results for individual regime groups are also reported in Table II. The three group equations are estimated using only the fifteen yearly observations for that particular group. The t* statistics given below the coefficient estimators in parentheses allow the comparison with table values which test the hypothesis that the coefficient is equal to zero. The table t values for the regressions are also given. If the t* does not equal or exceed the table value, the null hypothesis that a coefficient is zero and the variable does not impact the independent variable cannot be rejected. Inspection of the four outputs reveals that of the theoretical explanatory variables, the exchange rate regressor is negative in three of the four regressions (restricted, managed and

TABLE II

OLS ESTIMATES OF THE RESTRICTED AND REGIME GROUP EQUATIONS

RESTRICTED

$$X = 8141508 - 961349\ P - 14487\ ER - 50578\ Y + 1.0\ XL \qquad R^2 = .96$$

(1.80) (-1.13) (-0.63) (-1.99) (30.83) t* stats

VALUE OF t, df = 40

1-tail t (α=.05) = 1.68

MANAGED REGIMES

$$X = 6793307 + 441666\ P - 41881\ ER + 7516\ Y + 0.22\ XL \qquad R^2 = .56$$

(1.61) (0.54) (-1.71) (0.18) (0.86)

FLOATING REGIMES

$$X = 34309803 - 3667638\ P - 119603\ ER - 159897\ Y + 1.03\ XL$$

(2.99) (-1.75) (-2.09) (-1.73) (4.75) $R^2 = .87$

PEGGED REGIMES

$$X = 11568907 + 301053\ P + 8419\ ER - 93235\ Y + 0.16\ XL$$

(1.29) (0.32) (0.18) (-2.39) (0.53) $R^2 = .82$

VALUE OF t , df = 10

1-tail t (α =.05) = 1.81

1-tail t (α.=.10) = 1.36

floating) and positive but insignificant in the pegged. The importer income regressor is significant and negative in all but one equation. The price variable is significant only in the case of floating regimes. The lagged export volume is positive in all equations. R^2 is defined as the proportion of the variation in the dependant variable, grain exports, explained by the regressors other than the intercept variable. Compared to most previous work, the R^2 is very high in the restricted and the individual regime equations.

Table III summarizes the signs of the estimated coefficients and their significance for the restricted equation and the equations of the three regime groups. An asterisk next to a plus or minus sign in Table III indicates that the variable coefficient has a significant t statistic.

The lack of significance of the price variable and the negative sign on the importer income term are results that are worthy of some comment. According to the data used in this estimation, only in the case of floating regime countries does deflated U.S. price of grain significantly influence demand. Such results may be due in part to the structure of world markets where the U.S. is a supplier of last resort. Bilateral trade agreements between the U.S. and grain importers, and large volumes of U.S. concessional sales may also contribute to these results. Mixed results on price coefficient estimators is not uncommon in previous studies (Konandreas, Bushnell and Green, and Childs and Hammig).

From the signs of the income coefficient estimators it appears that U.S. grain may be an inferior good. An increase in affluence may result in a shift toward animal protein and away from grains. Another explanation may be that a drop in national income in highly agrarian countries could be the result of crop failures and result in larger imports of foreign grain. In either case, U.S. grain imports would be an inferior good. The single equation wheat export model estimated by Konandreas, Bushnell and Green (1978) also exhibited negative

TABLE III

SIGNS AND SIGNIFICANCE OF
ESTIMATED COEFFICIENTS

	ESTIMATED COEFFICIENT SIGN			
EQUATION	P	ER	Y	XL
Restricted	-	-	-*	+*
Managed Regimes	+	-*	+	+
Floating Regimes	-*	-*	-*	+*
Pegged Regimes	+	+	-*	+

and significant importer income coefficients. It should be pointed out that Konandreas, Bushnell and Green in their 1978 estimation reported coefficient inconsistencies with a priori expectations, to include the coefficient of the lagged dependant variable term (page 44).

Although these equations offer some interesting insights into the classification of U.S. commodities and the strength of the exchange rate term, it is not the purpose of this study to add to the debate over the importance of the exchange rate variable in explaining agricultural exports. The purpose of the statistical analysis is to estimate the significance of exchange rate regimes in explaining exports. Specifically, the study tests the hypothesis that there is no statistically significant difference in the explanatory power of export demand equations when the exchange rate regime is included in the model. In order to compute the F^* statistic needed for the test, the error sum of squares (ESS) from the restricted equation and the total error sum of squares from the three regime equations are used (Chapter IV). The total ESS of the three regime equations can also be found by running a regression using all forty-five observations and dummy variables to differentiate between regime groups, as was described in the last chapter. By estimating this unrestricted dummy variable model, the full effect of including the different regimes can be estimated, and these results compared with those of the restricted equation.

The results of the OLS estimation on the unrestricted model are reported in Table IV. The data sets for this equation as well as those of the individual regime observations are given in Table VI and Table VII in Appendix B. The high R^2 gives some indication of the magnitude of the explaining power of the unrestricted model when all regimes are considered together.

TABLE IV

ESTIMATION OF THE UNRESTRICTED EQUATION

UNRESTRICTED

$$X = 34309803 \underset{(4.17)}{} - \underset{(-2.63)}{27516495\ D1} - \underset{(-1.63)}{22740896\ D3} - \underset{(-2.44)}{3667638\ P} - \underset{(-2.92)}{119603\ ER}$$

$$- \underset{(-2.42)}{159897\ Y} + \underset{(6.62)}{1.03\ XL} + \underset{(2.11)}{4109304\ P{*}D1} + \underset{(2.09)}{3968691\ P{*}D3}$$

$$+ \underset{(1.40)}{77722\ ER{*}D1} + \underset{(1.83)}{128023\ ER{*}D3} + \underset{(1.84)}{167412\ Y{*}D1} + \underset{(0.81)}{66663\ Y{*}D3}$$

$$- \underset{(-1.94)}{0.82\ XL{*}D1} - \underset{(-2.15)}{0.88\ XL{*}D3}$$

$R^2 = .98$

$d_{DW} = 2.33$

VALUE FOR t, df = 30

1-tail t (α=.05) = 1.70

CHAPTER VI

CONCLUSIONS

The conclusions of this study are based on the comparison of the estimated F* statistic and a table F value. An F table, with the appropriate numerator and denominator degrees of freedom, gives critical values for the F statistic. These values allow an estimate of the probability or risk of concluding that the true F is greater than zero when in fact it is equal to zero (type I error). In the case of this study, F* measures the difference in explaining power of the model when exchange regimes are included and when the regime variable is excluded from the model. According to Chow (1960), when F* is significantly greater than zero there is a difference, and the statistical test confirms the deductive conclusion about exchange regimes. Stated in terms of the hypothesis, if F* were greater than the critical table value, the study fails to reject the alternative hypothesis that F is greater than zero.

Type I error is the probability of being wrong in failing to reject the alternative hypothesis and is referred to in statistical tables as the α value. An optimal α value can be calculated using a loss function, but this study conforms to the customary practice of selecting an arbitrary α value. Conclusions with regard to the true F statistic constitute the final step in the induction process. Statistical inference has been used to test the theoretical conclusions of Chapter III.

The table F value for ten and thirty degrees of freedom and an α of .05 is 2.16. Estimation of the linear functional form produced large error sums of squares in this case. The ESS for the restricted equation is 1.66 E+14 (166,000,000,000,000). The ESS for the unrestricted model is 8.76 E+13. The calculated F* is arrived at from

$$F^* = \frac{(ESSr - ESSu)/10}{S^2} = 2.68$$

which when compared with the table value of 2.16, is significant at the .95 level of confidence.

The magnitude of the calculated F* statistic leads to a failure to reject the alternative hypothesis, and a conclusion that there is a significant difference in the structural export equations when countries are grouped according to exchange rate regime. This confirms the theoretical inclusion of an exchange regime regressor in the model of U.S. grain exports. Statistical inference allows the qualification that this conclusion has a 5% or less probability of being wrong. (There is a 5% chance that the true F is equal to zero, and therefore, that there is no difference in the models.)

Given that there is a significant difference when countries are grouped and equations are allowed to vary on the basis of those groupings, can the study conclude at this point that this difference is due to exchange rate regimes? Might it be due to other characteristics common to the grouped countries? Are omitted variables causing variations in the dependant variable which are picked up by the dummy variables? How do the signs, magnitude and significance of estimated coefficients align with the theory of a shift in demand discussed in Chapter III?

Although the inference procedure has been followed and the results indicate a confirmation of the theory, the signs and significance of some coefficients reported in the previous chapter warrant a closer look at the data and its derivation.

After examination of the countries in each exchange group, the process of variable selection for inclusion in the basic model is reviewed in detail. According to Tweeten (1983), the practice of sequential experimentation with variables to enhance goodness of fit is a common empirical technique among agricultural economists, but its use is rarely reported when studies are published. This study reports the process.

Next, the magnitude of regressor coefficients are compared with the detail of deductive logic which concluded in Chapter III that pegged regime importers are less responsive to the advantages of trade in grains. These additional analyses constitute a further empirical testing of the theoretical conclusions.

Addressing the issue of additional common characteristics among regime groups, attention should be directed to Appendix A where the sampled importers are listed according to regime. It seems difficult to imagine any common characteristics other than exchange rate regime on the basis of these lists. One might speculate that pegged regime countries would have a high percentage of lesser developed countries and that developed countries would be common to the floating regimes. This is not the case, especially in the more recent groupings where the pegged list includes Austria, Finland, Norway, Sweden, and Israel, and the floating list includes Zambia, Pakistan, the Philippines, Chile, Columbia, Costa Rica, the Dominican Republic and Uruguay. Common characteristics based on affluence or economic development are not apparent.

The issue of omitted or misspecified variables is also a cause for investigation. The most basic model considered regressed grain exports on the price (unit value), the exchange rate and the importer income variable,

$$X = f(P, ER, Y)$$

To this basic equation were added a rest-of-world ending stocks variable (Qrow), a one period lag of the importer income, one, two, and three period lags of the exchange rate and the one period lag of exports (X_{t-1}). None of the additions improved the estimates or the consistency of the signs on the coefficients except for the lag of the dependant variable. When added to the basic equation, X_{t-1} improved the restricted R^2 from a .10 to .96. Its inclusion in the individual group equations improved their R^2 in every case, but not to so great a degree as in the restricted case. Although the model may be misspecified to some degree, this study uses or has tried nearly all variables included in past empirical research.

It seems unlikely that the model has omitted important variables. It is also apparent that the regime groups do not have other characteristics in common which would lead to significant differences in the estimated equations. If a comparison of the empirical results for the pegged and floating regimes confirms the theory of a shift in demand proposed in Chapter III, it would seem reasonable to conclude that the differences found by the Chow test were indeed due to exchange rate regime.

The discussion in Chapter III contrasted the gradual changes experienced when an importer's currency is floating with the dramatic changes which occur when the exchange rate is pegged and periodically revalued. The contractual risk involved and the findings of Juster and Wachtel (1972) and Chambers and Just (1979) led to the conclusion that the added risk and expense incurred by buyers importing grains under pegged exchange rates would distort demand. Specifically, buyers with the additional risk and expense of renegotiating contracts would shift their demand away from the imported grain. In order to confirm this theory, a comparison of empirically estimated equations for pegged and floating regimes should indicate less sensitivity to explanatory variables in the pegged regime estimates when compared with those of floating regime estimates. Variables such as price and exchange rate should be of lesser magnitude in explaining demand for imported grain the pegged equation.

Referring to the estimated equations for the pegged and floating regime countries reported in Table II, the R^2 s indicate that the equations are roughly equal in their explaining power. The coefficient of the price variable in the floating equation is negative and significant while the coefficient of the same regressor in the pegged equation is positive and insignificant. The coefficient of the exchange rate variable in the floating equation is negative and significant while the pegged coefficient is likewise positive and insignificant. The importer income coefficients are negative and significant in both equations but the coefficient in the pegged equation is smaller in absolute terms than that in the floating equation. The lagged export coefficient is positive and significant in the floating equation while this coefficient is smaller and insignificant in the pegged equation. The estimated coefficients in the managed regime equation fall between the pegged and floating regime coefficients as far as sign, magnitude and significance is concerned.

The empirical results indicate that the regressors used to specify this export demand model have less effect in determining demand in the pegged regime countries. This would indicate a shift in preference away from imported grain and tends to confirm the theoretical claims of Chapter III. More importantly for this chapter, the results of this comparison tend to confirm that the significant difference in structural equations between groups of countries in this model is due indeed to exchange rate regime.

Efforts should be made to further test and possibly extend the findings of this study. More recent data which reflect the current turn-around in U.S. grain exports may add valuable insights. Data which would re-group countries according to exchange regime on a yearly basis, rather than every five years, would tend to refine the estimations. Future models might attempt to assign a value to each country's exchange rate policy that reflects the degree of control over exchange rates exercised by the government. The discontinuous classifications of floating, managed and pegged would be eliminated and the exchange regime could be included as a continuous, quantitative variable. Such a specification would add a further degree of sophistication to the trade model. Estimating a regime variable coefficient would allow calculation institutional policy elasticities.

Pegged exchange rate policies and the resulting shift away from imports could mean that the countries which peg their currency subsidize domestic production to a greater extent than do countries with more market-oriented exchange policies. Empirical tests of this relationship may be a fruitful area for further research as well.

Shifts in demand away from import commodities by countries with pegged regimes should be of special interest to policy makers. Because of frequent revaluations of relatively large magnitude, importers which peg their currency burden themselves with additional risk and expense in their trade with other countries. In this way the pegging of a currency becomes a barrier to trade. The costs of such an institutional framework for exchanging currencies is born by both trading partners. The cost to the importing country of this policy should be estimated and considered by governments when deciding the degree of market influence over foreign exchange.

Lower commodity trade volume and world prices resulting from fixed exchange regimes hurts U.S. exporters and producers. If the relationships theorized in this study are confirmed by further tests, exchange rate regimes may become an issue of U.S. negotiations designed at reducing trade barriers.

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APPENDIXES

APPENDIX A

DETAILS OF DATA COLLECTION

Data on thirty-six buyers of U.S. grain were collected in the course of empirically testing whether exchange rate regimes have an impact on agricultural trade. The countries included in the test were selected on the basis of availability of national income and price data, as well as being purchasers of U.S. grain in the sample period 1972 to 1986. These countries are listed in Table V.

TABLE V

BUYERS OF U.S. GRAIN INCLUDED IN THE STUDY

Canada	Malaysia
Austrailia	Nepal
Japan	Pakistan
Austria	Philippines
Finland	Singapore
France	Thailand
Germany	Greece
Italy	Israel
Norway	Jordan
Sweeden	Saudi Arabia
Switzerland	Chile
United Kingdom	Columbia
Bunundi	Costa Rica
Malawi	Dominican Republic
South Africa	El Salvador
Zambia	Haiti
Bangladesh	Honduras
Korea	Uruguay

Grouped by regime for each period the countries are:

MANAGED (1983-86): Saudi Arabia, France, Germany, Italy.
FLOATING (1983-86): Canada, Australia, Japan, Switzerland, United Kingdom, South Africa, Zambia, Korea, Pakistan, Philippines, Greece, Chile, Columbia, Costa Rica, Dominican Republic, Uruguay.
PEGGED (1983-86): Austria, Finland, Norway, Sweden, Burundi, Malawi, Bangladesh, Malaysia, Nepal, Singapore, Thailand, Israel, Jordan, El Salvador, Haiti, Honduras.

MANAGED (1978-82): France, Germany, Italy.
FLOATING (1978-82): Austrailia, Canada, Japan, Switzerland, United Kingdom, South Africa, Korea, Philippines, Greece, Israel, Columbia, Uruguay, Saudi Arabia.
PEGGED (1978-82): Austria, Finland, Norway, Sweden, Burundi, Malawi, Zambia, Bangladesh, Maylaysia, Nepal, Pakistan, Singapore, Thailand, Jordan, Costa Rica, Dominican Republic, El Salvador, Haiti, Honduras, Chile.

MANAGED (1972-77): France, Germany, Norway, Sweden.
FLOATING (1972-77): Canada, Japan, Italy, Switzerland, United Kingdom, Philippines, Saudi Arabia.
PEGGED (1972-77): Austrailia, Austria, Finland, Burundi, Malawi, South Africa, Zambia, Bangladesh, Korea, Malaysia, Nepal, Pakistan, Singapore, Thailand, Greece, Israel, Chile, Columbia, Costa Rica, Dominican Republic, El Salvador, Haiti, Honduras, Uruguay, Jordan.

These countries represent from 32 to 46 percent of the total U.S. grain exports over the years sampled.

Grain export volumes by country of destination have a role in the computation of every variable of the model. The model is the same for all three regime groups:

$$X_t = \alpha + \beta_1 P_t + \beta_2 ER_{tw,t} + \beta_3 Y_{tw,t} + \beta_4 X_{t-1} + U_t \ ,$$

where X_t is the volume of U.S. grain exports to countries with a particular exchange regime in the t^{th} time period, α is the intercept coefficient and U_t is the error term for that time period (t = 1972, . . . , 1986). For years 1982 to 1986, export volumes by country of destination were read directly from the table values for Grains & Feeds in the calendar year supplement to the USDA Foreign Agricultural Trade of the United States (FATUS). Prior to 1982, the FATUS supplements did not report this Grains & Feeds aggregate and export volumes by country of destination were added for Wheat & Products, Rice, Feed Grains & Products and Blended Food Products. All volumes were quoted in metric tons (MT) except Blended Food Products prior to 1978 which were reported in thousands of pounds. These quantities were converted to MT units for the earlier years.

The value in dollars of these exports was obtained in a similar manner and used in the calculation of grain price variable, P. The unit value was calculated for each group by adding the value of exports to all countries in the group and then dividing by the volume (X_t). This unit value or price was then deflated by the U.S. consumer price index (CPI) from the country page of the IMF International Financial Statistics (IFS).

The exchange rate variable ER, as well as the group income variable Y are trade weighted. Each country's contribution to the group exchange rate and income values for a particular year were weighted according to the proportion of grain they bought relative to the total imported by the regime group. Thus, a weighting multiplier of the individual country volume divided by the group's total volume (X_i/X_t) was applied to the individual exchange rate and income values before adding to get the group data for that year.

Exchange rate information in terms of foreign currency per U.S. dollar was collected from the individual country pages of the IFS with line "rf" being preferred. Consumer price index data were also collected from individual country pages, line 64. In the absence of money illusion, only real exchange rates affect trade. For this reason, both currencies were deflated and a real exchange rate calculated. Since the exchange rate here is foreign currency divided by dollars (FCi/$), dividing both currencies by their respective CPI will deflate the exchange rate and yield the real exchange rate Q or ER. Simplified, this relationship is:

$$Q = ER = \text{Nominal Exchange Rate} * (\text{CPIus}/\text{CPIi}).$$

An index of the real exchange rate was then computed with 1980 as the base year. The CPIs were also based on 1980. This index was constructed by dividing the real exchange rate values by the 1980 value. The real exchange rate index was trade weighted and added to other country indices to form the exchange rate data set for a regime group as described above.

Deflated national income figures were gathered from the "GDP at Constant Prices" table in the front of the IFS. An income index with 1980 as the base year was constructed for these deflated figures. As with the exchange rate variable, the income index was trade weighted and added to other country indices to form the income data set for a regime group.

Individual country policies which determine the exchange rate regime were not static over the entire fifteen year period. Consequently, the country make up of the three exchange regime groups was allowed to change three times during the period covered by the empirical test. The first time period is from 1972 to 1977. The determination as to which group a country belongs during this period came from the classification of countries according to exchange regime made by the International Monetary Fund and published in their annual Report on Exchange Arrangements and Exchange Restrictions for 1976. The second period is from 1978 to 1982 and classification was made on the basis of the 1981 report. The most recent period is 1983 to 1986 with classification based on the 1986 report.

APPENDIX B

DATA

The data set for the individual exchange regime groups is in Table VI.

TABLE VI

REGIME GROUP DATA

X	P	ER	Y
MANAGED REGIMES			
3116121	0.860188	139.8662	105.7086
1757241	1.155322	159.2708	107.4366
2615626	1.775094	149.1054	105.3045
3174195	1.703337	139.9743	106.0678
3166837	1.314098	136.3028	103.5070
4386583	1.472412	124.7579	102.9983
4793542	1.411711	100	100
3831356	1.448779	99.32908	95.54662
5736392	1.469247	103.4131	92.82751
4442174	1.433203	106.4631	90.10048
7273695	1.813446	111.9145	85.31556
5136153	2.315275	107.6116	86.39324
3756872	2.463170	110.7000	85.59391
3566524	1.786634	110.3173	81.43303
2259940	1.241385	131.8497	77.67415

TABLE VI (Continued)

X	P	ER	Y
FLOATING REGIMES			
24030552	0.873134	104.6938	126.3399
26934168	1.024932	128.1693	120.8754
31156846	1.212592	122.5510	114.2654
29686471	1.248583	122.5297	109.9712
29316451	1.203712	116.5880	107.0281
30508557	1.572407	103.5650	102.7496
32116006	1.565229	100	100
28371963	1.694266	95.94637	94.75064
25019083	1.517086	93.85551	89.14334
20753894	1.478019	108.8488	86.77259
19074092	1.878182	116.5845	82.29509
16472410	2.222599	114.6132	81.30718
17063664	2.478527	118.0687	80.65711
20752122	1.786391	121.4297	74.81112
16297412	1.186413	132.3414	70.33379
PEGGED REGIMES			
3404480	0.937787	118.1820	115.9336
3074789	1.125081	122.4817	112.5312
3195840	1.148586	131.4707	116.6675
2285921	1.221075	121.6253	112.4552
2033179	1.259208	118.0751	111.4033
4078990	1.697733	104.7364	105.5547
4902112	1.785008	100	100

TABLE VI (Continued)

X	P	ER	Y
3018300	1.816571	103.8121	94.57023
4328677	1.673322	102.8412	87.50185
8756153	1.546885	101.3160	81.48656
8076149	2.040066	109.3535	74.77563
9059812	2.747561	111.8650	73.49075
7608612	3.014121	109.6010	68.81817
8772565	2.412355	118.4526	62.90498
7991540	1.477638	122.1810	58.80829

The data set for the restricted model was formed by stacking the three data sets for the regime groups on top of one another. The data set for the unrestricted dummy variable equation is given in Table VII. The fifteen variables (including exports but excluding the intercept regressor) are listed five at a time in the three sections of Table VII.

TABLE VII

UNRESTRICTED MODEL DATA

X	D1	D3	P	ER
3116121	1	0	0.860188	139.8662
1757241	1	0	1.155322	159.2708
2615626	1	0	1.775094	149.1054

TABLE VII (Continued)

X	D1	D3	P	ER
3174195	1	0	1.703337	139.9743
3166837	1	0	1.314098	136.3028
4386583	1	0	1.472412	124.7579
4793542	1	0	1.411711	100
3831356	1	0	1.448779	99.32908
5736392	1	0	1.469247	103.4131
4442174	1	0	1.433203	106.4631
7273695	1	0	1.813446	111.9145
5136153	1	0	2.315275	107.6116
3756872	1	0	2.463170	110.7000
3566524	1	0	1.786634	110.3173
2259940	1	0	1.241385	131.8497
24030552	0	0	0.873134	104.6938
26934168	0	0	1.024932	128.1693
31156846	0	0	1.21259	122.5510
29686471	0	0	1.248583	122.5297
29316451	0	0	1.203712	116.5880
30508557	0	0	1.572407	103.5650
32116006	0	0	1.565229	100
28371963	0	0	1.694266	95.94637
25019083	0	0	1.517086	93.85551
20753894	0	0	1.478019	108.8488
19074092	0	0	1.878182	116.5845
16472410	0	0	2.222599	114.6132

TABLE VII (Continued)

X	D1	D3	P	ER
17063664	0	0	2.478527	118.0687
20752122	0	0	1.786391	121.4297
16297412	0	0	1.186413	132.3414
3404480	0	1	0.937787	118.1820
3074789	0	1	1.125081	122.4817
3195840	0	1	1.148586	131.4707
2285921	0	1	1.221075	121.6253
2033179	0	1	1.259208	118.0751
4078990	0	1	1.697733	104.7364
4902112	0	1	1.785008	100
3018300	0	1	1.816571	103.8121
4328677	0	1	1.673322	102.8412
8756153	0	1	1.546885	101.3160
8076149	0	1	2.040066	109.3535
9059812	0	1	2.747561	111.8650
7608612	0	1	3.014121	109.6010
8772565	0	1	2.412355	118.4526
7991540	0	1	1.477638	122.1810

Y	Xt-1	P*D1	P*D3	ER*D1
105.7086	1757241	0.860188	0	139.8662
107.4366	2615626	1.155322	0	159.2708
105.3045	3174195	1.775094	0	149.1054

TABLE VII (Continued)

Y	Xt-1	P*D1	P*D3	ER*D1
106.0678	3166837	1.703337	0	139.9743
103.5070	4386583	1.314098	0	136.3028
102.9983	4793542	1.472412	0	124.7579
100	3831356	1.411711	0	100
95.54662	5736392	1.448779	0	99.32908
92.82751	4442174	1.469247	0	103.4131
90.10048	7273695	1.433203	0	106.4631
85.31556	5136153	1.813446	0	111.9145
86.39324	3756872	2.315275	0	107.6116
85.59391	3566524	2.463170	0	110.7000
81.43303	2259940	1.786634	0	110.3173
77.67415	1932360	1.241385	0	131.8497
126.3399	26934168	0	0	0
120.8754	31156846	0	0	0
114.2654	29686471	0	0	0
109.9712	29316451	0	0	0
107.0281	30508557	0	0	0
102.7496	32116006	0	0	0
100	28371963	0	0	0
94.75064	25019083	0	0	0
89.14334	20753894	0	0	0
86.77259	19074092	0	0	0
82.29509	16472410	0	0	0
81.30718	17063664	0	0	0

TABLE VII (Continued)

Y	Xt-1	P*D1	P*D3	ER*D1
80.65711	20752122	0	0	0
74.81112	16297412	0	0	0
70.33379	14875340	0	0	0
115.9336	3074789	0	0.937787	0
112.5312	3195840	0	1.125081	0
116.6675	2285921	0	1.148586	0
112.4552	2033179	0	1.221075	0
111.4033	4078990	0	1.259208	0
105.5547	4902112	0	1.697733	0
100	3018300	0	1.785008	0
94.57023	4328677	0	1.816571	0
87.50185	8756153	0	1.673322	0
81.48656	8076149	0	1.546885	0
74.77563	9059812	0	2.040066	0
73.49075	7608612	0	2.747561	0
68.81817	8772565	0	3.014121	0
62.90498	7991540	0	2.412355	0
58.80829	6814320	0	1.477638	0

ER*D3	Y*D1	Y*D3	Xt-1*D1	Xt-1*D3
0	105.7086	0	1757241	0
0	107.4366	0	2615626	0
0	105.3045	0	3174195	0
0	106.0678	0	3166837	0

TABLE VII (Continued)

ER*D3	Y*D1	Y*D3	Xt-1*D1	Xt-1*D3
0	103.5070	0	4386583	0
0	102.9983	0	4793542	0
0	100	0	3831356	0
0	95.54662	0	5736392	0
0	92.82751	0	4442174	0
0	90.10048	0	7273695	0
0	85.31556	0	5136153	0
0	86.39324	0	3756872	0
0	85.59391	0	3566524	0
0	81.43303	0	2259940	0
0	77.67415	0	1932360	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

TABLE VII (Continued)

ER*D3	Y*D1	Y*D3	Xt-1*D1	Xt-1*D3
0	0	0	0	0
0	0	0	0	0
118.1820	0	115.9336	0	3074789
122.4817	0	112.5312	0	3195840
131.4707	0	116.6675	0	2285921
121.6253	0	112.4552	0	2033179
118.0751	0	111.4033	0	4078990
104.7364	0	105.5547	0	4902112
100	0	100	0	3018300
103.8121	0	94.57023	0	4328677
102.8412	0	87.50185	0	8756153.
101.3160	0	81.48656	0	8076149.
109.3535	0	74.77563	0	9059812.
111.8650	0	73.49075	0	7608612.
109.6010	0	68.81817	0	8772565
118.4526	0	62.90498	0	7991540
122.1810	0	58.80829	0	6814320

As is evident from Table VII, the dummy variables have a value of one only when they are associated with an observation from their particular regime.

When multiplied times an explanatory variable, the product produces another column of the regressor for the observations of that particular regime group.

The OLS regressions were run on Micro TSP. The restricted model regression was produced by stacking the three data sets of Table VI and running the regression on all 45 observations.

VITA

James M. Gleckler

Candidate for Degree of

Doctor of Philosophy

Thesis: EXCHANGE RATE REGIMES IN MODELS OF AGRICULTURAL EXPORTS

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Tulsa, Oklahoma, 23 February 1947.

Education: Bachelor of Arts degree, University of Tulsa, May 1974; Master of Science degree, Oklahoma State University, May 1977; Completed requirements for Doctor of Philosophy degree, Oklahoma State University, December, 1988.

Professional Experience: Instructor, Northeastern Oklahoma A&M College, August 1980 to present.