SOME EFFECTS OF EXCHANGE RATE
FLEXIBILITY ON UNITED STATES AGRICULTURE

BY

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The system of flexible exchange rates which was adopted in 1973 has been the subject of considerable discussion in the general economic literature. Both proponents and critics of the system have offered numerous theoretical and empirical contributions on the subject. By contrast, the recent U.S. agricultural economic literature on exchange rates has concentrated on the impact of the dollar devaluations of the early 1970s on the surge of agricultural exports registered during the decade. Little discussion has taken place about the issue of the effects of exchange rate flexibility per se on U.S. agriculture. This study addresses said issue.

The review of the literature indicates that the flexible exchange rate is determined in the short run by financial market variables. To the extent that an export-dependent agricultural sector such as that of the United States is affected by flexible dollar exchange rates, then financial market variables indirectly affect the agricultural sector.

Among the objectives of the empirical analysis of this study has been to obtain an indication of the importance of this linkage between agriculture and the financial market.

The principle tool for the empirical analysis is a two-block recursive system of equations estimated via ordinary least squares and three-stage least squares. Impact elasticities are derived using the reduced-form coefficients.

The main empirical findings are the following:

- a) No special advantages are found in constructing an effective exchange rate for U.S. agricultural exports;
- b) Exchange rate volatility has had no statistically significant impact on agricultural exports;
- c) Changes in agricultural export flows are largely absorbed in the short run by changes in domestic consumption;
- d) The flexible exchange rate and its determinants affect agricultural exports but account only for a minor part of registered export fluctuations during the study period;
- e) There is no perceptible delay in response in the agricultural sector to changes in financial market conditions;

The general conclusion of the study is that although flexible exchange rates have tied U.S. agriculture to the international financial market, their importance to agriculture can be overstated.

CHAPTER I INTRODUCTION

The exchange rate--the price of one nation's currency in terms of another--has been a research issue of great concern during the last decade. A great number of contributions to the literature have dealt with many aspects of exchange rates. A motivating factor behind this research activity has been the adoption of flexible exchange rates during the early 1970s after decades of a pegged rate regime.

This dissertation is also motivated by the change in exchange rate regimes. It focuses on an area that has heretofore received little attention: the relationship between a flexible dollar exchange rate, its determinants, and an American agricultural economy heavily dependent on income from export sales. The general research objective is to examine how an exchange rate that is free to change constantly and the factors that explain its movements affect the American agricultural sector. The more specific objectives are a) to examine the implications that the exchange rate literature poses for the relationship between flexible exchange rates and agriculture, b) quantify the relationship between the determinants of the exchange rate, exchange rate volatility and agriculture, and c) obtain an indication of the extent to which the financial markets have contributed to agricultural income instability during the flexible exchange rate period.

This dissertation is divided into seven chapters including these introductory remarks. Chapter II presents a discussion of the role of

the exchange rate in the adjustment of the balance of payments. Also, a short historical account is given of the international (Bretton Woods) monetary system that was established after World War II. Special emphasis is placed on how the economic thinking of the World War II period led to the Bretton Woods system and how the system started to disintegrate in the early 1970s.

Chapter III is an overview of the research issues dealing with the flexible exchange rate system which replaced the pegged rates of the Bretton Woods system. The issues have been divided into the categories of exchange rate instability, international trade and investment, national and international inflation, external adjustment, macroeconomic policy, and the determination of flexible exchange rates. Special attention has been given to the latter issue because of its relevance to agricultural economics. However, since the literature on exchange rates is so voluminous, no attempt has been made to be exhaustive on every issue. Rather, the purpose is to present the problems that have been of concern and some of the research results that have been obtained thus far.

Chapter IV deals with exchange rate issues in the agricultural economy. The chapter is divided into two broad categories: literature dealing with fixed exchange rates and that dealing with the flexible rate system. The category on fixed rates has by far the larger number of publications and is thus subdivided into theoretical and empirical contributions. The second category focuses on how flexible exchange rates serve to link the agricultural economy with the general economy.

Chapter V is a brief section that endeavors to interrelate the numerous articles reviewed in Chapters II, III, and IV. The purpose

is to show the similarities and differences between the various articles either in their objectives or in their view of the role of flexible exchange rates in the national economy.

Chapter VI presents the empirical analysis of the dissertation. The specific objectives of the empirical research are presented along with the model designed to meet those objectives. A series of tables then report the estimated coefficients for the several equations of the model. The latter section of the chapter relates these findings to the objectives of the dissertation, i.e., an indication is obtained of the extent to which the research objectives have been fulfilled. Chapter VII endeavors to draw some conclusions from the research undertaken.

CHAPTER II EXCHANGE RATES AND THE BRETTON WOODS SYSTEM

This chapter is devoted to a brief overview of exchange rate theory and institutions during the Bretton Wood fixed exchange rate system. It starts by briefly describing the role of exchange rate changes in the adjustment of the balance of payments. A short historical account is next given of the international monetary system that was established after World War II in accordance with the then predominant views on the exchange rate, and how that system evolved in the early 1970s.

Exchange Rates in the Adjustments of the Balance of Payments

How changes in the exchange rate--defined as the local currency price of foreign currency--serve to equilibriate the balance of payments can be more easily illustrated with the assumption of a world composed of two countries, Northland and Southland. Northland denominates its currency in dollars and Southland in pesos. At some given exchange rate there is an excess supply of dollars and an excess demand of pesos. A depreciation of the dollar raises the dollar price of Southland's exports and lowers the peso price of Northland's exports to Southland. The general effect is that Northland's imports are restrained and its exports expand.

In the "normal" adjustment process (the "abnormal" cases are discussed below) the higher dollar price of goods flowing to Northland

reduces that country's quantity demanded, thus lowering their peso price. For goods flowing to Southland the lower peso price increases the quantity demanded, and thereby their dollar price increases. In short, Northland's traded goods rise in price relative to domestic goods while the opposite is true in Southland. These changes in relative prices lead Northlanders to reduce their consumption of imports and to increase production of exports. Also, the vague line between domestic and export goods shifts as more goods become profitable for export. The opposite trend occurs in Southland where relative price changes caused by the depreciation produce higher incentives to consume imports. Thus, the increase in Northland's net exports serves to reduce the excess supply of dollars, and the decrease in Southland's net exports reduces the excess demand for pesos. A move is made toward a balance of payments equilibrium in both countries.

This equilibrating mechanism requires an implicit assumption about the elasticities of import demand and export supply. The assumption is that the elasticities are large enough so that the rise in the dollar cost of Northland's imports is followed by a sufficiently large reduction in imports to lower the total import bill. Inelastic import demand and export supply may bring about the condition that the depreciation in a country's currency actually aggravates its balance of payments deficit. The condition which the elasticities must satisfy in order to bring about a balance of payments improvement appears in Sohmen [1969, 16]. A country's trade balance, in terms of domestic currency, is defined as $B_D = pX - qM$. In terms of foreign currency, it is $B_F = B_D / r$. The condition for improvement for the domestic currency is

$$\frac{dB_D}{dr} = X_0 \frac{\delta_x(\sigma_x+1)}{\sigma_x+\delta_x} + M_0 \frac{\sigma_m(\delta_m-1)}{\sigma_m+\delta_m} > 0 \quad (1)$$

where σ_x = the elasticity of export supply

σ_m = the elasticity of import supply

δ_x = the elasticity of export demand

δ_m = the elasticity of import demand

X = physical quantity of exports

M = physical quantity of imports

r = exchange rate (defined as units of domestic per unit of foreign currency).

All values are measured at initial equilibrium, and all elasticities are in absolute value. Domestic currency is defined as the numerator in the exchange rate ratio. The condition improvement for the for foreign currency is defined as

$$\frac{dB_F}{dr} = X_0 \frac{\sigma_x(\delta_x-1)}{\sigma_x+\delta_x} + M_0 \frac{\delta_m(\sigma_m+1)}{\sigma_m+\delta_m} > 0 \quad (2)$$

Modern authors such as Yeager [1976, 167-172] and Sohmen [1969, 20-28] have argued that stable equilibrium levels of exchange rates must exist, i.e., elasticities cannot remain perversely low over the entire range of demand and supply. Furthermore, real world situations indicate that very probably exchange rates have only one, and this a normal, equilibrium. However, the school of "elasticity pessimism" had considerable influence among economists in the years following World War II. Their pessimism led them to oppose devaluations as a means for correcting balance of payments deficits. They argued that the demand elasticities might not be high enough to guarantee that the deficits would be reduced or eliminated. They also drew the further conclusion

that flexible exchange rates are not feasible in light of these low elasticities which they thought to prevail; free market forces would only lead to instability and chaos in an international market faced with persistent disequilibrium. Their thinking was to greatly influence international monetary relations for 30 years.

The Bretton Woods System*

The international monetary system that was to endure for almost 30 years following World War II was given form by the Articles of Agreement of the International Monetary Fund (IMF). The system came to be commonly known as the Bretton Woods system, after the town in New Hampshire where the articles were signed by 44 countries in 1944. The Articles contained two important provisions. First, contributions were made by all member countries to a fund from which any member could borrow to meet temporary balance of payments deficits. Second, each member established a par value of its currency in relation to the 1944 gold content of the U.S. dollar and maintained its exchange rate within plus or minus one percent of its parity value. Changes in parity values were allowed only in instances of "fundamental disequilibrium" in the balance of payments. Under any circumstance, changes in the exchange rate of more than 10 percent from the initial parity needed the prior approval of the IMF.

The Bretton Woods system was a compromise reached between the concepts of exchange rate stability and national independence in fiscal and monetary policy. While national governments wanted that independence, letting exchange rates move freely in response to market forces was

*This historical account largely follows Yeager [1976].

deemed unacceptable in light of the prevailing "elasticity pessimism" described in the previous section. Consequently, the Bretton Woods system pegged rates to given parities but allowed adjustments in those parities when called for by fundamental economic conditions. Strictly speaking, this system was one of adjustable pegs rather than one of truly fixed exchange rates.

By historical standards world trade grew rapidly during the postwar years up to the 1970s. The extent to which the Bretton Woods system is responsible for this growth is a matter for debate. Yeager [1976] has argued that special postwar circumstances were factors underlying the growth in trade. Whether coincidental or not, the association between growth in trade and the Bretton Woods system did not impede the latter from showing increasing signs of strain after 1965.

The compromise between independent national macroeconomic policies and the system of pegged exchange rates became increasingly difficult to maintain. Independence in economic policy led to accentuated differences in underlying economic conditions between industrialized countries, i.e., more frequent "fundamental disequilibria" in the balance of payments. At the same time, an increasing integration of the world economy, a relaxation of control in capital movements, and difficulties in the attempts to control them allowed speculative capital flows to become more responsive to those disequilibrium conditions. The necessary compensatory movements by central banks became more frequent and larger.* In order to diminish these flows, governments reverted to

*See Willett [1977, 16-17] for a list of known reserve movements in the 1960-73 period. These movements by central banks were designed to neutralize the flow of funds initiated by individuals, e.g. an outflow of dollars can be compensated by a purchase of dollars overseas by the U.S. Federal Reserve Bank.

more frequent changes in the par values of their currencies. The need to revalue became so frequent that countries eventually adopted a system of allowing rates to float within a band of values beyond which official intervention took place.

The 1970-73 dollar movements are an important illustration of the increasing difficulties experienced in maintaining the viability of the Bretton Woods system. During the late 1960s the United States experienced a loss in competitiveness in world markets and a consequential deterioration in its trade balance. The 1970 recession brought about a recovery in the trade balance. However, the recovery of \$1.5 billion contrasted with the recovery of \$3.8 billion in the earlier recession year of 1960 when U.S. trade was half as large. Furthermore, only a small part of the divergence in export price trends between the U.S. and foreign trends was reversed by the recession. In 1970, U.S. and European monetary policies started to move in opposite directions. Stagnation in real output and higher unemployment brought a shift toward monetary ease in the U.S. while Europe maintained tight monetary control. A drop in U.S. interest rates relative to those in Europe resulted in a large outflow in capital; the U.S. official settlements deficit reached \$5.6 billion in the first quarter of 1971.

Throughout 1971 exchange rate expectations also turned against the dollar as analysts realized that the improvement in the trade balance in 1970 was the result of demand conditions and not of fundamental reverses in export price trends. As expectations were confirmed by new American trade deficits in early 1971, movement out of the dollar in international portfolios resulted in the upward floating of several European currencies in May. By August liquid dollar liabilities to foreign

official institutions were three times as large as U.S. official reserves. In that month President Nixon announced a price-and-income freeze, suspended the gold convertibility of the dollar, and imposed a 10 percent import surcharge. After a week's closure, foreign exchange markets experienced a floating of most major currencies. The one exception was the yen, which remained pegged. After absorbing \$4.4 billion in August alone, the Japanese authorities finally gave up and allowed the yen to float.

The culmination of these events was the Smithsonian Agreements signed in December of 1971. The dollar was devalued 7.89 percent in relation to gold, and the import surcharge was removed. Other countries soon announced official appreciations of their currencies against the dollar. The trade-weighted average devaluation relative to America's 14 major trade partners was 10.35 percent. In yet another attempt to keep the Bretton Woods system alive, allowed divergences from parity rates were increased from plus or minus one percent to 2.25 percent.

It should be apparent that the Smithsonian Agreements did not address any of the fundamental reasons for the slide of the dollar (decreasing competitiveness of American products in international markets and persistent American balance of payments deficits). Thus it is not surprising that bearish expectations continued. U.S. money supply grew by 8.3 percent in 1972 after registering a growth of 6.6 percent in 1971 and 6.0 percent in 1970. Price and wage controls went from a more restrictive Phase II to a looser Phase III. A strong business recovery in the U.S. continued swelling its trade deficit. These facts help explain the further deterioration of the dollar in 1973.

In January, 1973, pressure on the Swiss franc resulted in the interruption in the support of the dollar by Swiss authorities. Efforts to exit out of the dollar then concentrated on other currencies. Pressure kept mounting in February. On March 12, the U.S. announced a 10 percent devaluation against Special Drawing Rights (SDR), an IMF basket of currencies, and the Japanese allowed their currencies to float, emulating Canada, Britain, and Switzerland. On March 11, Germany, France, Belgium-Luxembourg, Holland, and Denmark had agreed to float their currencies jointly, i.e., member's currencies could float against outside currencies but not against each other. Shortly thereafter, Norway and Sweden also entered the joint float.

It is evident that the increasing burden of compensatory capital flows by central banks resulted in an involuntary, piecemeal floating of exchange rates. The cost of preventing what was feared as the chaotic nature of market-determined rates was deemed too large to absorb. Thus floating rates became a passive outcome, not one especially desired. It was not until January, 1976, that authorities officially accepted the float with the Jamaica Agreements of the Interim Committee of the Governors of the International Monetary Fund.

CHAPTER III FLEXIBLE EXCHANGE RATES

Since 1973, exchange rate flexibility has been adopted by most of the developed countries but not by centrally planned economies. Exchange rates have had the freedom to be determined by market forces, albeit with varying degrees of intervention by governments interested in controlling large movements. This control is especially applicable to countries in the European joint float. Many articles, both critical and supportive of the performance of flexible exchange rates have been published. Others have concentrated on elucidating the relationship between market forces and the exchange rate, i.e., how the former determine the latter. This section comprises a review of the major issues dealing with flexible exchange rates.

Exchange Rate Instability

A major criticism that has been levied against the system of exchange rate flexibility is that it has allowed "excessively" volatile movements in exchange rates. "Excessive" has been defined as those movements which substantially and persistently exceed changes in underlying economic conditions. For example, Bernstein [1978] points out that the dollar-deutsche mark rate has risen and fallen alternatively by 10 to 20 percent over a three-to-four-month period, only to return to its original position. It is pointed out that obviously economic conditions cannot change that rapidly.

This view glosses over the role of expectations and asset markets in the determination of exchange rates. As will be discussed in the section on exchange rate determination, expectations play an important role in determining rates by affecting asset preferences. These expectations tend to be very unstable. Forecasting monetary and fiscal variables in different countries is at best a matter of guesswork [Artus and Young, 1979]. The basis for forecasts is normally very tenuous information which is easily amended by a new piece of information. Thus expectations are subject to frequent and substantial revisions, and exchange rates change accordingly. However, these movements are not an indication of an inappropriately working market. Expectations may be properly formed ex ante even though they may overstate underlying conditions ex post [Willett, 1977].

Closely related to the issue of expectations is the question of destabilizing speculation under flexible exchange rates. This subject has received a great deal of attention by economists. A fair conclusion that can be drawn from the literature is that while cases of destabilizing speculation are hypothetically conceivable, quite general conditions would lead to stabilizing speculation. The point was succinctly stated by Friedman:

People who argue that speculation is generally destabilizing seldom realize that this is largely equivalent to saying that speculators lose money, since speculation can be destabilizing in general only if speculators on the average sell when the currency is low in price and buy when it is high. It does not, of course, follow that speculation is not destabilizing; professional speculators might on the average make money while a changing body of amateurs regularly lost larger sums. But while this may happen, it is hard to see there is any presumption that it will; the presumption is rather the opposite. [1953, 175]

A more refined criticism deals with bandwagon speculation [Bernstein, 1978]. This view holds that bandwagon effects accentuate divergences around equilibrium rather than divorce exchange rates from equilibrium. Exchange speculators, according to the view, operate on a very short time span. They measure their opportunities for profit in the next few days or weeks, not months. Thus, once a decline starts, even for sound economic reasons, bearish speculators enter the market as sellers, hoping for a further decline during the next few days. This process continues until it becomes too risky to hold a short position even for a brief time period. Then the currency begins to appreciate until it becomes too risky to hold a long position even for a brief time period, presumably above equilibrium value. The result is a wider fluctuation than called for by either economic conditions or reasonable expectations focused on a longer time frame. Artus and Young [1979] maintain it is difficult to explain exchange market developments in October 1978 without referring to bandwagon effects.

Empirical studies have so far failed to determine whether fluctuations in exchange rates can be explained in terms of efficient or inefficient speculation [Willett, 1977]. Thus neither theory nor observation can lead to any definite conclusion about the possible detrimental effects of speculation on exchange rates. However, some authors argue that this indeterminacy does not damage the case for preferring flexible over pegged exchange rates. Sohmen [1969] argues that under a flexible system authorities still have at their disposal all the traditional means for correcting excesses; central banks can always employ their policy tools for guiding international flows in such a way that the desired time path of exchange rates comes about. Yeager

[1976] argues that pegged rates give speculators a one-way option that offers the possibility of profit at low risk: the timing or the size of the exchange rate change may not be known, but the direction of movement of a currency under pressure is known with a high degree of certainty. Speculators thereby have a low risk mechanism with which to put further pressure on a currency and create a change larger than necessary for achieving equilibrium.

Additional reasons besides speculation have been offered for the observed instability of exchange rates. McKinnon [1976] has pointed out that there might be an inadequate supply of private capital available for taking net positions in the market on the basis of long-term expectations. Thus shorter term variations in the demand for foreign exchange lead to large short-term variations in exchange rates, regardless of bandwagon effects. Dornbusch [1980] has hypothesized that the slow speed of adjustment of the goods market leads the exchange market to overshoot equilibrium rates in response to a change in monetary policy. Finally, another possible source of instability deals with the multicurrency international reserves of central banks [Artus and Young, 1979]. The banks are aware that any major shift in the composition of reserves can lower the value of their portfolios. Consequently, they may hold larger stocks of a given currency than they would choose to have. The possibility that some of these balances might come in the market creates uncertainty for both private and official holders of the overhanging currency.

Wide movements in exchange rates since the breakup of the Bretton Woods system are an observable fact. What is more open for debate is how much these movements have been an efficient response to rapid

changes in the goods and asset markets and how much by an inherent erratic nature of the exchange market. A tentative conclusion could be that reached by a conference sponsored by the American Enterprise Institute for Public Policy Research and the U.S. Department of the Treasury:

The results . . . at the conference, although far from being unchallengeable, tend to indicate that foreign exchange markets are essentially efficient. On the basis of this evidence, the often sharp fluctuations of exchange rates around the long-term trend would seem to reflect the instability of underlying economic conditions and policies, rather than defects inherent in the working of foreign exchange markets [Dreyer 1978, 283].

International Trade and Investment

The reason for concern over exchange rate volatility has been its potential detrimental effect on foreign trade and international investment. Regarding trade, exchange rate variability poses two types of risk to importers and exporters. One is the exchange risk where rates change disadvantageously in the period between contract and settlement. For example, an American importer of Japanese cameras contracts in June for shipment and payment in yen in August. If in July the dollar depreciates, the dollar payment for the shipment increases. A likewise disadvantageous change occurs on the export side. A less obvious risk deals with changes in price competitiveness. If that same importer makes a contract in June for delivery and settlement in August, but the dollar appreciates in September, the value of his inventory is lowered. His competitors are able to purchase cameras at a lower dollar price. Regarding investment, possible exchange rate changes make it more difficult to estimate the expected future stream of returns. Thus any investment becomes more risky. All this exchange-rate-induced risk,

it can be argued, curtails international trade and investment as agents shift from international to domestic economic activities.

This argument would be a great deal stronger were it not for a variety of tools available which traders can use to reduce their exchange risk. These include a) hedging via either currency futures or forward purchases and sales of currencies in banks, b) borrowing and lending in foreign countries (for example, an exporter raises a loan in the pertinent foreign country, exchanges it at the current spot rate, and then repays the loan when the foreign currency receivables come in), c) invoicing in the home currency, d) contractual clauses on the revision of prices subject to changes in exchange rates, e) lagging and leading payables and receivables, and f) compensation among subsidiaries of multinational corporations.

These tools for exchange risk reduction do not deny that business has become more complicated for traders. In a survey reported by Teck [1978] almost all respondents felt that foreign exchange risks had become more of a problem in the 1970-75 period and could no longer be ignored. A total of 60 percent reported an increased commitment in exchange rate exposure management since 1970. However, these added complications do not seem to have had a significant effect on trade. Statistical evidence tends to be negative, but of course cannot accurately measure the potential trade inhibited by flexible rates. Hooper and Kohlhagen [1978] introduced several proxies for exchange rate uncertainty in import and export volume equations for the U.S. and West Germany for 1965-1975 and found they did not play a significant role. Artus and Young [1979] report that various tests making use of the International Monetary Fund's world trade model have also failed to

identify any systematic effect of exchange rate uncertainty on disaggregated trade flows for industrial countries through 1977. An explanatory factor behind these findings may be that the variability of purchasing power parities has actually decreased since floating was initiated [Balassa 1979]. Thus exchange rate changes that have been unfavorable to traders have in general been offset by favorable price movements and vice versa.

On the subject of foreign direct investment, Artus and Young [1979] also report that little evidence has accumulated suggesting that financial and non-financial enterprises have significantly curtailed international capital movements in response to exchange rates. Balassa's findings of offsetting price and exchange rate movements would indicate that other determinants of investment flows, e.g., access to material inputs, labor with appropriate skills, and output markets, would dominate investment decisions. However, if an investment decision places a large emphasis on the stream of returns during the first few years, then exchange rate instability during that period could be a crucial factor in decision-making.

In comparing trade and investment effects under truly pegged and flexible exchange rates, it is incontrovertible that, ceteris paribus, pegged rates facilitate trade and investment. Flexible rates do increase risk relative to fixed rates, since exposure management reduces but does not eliminate that risk. Also, the resources expended in exposure management create an additional cost for traded goods. However, the new international environment does not seem to have overburdened producers. Surveys have shown a general satisfaction by business with floating [Burtle and Mooney, 1978], and there has been no extensive lobbying for a return to pegged rates.

Yet the comparison of flexible exchange rates with fixed rates under ceteris paribus conditions is largely artificial. Any useful comparison must consider the real world where national governments follow disparate macroeconomic policies in pursuit of domestic rather than international goals. Under these conditions fixed exchange rates tend toward disequilibrium. The policies necessary to keep fixity at disequilibrium may well impede trade more severely than the risk of fluctuations. Trade barriers often arise in these instances [Yeager, 1976]. Furthermore, keeping nominal exchange rates fixed would result in changing real rates that can inhibit trade. A country that has a rapid inflation relative to a trading partner but keeps its exchange rate fixed soon loses export competitiveness. If its exports are reduced, imports must also be reduced, lest there be accumulating balance of trade deficits.

The overall indication from the evidence is that if flexible exchange rates have curtailed international trade and investment, the effect has been mild and perhaps less severe than could have been experienced under a continuation of the adjustable peg.

Inflation and Flexible Exchange Rates

A traditional argument for exchange rate flexibility is that it insulates a country from outside inflationary influences while bottling its own inflation within its borders. For example, Southland suddenly increases its money supply by 50 percent, ceteris paribus. Consequently, inflationary pressures push up the price of its products including exports. As export prices rise, foreign customers will turn to other sources of supply. As the prices of domestic import-competing

products also rise, Southlanders shift to imports. The result is an increase in demand for foreign currency and a decrease in demand for Southland's currency. If exchange rates have the flexibility to respond to market forces, Southland's currency will depreciate to the point where its demand and supply are again in equilibrium. The result of the process is that Southland's expansion of its money supply resulted in a solely internal inflation; prices in other countries were not affected.

Consider the same change in money supply under fixed exchange rates. As Southland's prices rise, it will develop a balance of payments deficit when foreign customers buy less of its now more expensive products and its citizens buy more of the relatively cheaper imports. The deficit translates into a surplus of Southland's currency abroad. This surplus increases money income overseas (unless sterilized by central banks) and, therefore, foreign prices rise. Inflation is thereby transmitted abroad.

In a detailed review of this issue, Salant [1977] concludes that one can a priori expect a country will be less vulnerable to external inflationary influences if its exchange rate is flexible rather than fixed, except in two cases: a) where there is a rise in the world price of imports for which the demand is price-inelastic and b) where the external inflation generates a capital outflow. In the first case a rise in the world price of imports results in a depreciation of the home currency which aggravates the import price rise and raises the home price of exportable output. These effects can trigger an inflationary process by a repetition of a price-of-tradeables-exchange rate-general price-wage-exchange rate spiral until arrested by monetary restriction or until import prices move to the elastic range of demand. Under fixed

rates a price rise of inelastic imports would induce a balance of payments deficit and thereby a contraction of the monetary base. This contraction serves to counteract the initial inflationary move and thereby to reduce the vulnerability to outside inflation. Salant regards this case as unlikely, but perhaps it is very relevant to developing countries where the elasticity of imports may be reduced by a severely limited domestic industrial base.

The second case deals with a capital outflow generated by profit opportunities abroad that are increased by external inflation. Under a fixed exchange rate this effect is unambiguously deflationary. Under flexible rates, however, the currency depreciates, increasing the domestic price of traded goods. This price effect reduces the real money supply if nominal money rises less than the average domestic price level. Nevertheless, this monetary contraction may not be enough to reduce the prices of domestic products sufficiently to counteract the rise in tradeables. Then the domestic price level as a whole rises while output and employment may decrease. If the monetary authorities respond with an expansion in money supply, then any mitigating effects on inflation of the initial contraction are reduced or eliminated. Again, Salant considers this case as special. He concludes that in general floating rates block the market mechanism by which inflation is transmitted. In a different analysis Willett arrives at a similar conclusion:

There are some types of episodes in which greater inflationary pressures would be generated under freely floating rates than under realistic alternative exchange rate regimes. In actual practice, however, episodes of any great significance are more the exception than the rule. [1977, 66]

A separate question deals with whether the rate of world inflation is likely to be greater under a fixed or a flexible exchange rate system. The arguments suggesting that flexible rates promote world inflation have two basic elements. One is an asymmetry in response to exchange rate changes. Depreciating countries see the domestic price of tradeables rise after the depreciation. There follows pressure to increase income and wages to maintain their purchasing power, creating another round of price rises. In the appreciating countries, on the other hand, the domestic price of tradeables drops, but a downward rigidity in incomes and wages makes any general price decrease less than the increase in the depreciating country. Consequently, world inflation as a whole rises. Under fixed exchange rates the net inflationary effect would have been avoided.

The second element is implied in the first: monetary and fiscal policy allows the price-wage spiral to continue in the depreciating country. These accommodating policies may or may not have also led to the initial depreciation.

Willett [1977] argues that these asymmetries are relevant only when the value of a country's currency changes because of circumstances other than the country's underlying economic conditions. If only the "relevant" ones are considered, their magnitude can be easily exaggerated because, unlike with wages, there does exist a downward flexibility in the prices of internationally traded goods. If the exchange rate change is then persistent enough to be incorporated into wages, then it is unlikely to be caused by other than fundamental economic factors.

Willett's analysis is then focused on macroeconomic policy. He emphasizes the importance of discerning cause and effect. If a currency depreciates in response to monetary and/or fiscal policy, it is improper to blame the depreciation for the rise in the price of tradeables. Even if the depreciation gives rise to a demand for higher wages, a continuing exchange rate-price-wages-price-exchange rate spiral is possible only in light of an accommodating macroeconomic policy. Thus the problem lies with the policy and not with the flexibility of exchange rates.

Salant [1977] agrees that in a narrow, almost mechanical sense, a flexible exchange rate system allows every country to control its national price level. Through the appropriate policy a nation can keep stable prices despite exchange rate changes caused from the outside. Thus, world inflation could conceivably be eliminated. But, he adds, this view assumes that monetary and fiscal policies are determined solely with the view of avoiding inflation. Although a conclusion such as Willett's is correct in light of this assumption, he feels the view taken is too narrow; most countries are not completely unresponsive to changes in the demand for output and employment.

The arguments above lead one to infer that flexible exchange rates can promote control of world inflation by giving countries the option to a) adopt a noninflationary domestic macroeconomic policy and b) allowing them to isolate themselves from outside inflationary sources. However, if controlling inflation is only one of several economic goals, these conclusions become more controvertible. If broader economic goals are considered, then the conclusions become more equivocal. For example, Dornbusch and Krugman [1976] argue that the short-run Phillips curve is

steeper under flexible than under fixed exchange rates. If they are correct, countries with the economic goal of full employment must be willing to accept a higher rate of inflation under flexible rates than under fixed rates.

Flexible Exchange Rates and External Adjustment

Before their adoption in 1973, it was expected that flexible exchange rates would greatly facilitate the international adjustment process. It was anticipated that exchange rate movements would ensure that financing flows would be available to offset any short-run excess demand or supply for foreign exchange originating from the current account. In the long run, flexible rates would ensure that the demand and supply of foreign exchange would be consistent with the foreign investment flows that reflect differences in propensities to save and differences in investment opportunities between countries. On the whole, flexible rates were expected to prevent the occurrence of the protracted maladjustments experienced in the late 1960s and early 1970s.

Artus and Young [1979] argue that these expectations were not met because the usefulness of flexible rates in facilitating external adjustment implied three conditions which were also not met. These conditions are: a) a supportive aggregate demand-management policy, b) sustained changes in the relative prices of foreign and domestic goods, and c) changes in relative prices that lead to a switch in domestic and foreign demand between foreign and domestic goods. The first condition was often not met as countries with current account surpluses such as West Germany placed a large emphasis on controlling inflation even if it reduced the demand for foreign goods, while deficit countries such as

the United States placed its emphasis on reducing short-term unemployment. While not necessarily disagreeing with the need for proper demand management (although perhaps emphasizing monetary control), Willett [1977] regards as a truism the fact that countries with differing rates of inflation cannot achieve adjustment with a one-shot move in exchange rates. Under these circumstances a continuous change in exchange rate is needed in order to prevent greater imbalances. If inflation in the U.S. is higher than in West Germany, the dollar should face a long-term downward trend in relation to the mark, not just a short-term adjustment.

Artus and Young's second condition deals with the fact that the absence of money illusion induces workers to demand higher wages in response to a depreciation. Unless foreign goods form a small portion of a country's consumer basket, a depreciation will be regarded as an increase in the cost of living and consumers will demand compensating adjustments in wages. These wage hikes will undermine the needed change in relative prices between foreign and domestic goods caused by the change in exchange rate; the price of domestic relative to foreign goods will rise again. As explained in the section on world inflation, this exchange rate-foreign prices-wages-price spiral can only occur in light of an accommodating monetary and/or fiscal policy. Restrictive policies would lead the economy to properly respond to the change in exchange rate.

The third condition is that demand for foreign and domestic goods must change when their relative prices change. Artus and Young point out that this shift has often not materialized. They provide the extreme example of Switzerland, whose export volume kept increasing in 1978 despite a 30 to 50 percent loss in cost and price competitiveness

in the preceding five years due to appreciation of the Swiss franc. They claim the Swiss have highly specialized exports which cannot be easily shifted to the domestic market. Instead, they shifted toward highly technical exports with low price elasticities.

McKinnon [1981] makes the altogether different argument that modern international economic conditions make exchange rates no longer the most direct instrument for influencing the trade balance. His position is that both proponents of fixed and flexible exchange rates have in mind the elasticities approach (discussed in the first section of this chapter) when considering an equilibrium exchange rate. The implied assumptions of this approach no longer hold in the modern world. McKinnon summarizes these assumptions as those of an "insular economy," one where a country engages in foreign trade but a) trade is a small proportion of GNP such that exchange rate changes do not influence prices, b) net domestic wealth holdings of financial or real assets are not much influenced by the foreign sector, and c) the national monetary system is insulated from foreign exchange. These conditions prevent exchange rate changes from having price or income effects in a country, thereby limiting the determinants of exchange equilibrium to the elasticities of export and import demand and supply. These conditions, however, do not apply to today's world characterized by integrated capital markets and industries more open to commodity trade than in the past.

McKinnon offers a model of an "open economy" more appropriate to modern economic situations; i.e., the above assumptions no longer hold. He begins with the familiar identities of national income, assuming that

the current account and the trade balance are the same while foreign and domestic prices are initially set to unity:

$$Y = C + Id + G + X - R \cdot Z \quad (3)$$

where Y = national income,

C = private consumption,

Id = total domestic investment,

G = government consumption,

X = exports in domestic currency,

R = domestic cost of foreign exchange,

Z = imports in foreign currency.

Define social saving to be

$$S = Y - C - G \quad (4)$$

so that

$$S - Id = X - R \cdot Z = If \quad (5)$$

where If = net foreign investment.

Define Sp as private saving and Sg as government saving. If T is total tax less transfers, then public sector saving is

$$Sg = T - G \quad (6)$$

and total saving is

$$S = Sp + (T - G) \quad (7)$$

The final result is

$$Sp + (T - G) - Id = X - R \cdot Z = If. \quad (8)$$

The elasticities approach emphasized the right-hand side of equation (8). However, it can be seen that an improvement in the trade balance must involve either a rise in private saving, a rise in public saving, or a fall in domestic investment. Public saving enters as a wedge between the private actions of saving and investment and the net claim on foreigners.

McKinnon further argues that a) there is no change in private saving (S_p) with respect to a depreciation (R increase), b) there is a positive change in government saving ($T - G$) with respect to a depreciation, and c) there is also a positive change in domestic investment (I_d) with respect to a depreciation. The conclusion to be drawn from equation (8) is that a change in the exchange rate will exert an ambiguous change in the trade balance; government saving becomes the most direct instrument for public officials to influence the trade balance (assuming that they do not interfere with private saving and investment). Since the effect of exchange rates on external adjustment is indeterminate, external imbalances can persist despite freely floating exchange rates.

Macroeconomic Policy Under Flexible Exchange Rates

This section deals with the nature of fiscal and monetary policy in economies with floating exchange rates and fairly unrestricted capital markets (characteristic of developed economies). One theme was already introduced in the previous section: the importance of fiscal policy to the trade balance. In accordance with McKinnon's [1981] arguments, a persistent imbalance in the trade account does not necessarily imply a disequilibrium exchange rate. An increase in a country's budget deficit will decrease the net trade surplus while a change in the exchange rate

will have an ambiguous effect. In the modern economy fiscal policy takes on an international dimension in addition to its traditional role in domestic demand-management.

The international dimension, according to the model, makes it imperative for fiscal authorities to consider the international effects of their policies. McKinnon uses the example of the depreciation of the dollar in relation to the yen in the late 1970s. U.S. government dissaving rose in the 1973-75 recessionary period in response to a fall in private investment. Investment recovered in 1976-77, but government continued to be a large dissaver even in the 1977-79 inflationary boom. During the 1977-78 period the dollar faced a real depreciation of 25 percent (35 percent nominal), but there was not predictable effect in the trade balance with Japan.

As with fiscal policy, monetary policy also has an international dimension in the open economy. In the same reference McKinnon uses the same dollar-yen episode to cite an illustration of the international aspect. As is discussed below, expectations of future exchange rate movements can affect interest rates today. During the 1977-78 period expectations of further decline of the dollar increased U.S. interest rates as a flight out of dollars took place, and a liquidity squeeze was created. At the time the Federal Reserve Bank was keying on interest rates (federal funds rate) as their instrument of monetary control. When interest rates rose because of the exodus out of the dollar, monetary authorities proceeded to expand the money supply further to reduce the interest rates. This expansionary policy has the perverse effect of aggravating the flight out of the dollar, since a further depreciation was then more assuredly expected. Again, there was an

upward pressure on U.S. interest rates. The failure by the Federal Reserve Bank to recognize the decrease in the international demand for the dollar while recognizing only domestic interest rates resulted in a loss of monetary control. McKinnon also argues that maintaining the monetarist principle of fixed money growth would have had a similar effect in light of the slack in the demand for dollars.

In another vein, Dornbusch and Krugman [1976] propose that the short-run Phillips curve is much steeper in an open economy when using monetary policy to achieve an expansion in output. In terms of Figure 1, the schedule PP represents the traditional inflation-unemployment tradeoff in a given country. In an effort to increase output and decrease unemployment from U^0 to U^1 an expansionary monetary policy is put into place. The immediate effect is a depreciation of the currency. Consequently, the price of imports is immediately increased, and wage pressures surge. As a consequence of the depreciation and resulting price increases, the new Phillips relationship is represented by the schedule $P'P'$; the MM schedule covers the period before and after the depreciation. Thus an attempt to move from A^0 to A^1 via monetary expansion results in a move to A'' . In the open economy reductions in unemployment are brought about by higher rates of inflation than in the insular economy. In Figure 1 the difference is $I''-I'$. More effective attempts to increase short-run output would have to involve a monetary-fiscal policy mix where a fiscal expansion is applied along with an accommodating monetary policy to maintain exchange rates.

In light of their arguments, both Dornbusch and Krugman and McKinnon argue for a need to offset exogenous disturbances of the exchange rate. Dornbusch and Krugman [1976] hold that exchange rate

Figure 1. The Phillips Curve in an Open Economy

movements can disrupt price performance just as commodity inflation due to crop failures can. And just as inventories can be used to assuage the shocks, inventories of foreign exchange or the ability to borrow can be used to peg the exchange rate while the shock is in place. The inflationary impact of a depreciation is thus avoided. There is also the option of using a single-minded monetary policy to wring out inflation regardless of the output effect. This option may be preferred by authors such as Willett [1977], who would doubt the frequency and magnitude of truly exogenous exchange rate changes.

Exchange Rate Determination

The literature discussed heretofore concerned itself with the impact of flexible exchange rates on various aspects of national and international economies. Frequent reference was made to the fact that the exchange rate depends on "underlying economic conditions." Many authors considered these conditions to be the proper focus of attention when concerned about the detrimental impact of exchange rate movements. Another branch of the literature has looked specifically at these linkages between the "underlying economic conditions" and the exchange rate. Its purpose has been to explain and model how economic variables determine the exchange rate. The result of this effort has been the contribution of many alternative models, each with its own assumptions about how the economy functions or with simplified assumptions for facilitating modeling. The attempt to compare and contrast these many models has become an arduous task in itself, a task undertaken by Murphy and Van Duyne [1980]. It is useful to share their overview before looking in detail at two alternative models.

Murphy and Van Duyne acknowledge that the recent models emphasize the role of the financial or asset markets (but also include the goods market) in the short-run determination of exchange rates. This emphasis contrasts with previous approaches which concentrated exclusively on the goods market, e.g., the elasticities approach. The authors group the models on the basis of the models' assumptions on asset substitutability and the role of wealth in asset demand functions. One group of models, labeled as the "portfolio balance approach," assumes that foreign and domestic bonds are imperfect substitutes and stresses portfolio balance considerations in asset or financial markets. Specifically, portfolio holders try to have the optimal balance of domestic and foreign assets in light of their returns and risk differentials. The other group of models, the "monetary approach," assumes that foreign and domestic assets are perfect substitutes, so that portfolio holders are indifferent between the two. Additionally, the monetary models assume wealth effects to have no effect in determining the exchange rate. Consequently, it is possible to focus only on money market equilibrium for exchange rate determination. The portfolio balance approach group includes the models by Henderson [1977], Kouri [1976], Isard [1978], and Branson et al. [1977]. The monetary approach group includes the models by Dornbusch [1976], Bilson [1978] and Frankel [1979].

Murphy and Van Duyne [1980] distinguish between the models in each group on the basis of three types of assumptions. First are substitutability assumptions. If two assets are perfect substitutes, they can be aggregated, thereby reducing the number of assets one has to deal with. The second type of assumptions deals with the speed of market adjustment. All the presented models assume that asset markets

adjust immediately, but various assumptions are made about the speed of price and output adjustment in the goods market. Specialization assumptions are the third type. These restrict the number of internationally traded assets or the number of goods produced in each country. Table 1 includes the assumptions made by the different models under these three categories.

Several highlights can be discerned from Table 1. It can be readily seen that all models in the portfolio balance group explicitly consider foreign and domestic assets. Henderson's [1977] asset market is simple in that only domestic and foreign monies are considered. No distinction is made between interest-bearing and non-interest-bearing assets, since he assumes all interest rates are pegged. Isard's [1978] model is more realistic in that neither foreign nor domestic interest rates are fixed. However, he disregards the goods market by assuming it does not achieve a short-run equilibrium. The model by Branson et al. [1977] is a simpler version of Isard's model in that the former assumes that both domestic money and domestic bonds are held only domestically. Isard makes the assumption only for domestic money.

The contrast between the monetary and portfolio balance models is also readily seen as all of the former assume perfect substitutability between foreign and domestic interest-bearing assets, i.e., bonds. The models differ with each other in their market adjustment and specialization assumptions. Dornbusch [1976] assumes a slowly adjusting goods market while Bilson [1978] assumes perfectly substitutable foreign and domestic goods and sufficient price flexibility to constantly maintain purchasing power parity (i.e., the price of a good in terms of a given currency is identical in all countries). Regarding

Table 1. Assumptions of Exchange Rate Determination Models

Model	Substitutability Assumptions	Speed of Market Adjustment Assumptions	Specialization Assumptions
<u>Portfolio Balance Approach</u>			
Henderson Model	Foreign and domestic interest rates are pegged. Domestic bonds and money are aggregated to a composite asset. Only assets then considered are domestic and foreign monies.	Prices are slow to adjust in the goods market. Short-run equilibrium achieved by changes in output.	Only domestic residents hold domestic money. But foreign money is held both by the domestic and foreign country.
Kouri's Model	Same as Henderson.	Home and foreign goods are perfect substitutes; goods market adjusts by changes in price level, not output. Purchasing power parity always holds.	Same as Henderson.
Isard's Model	Domestic and foreign interest rates are not fixed. Domestic bonds must then be considered as a distinct asset.	Home and foreign goods are imperfect substitutes. Both prices and output adjust slowly; there is no short-run equilibrium.	Only domestic residents hold domestic money. Bonds are short term and have a fixed price. Foreign bonds and foreign money are aggregated into a foreign asset composite.

(continued)

Table 1. (continued)

Model	Substitutability Assumptions	Speed of Market Adjustment Assumptions	Specialization Assumptions
Branson's Model	Same as Isard.	Same as Isard.	Only domestic residents hold domestic money and domestic bonds. Otherwise same as Isard.
<u>Monetary Approach</u>			
Dornbusch's Model	Foreign and domestic bonds are perfect substitutes.	Slow adjustment in the goods market. Both prices and output are fixed in the short run.	Domestic money is held only by domestic residents. Foreign interest rates and foreign prices are fixed.
Bilson's Model	Same as Dornbusch.	Home and foreign goods are perfect substitutes; there is short-run price flexibility. Purchasing power parity always holds.	Domestic money is held only by domestic residents. Foreign interest rate is not fixed. Foreign money market is explicitly considered.
Frankel's Model	Same as Dornbusch.	Same as Dornbusch.	Same as Bilson.

Source: Murphy and Van Duijne [1980].

specialization, Dornbusch makes a typical small country assumption: foreign prices and foreign interest rates are fixed to the domestic country. Bilson does not make this assumption and allows foreign interest rates to vary. Frankel's [1979] model is a mixture of Dornbusch and Bilson; he makes the market adjustment assumptions of Dornbusch while making the same specialization assumptions as Bilson.

Table 1 presents the general distinguishing features of the different models but does not give a precise indication of the nature of the models. To allow a more precise familiarity with the models, a representative from the balance approach and one from the monetary approach will be reviewed in detail. Branson's model will serve as the portfolio balance approach representative, while Frankel's model will shed light on the monetary approach. Both of these models have had empirical applications.

Branson's Exchange Rate Determination Model

Branson et al. [1977] begin the theoretical formulation of their model by assuming a small country which faces a fixed interest rate on world-traded assets. In the short-run, i.e., at each instant in time, the exchange rate is determined as part of the financial or asset market system which equates the quantity demanded for assets with the existing stock. Assets are aggregated into two categories: domestically issued assets B bearing interest rate r and foreign-issued assets F bearing fixed interest rate $\bar{r}$. Domestic portfolio balancers also hold domestic money M . It is assumed that neither B nor M is traded; only F is traded but cannot be swapped for B or M . The stock of B , M , and F is predetermined by history. F can be accumulated only by running a current account surplus over time.

Short-run asset market equilibrium is attained when the following conditions are met:

Supply = Demand

$$M = m(r, \bar{r}) W \quad (\text{Money market}) \quad (9)$$

$$B = b(r, \bar{r}) W \quad (\text{Home asset market}) \quad (10)$$

$$eF = f(r, \bar{r}) W \quad (\text{Foreign asset market}) \quad (11)$$

$$W = eF + B + M \quad (\text{Balance sheet constraint}) \quad (12)$$

The exchange rate e is defined as the home currency price of foreign currency. Both B and F are short-run fixed price assets so that they accrue no capital gains as r and $\bar{r}$ change.

The balance sheet constraint (12) and an assumption of imperfect substitutability between assets imply

$$m_r + f_r = -b_r \quad 0 \qquad m_r + b_r = -f_r \quad 0$$

where a subscript denotes a partial derivative. Given the balance sheet constraint (12), the three market equilibrium conditions (9) - (11) contain two independent equations in e and r . Any pair of (9) - (11) with W substituted from (12) can be used to determine equilibrium values of e and r .

The model is represented graphically in Figure 2 where the pair of e and r satisfying the three market conditions is plotted. MM reflects equilibrium in the money market. As the domestic interest rate r increases, portfolio balancers will want to move out of non-interest-bearing domestic money. To maintain money market equilibrium, the exchange rate has to depreciate (e must rise) to increase the attraction of domestic money relative to foreign bonds. (The depreciation has made them more expensive.) The MM has a positive slope. BB represents

Figure 2. Graphical Representation of Branson's Model

Figure 3. Graphical Representation of Open-Market Purchase of Domestic Assets by Central Bank in Branson's Model

Source: Murphy and Duynes [1980].

equilibrium in the domestic bond market. As the domestic interest rate r rises, portfolio balancers will want to increase their holdings of domestic bonds. To maintain equilibrium (since the stocks of bonds and money are fixed in the short run), the domestic currency must appreciate (e decreases) to cheapen foreign bonds and thereby increase their attraction relative to domestic bonds. BB has a negative slope. FF represents equilibrium in the foreign bond market where the (foreign) interest rate $\bar{r}$ is fixed. If domestic interest rate r increases, the attraction to foreign bonds relative to domestic bonds will diminish. To maintain equilibrium, the home currency must appreciate (e falls) to make foreign assets cheaper and thereby increase their attraction again. FF must have a negative slope. Finally, at the intersection of MM , BB , and FF there is equilibrium in the financial or asset market.

The mechanics of the model can also be graphically represented. Figure 3 illustrates the case where the domestic money supply is increased by a purchase of domestic bonds. Initial equilibrium occurs at r_0, e_0 . The open-market operation shifts MM to $M'M'$ and BB to $B'B'$. The shift occurs because the domestic interest rate must decline in order to persuade portfolio holders to shift out of bonds and into money. (The shift in MM is larger than in BB because the decline in interest rate necessary to reestablish equilibrium in the domestic bond market is smaller than the decline needed to reestablish equilibrium in the money market. Imperfect substitutability implies that own-price elasticities of demand are larger than cross-elasticities.) The decline in interest rate, however, creates attraction for a fixed supply of foreign bonds with a fixed interest rate. The increased demand for foreign bonds causes a depreciation of the domestic currency so that the

value of foreign assets matches the value demanded. The result is that the equilibrium exchange rate and domestic interest rate shift from $r_0 e_0$ to $r_1 e_1$. The important conclusion is that raising the domestic money supply directly changes the exchange rate e in order to achieve equilibrium in the financial market. The depreciation comes quickly, before any effects on the price level are seen.

Branson et al. experiment with the effect on r and e of changes in any one of the asset stocks, leaving the others constant. The results are reported in Table 2 along with those of open-market operations.

The model thus far has focused on one country facing a world market. Branson et al. translate it into an operational theory of determination of one bilateral exchange rate. If the analysis is extended to two countries, each with J earning assets and a money, the interaction of demand for the fixed supply of $2J + 2$ assets determines $2J$ rates of return (no returns to the two monies) plus one exchange rate e . The equilibrium exchange rate occurs when the two private sectors are willing to hold the stocks of the two national monies.

As reported in Table 1, an increase in the domestic stock of bonds has an indeterminate effect on the exchange rate. The authors proceed to eliminate this variable from the bilateral model. Only the foreign and domestic money stocks and net foreign assets are considered. Because of the symmetry, only one F should be included for one bilateral exchange rate. For example, in modeling the U.S. dollar-deutsche mark rate only net claims by Germans on the U.S. should be considered. However, a lack of data availability forces the authors to include both countries' total private stock of net foreign assets, i.e., net claims by Germans on the world and net claims by Americans on the world. (The

Table 2. Effects of Increases on Asset Stocks on Short-Run Equilibrium Interest Rate (r) and Exchange Rate (e)

Effects on:	Effects of Accumulation of Stocks			Effects of Open-Market Operations	
	ΔM	ΔB	ΔF	$\Delta B = - \Delta M$	$e \Delta F = - \Delta M$
r	-	+	0	-	-
e	+	?	-	+	+

Source: Branson et al. [1977].

implicit assumption is that third-country assets are perfect substitutes for German assets in the eyes of U.S. portfolio holders, and vice versa.) Considering these limitations and the information in Table 1, the exchange rate determination equation in this example becomes

$$e (\$/DM) = h (M_u^+, \bar{M}_g, \bar{F}_u, F_g^+) \quad (13)$$

where M_u = U.S. money stock

M_g = W. German money stock

F_u = total net foreign assets held by U.S.

F_g = total U.S. net foreign assets held by W. Germany

and the signs over the arguments indicate the sign of the partial derivatives.

Branson, therefore, focuses on the financial market as the determinant of the exchange rate in the short run. The market is constituted of domestic and foreign non-interest-bearing monies and domestic and foreign interest-bearing bonds. The assets are gross substitutes, but no domestic asset is traded in the world market, and foreign interest rates are fixed. The important result of the model is that the exchange rate along with the domestic interest rate equilibrate the quantity of assets demanded with their predetermined stock. Therefore, changes in stocks will directly affect the exchange rate in order for the latter to help maintain equilibrium.

*For a critique and revision of this model see Bisignano and Hoover [1982].

Frankel's Exchange Rate Determination Model

Frankel's [1979] model arises out of the contradictory predictions obtained by different models within the monetary framework. One school which he labels the "Chicago theory" assumes prices are perfectly flexible. For example, if the nominal money supply is increased by 10 percent, prices immediately increase by 10 percent, ceteris paribus, leaving the real money supply constant. Therefore, if the domestic interest rate rises relative to the foreign rate, it is because the domestic currency is expected to lose value through inflation, not because the real money supply has changed. If the local currency is expected to lose value, demand for it falls relative to the foreign currency, causing an immediate depreciation (the exchange rate e rises). Consequently, there is a positive relationship between the exchange rate and the nominal interest differential between countries.

The other type of model Frankel labels as the "Keynesian theory" because it assumes that prices are sticky in the short run. Thus if the nominal money supply rises, the real money supply also rises, at least in the short run. Therefore, a change in the domestic interest rate reflects changes in the tightness of monetary policy; real money supply has changed. A contraction of the nominal money supply, for example, results in a contraction of the real money supply and a rise in the interest rate. The higher interest rate attracts a capital inflow, which in turn causes an appreciation of the currency (the exchange rate e decreases). Consequently, there is a negative relationship between the exchange rate and the nominal interest differential.

It is this discrepancy between the "Chicago" and the "Keynesian" theories which Frankel endeavors to reconcile. In doing so he combines

the assumption of sticky prices with the assumption that there are secular rates of inflation in both the domestic and foreign countries; neither the domestic nor the foreign interest rate is fixed.

Frankel makes two fundamental assumptions in the development of his model. The first is that domestic and foreign bonds are perfectly substitutable so that interest rate parity is maintained:

$$d = r - r_f \quad (14)$$

where d = forward discount,

r = log of one plus the domestic rate of interest,

r_f = log of one plus the foreign rate of interest.

The forward discount is the expected rate of depreciation; there are no risk premiums for foreign relative to domestic bonds.

The second fundamental assumption is that the expected rate of depreciation is a function of the spot rate and of the expected long-run inflation differential between the domestic and foreign countries:

$$d = z (e - \bar{e}) + LI - LI_f \quad (15)$$

where e = log of spot exchange rate,

$\bar{e}$ = log of equilibrium exchange rate,

LI = current rate of expected domestic long-run inflation,

LI_f = current rate of expected foreign long-run inflation.

Equation (15) states that in the short run the exchange rate is expected to return to equilibrium at a rate which is proportional to the current gap. And when in long-run equilibrium ($e = \bar{e}$), the rate of depreciation is equal to the long-run inflation differential ($LI - LI_f$). Combining equations (14) and (15), one obtains

$$e - \bar{e} = -1/z [(r - LI) - (r_f - LI_f)]. \quad (16)$$

Frankel calls the expression in brackets the real interest differential.

The author next assumes that purchasing power parity holds in the long run:

$$\bar{e} = \bar{p} - \bar{p}_f \quad (17)$$

where $\bar{p}$ and $\bar{p}_f$ are the logs of the equilibrium price levels at home and abroad, respectively. The equation states that in the long run domestic prices are identical with the foreign ones deflated by the exchange rate.

Conventional money demand equations are also assumed for both countries:

$$m = p + hy - gr \quad (18a)$$

$$m_f = p_f + hy_f - gr_f \quad (18b)$$

where m, m_f = logs of domestic and foreign money supply,

p, p_f = logs of domestic and foreign price levels,

y, y_f = logs of domestic and foreign output,

r, r_f = logs of domestic and foreign interest rates.

Subtracting (18b) from (18a):

$$m - m_f = p - p_f + h(y - y_f) - g(r - r_f) \quad (19)$$

Using bars to denote equilibrium, we obtain the long-run relationship

$$\bar{e} = \bar{p} - \bar{p}_f = \bar{m} - \bar{m}_f - h(\bar{y} - \bar{y}_f) + g(\bar{r} - \bar{r}_f). \quad (20)$$

equation (20) illustrates the monetary theory of the exchange rate: the latter is determined by the relative demand for and supply of the two

currencies. In full equilibrium an increase in the money supply inflates prices and depreciates the currency proportionately; an increase in income and a decrease in the expected rate of inflation will appreciate the currency.

By substituting equation (20) into equation (16) and assuming that current actual levels are current equilibrium values, the model of the real interest theory of exchange rate determination is obtained:

$$e = m - m_f - h (y - y_f) - 1/z (r - r_f) + (1/z + g) (LI - LI_f) \quad (21)$$

By letting $a = (-1/z)$ and $b = (1/z + g)$ and adding an error term, the model is converted to

$$e = m - m_f - h (y - y_f) + a (r - r_f) + b (LI - LI_f) + u. \quad (22)$$

Frankel considers his model to be a general monetary model in that both Dornbusch's [1976] and Bilson's [1978] models are special cases of the present one. If one lets $b = 0$, one is left with a model that is very similar to Dornbusch's "Keynesian theory" model where secular inflation is not a factor. The difference remains that Dornbusch holds foreign interest rates fixed while Frankel does not. The former is a small country case while the latter is a two-country case.

In a model like Bilson's "Chicago theory" the interest rate differential can be viewed as the inflation differential, i.e., $(r - r_f) = (LI - LI_f)$. Logical transition leads to this conclusion. First, purchasing power parity insures that the rate of depreciation is equal to the difference in inflation between countries so that the relative purchasing power of the currencies is unaffected. For example, if the inflation in the U.K. is five percent higher than in the U.S.,

then a yearly five-percent devaluation of the pound relative to the dollar would maintain relative prices in both countries equal. Second, interest rate parity, equation (14), insures that the depreciation is equal to the difference in interest rate between countries. Then by transition one can logically argue that a) since the inflation differential is equal to the depreciation and b) since the depreciation is equal to the interest differential, it follows that c) the inflation differential ($LI - LI_f$) equals the interest differential ($r - r_f$). One of these terms in equation (22) would be redundant in Bilson's view. If one lets $a = 0$, one is left with a form of Bilson's model. Frankel's model can thus be collapsed into one representing the "Chicago theory."

Whereas the "Keynesian theory" would hypothesize $a < 0$, $b = 0$ and the "Chicago theory" that $a = 0$, $b > 0$, Frankel hypothesizes that $a < 0$, $b > 0$. In other words, there is a negative relationship between the exchange rate and the nominal interest differential, but inflationary expectations also play a role in the determination of exchange rates.

Frankel's model, in conclusion, represents a generalized framework for the monetary approach to exchange rate determination. As in all the monetary models, foreign and domestic interest-bearing assets are considered perfectly substitutable, and only the money market is included. It also combines the short-run price stickiness of some approaches with the variable foreign interest rate assumption of others. It additionally considers long-run inflation expectations as an explicit explanatory factor in exchange rate determination. In so doing, Frankel accepts the "Chicago theory" notion that the rate of change on the price levels affects the exchange rate, but without also assuming perfect price flexibility and continuous purchasing power parity. He thus

combines the more credible assumptions of the monetary approach while discarding some of the more unrealistic ones.

Summary of Flexible Exchange Rate Issues

The literature on flexible exchange rates reviewed in this chapter has indicated the following:

- a) Much of the exchange rate instability experienced since the inception of the float can be attributed to unstable underlying economic conditions;
- b) Bandwagon speculative forces seem to have played a role in registered oscillations around equilibrium values,
- c) Exchange rate flexibility has added to the risk faced by traders, but that added risk does not seem to have significantly curtailed international trade and investment;
- d) Flexible exchange rates can insulate countries from external inflationary shocks, isolate national inflationary pressures from the international economy, and reduce world inflation. But these salutary effects necessitate single-goal monetary policies aimed at controlling inflation regardless of output and employment effects;
- e) Flexible exchange rates can alleviate external imbalances, but there must be congruent fiscal and monetary policies to attain the desired changes in the current account;
- f) Flexible exchange rates reduce the need for compensatory financial flows from central banks (freely floating rates obviate the need entirely), but they add international dimensions to fiscal and monetary policy which complicate policy-making;

- g) Recent theories of flexible exchange rate determination have the common element of emphasizing the financial rather than the goods markets in determining exchange rate equilibrium. However, there is considerable divergence as to how to model the structure of the financial markets and the role of the exchange rate in them.

The overall evidence seems to indicate that the performance of the flexible exchange rate has been neither as poor as its critics at first feared nor as excellent as its proponents first suggested.

CHAPTER IV EXCHANGE RATE ISSUES IN THE AGRICULTURAL ECONOMICS LITERATURE

Introduction

The exchange rate did not become a major issue of research concern in the agricultural economics literature until the early 1970s. The devaluations of the dollar at that time were followed by a great surge in agricultural exports and prices. A research focus was naturally placed on the exchange rate as a possible explanatory factor behind these trade effects. A consequence has been that the literature has concentrated almost exclusively on the effects on agriculture of a discreet, one-shot change in the exchange rate. This focus developed despite the fact that by the time the research was conducted, exchange rate flexibility had been adopted and the value of currencies was changing continuously. The issue of exchange rate variability has received minimal and delayed attention.

This review will group the references into two broad categories. The first group includes the references that deal with discreet devaluations in 1971 and/or 1973 and encompasses most of the publications. The category is subdivided into theoretical and empirical contributions. The second group is a part of the literature which focuses on the linkages of the agricultural economy with the general economy under flexible exchange rates. As will be clarified below, the exchange rate provides one of these linkages.

The Agricultural Economy and Discreet Dollar
Devaluations: Theoretical Studies

Seminal work in this area was provided by Schuh [1974], although the article itself concentrated on the broad effects on U.S. agriculture of the overvaluation of the dollar in the 1950s and 1960s. Schuh postulated that the overvaluation had four major impacts on the U.S. agricultural economy: a) an undervaluation of U.S. agricultural resources in relation to their world opportunity cost, b) this undervaluation forced a more rapid rate of technological change than would have otherwise occurred, c) a larger share of the benefits from technical change accrued to U.S. consumers than under an equilibrium exchange rate, and d) the 1971 and 1973 devaluations and the subsequent float implied structural changes for U.S. agriculture.

Schuh's reasoning can be illustrated with the aid of Figure 4. Curves DD and SS represent domestic demand and supply conditions, respectively. I_d represents the international demand for agricultural products. The line is drawn horizontally to facilitate exposition. Schuh presumes that demand is highly, but not perfectly, elastic. If I_d prevails, the price of output will be P_1 with quantity Q_4 produced. Of this total Q_1Q_4 is exported, while OQ_1 is consumed locally. Export earnings would include Q_1ABQ_4 , while domestic earnings include OP_1AQ_1 , yielding total gross earnings OP_1BQ_4 . Now assume the currency is overvalued. Viewed externally, the overvaluation signifies a rise in product prices in terms of foreign currency which reduces demand to $I'd$. The consequence to the farm sector is that output price drops to P_2 and quantity supplied, to Q_3 , indicating the product is undervalued in relation to its equilibrium exchange rate alternative. Gross income is

Figure 4. Demand and Supply Conditions for Industry Producing for both the Domestic and Foreign Markets

Source: Schuh [1974].

reduced to OP_2CDQ_3 . Export earnings are reduced by an amount equal to the shaded area. The magnitude of the declines will depend on the respective elasticities of demand and supply and the extent of the overvaluation.

Schuh concentrates on the effects of this overvaluation on the rate of technical change and the structural effects of technical change, e.g. the rate of release of labor from the farm sector. However, he went on to hypothesize that "an important share of the rise in agricultural prices in mid-1973 is the result of monetary phenomena [i.e., the exchange rate] which induced an export boom" [Schuh 1974, 12]. He also specifically predicted that a devaluation would result in a rise in the relative price of food and a shift in the U.S. agricultural product mix toward export products. These price and export quantity effects of a devaluation comprised a minor portion of the paper. But they elicited a great deal of controversy in the literature that has not been completely resolved to date.

Grennes [1975] directly responded to Schuh's article. He expressed concern over the poor evidence presented to claim that the dollar had been overvalued during the 1950s and 1960s. He also argued that a dollar overvaluation causes a positive terms-of-trade effect (by extracting more foreign exchange per unit of product) whose gains may or may not dominate losses due to production and consumption inefficiencies (arising from a reduction in foreign demand), but at least the losses are mitigated. Grennes makes the additional comment that the export subsidy programs in place during the period also helped counteract the effects of a possible overvaluation. A conclusion from his arguments is that a dollar overvaluation, even if present, may not have had the

pervasive impacts Schuh suggested. The implication can be that a devaluation would also not produce pervasive effects.

An analysis by Kost [1976] also contradicted Schuh's work. Kost examines four cases: a) a devaluation by the exporter, b) a devaluation by the importer, c) a revaluation by the exporter, and d) a revaluation by the importer. He concentrates on the first case as the one of interest to U.S. agriculture. This case is represented by an increase in import demand from the perspective of the export country (in a two-country model). This shift in demand will be equal to the percentage devaluation change; thus, according to Kost, there are upper limits to the export price and quantity changes. As illustrated in Figure 5 (where $\% \Delta e$ indicates the devaluation in percentage terms), the maximum increase in quantity exported occurs when export supply ES is perfectly elastic (I_d representing import demand). Then the upper limit in the increase in exports is equal to the devaluation in percentage terms. As illustrated in Figure 6, the maximum change in price occurs when export supply is perfectly inelastic. The upper limit in price change will also be equal to the devaluation in percentage terms. When there is a maximum change in price there is no change in quantity, and vice versa.

Kost argues that both the elasticity of demand and supply is very low for U.S. agricultural products, particularly in the short run. Therefore, one can only expect a small impact on agricultural trade as a result of a change in the exchange rate, and what effect there is will be primarily reflected in prices. Kost's arguments imply that the exchange rate could not have had the pervasive impacts Schuh suggested and that devaluations would not produce the price and quantity effects Schuh predicted.

Figure 5. Maximum Effect on Export Quantity as a Result of a Devaluation, According to Kost [1976]

Figure 6. Maximum Effect on Export Price as a Result of a Devaluation According to Kost [1976]

Kost's line of reasoning is disputed by Bredahl and Gallagher [1977]. They draw different conclusions from a simple two-country, one-product free trade model:

$$QD = a_2 + (b_2 \times \$P) \quad (b_2 \leq 0) \quad (23)$$

$$QS = a_1 + b_1 \$P \quad (b_1 \geq 0) \quad (24)$$

$$QD = QS \quad (25)$$

where QD = excess quantity demanded,

QS = excess quantity supplied,

x = foreign currency price of the dollar,

$\$P$ = product price in dollars.

The effect of an exchange rate is determined by totally differentiating each equation and solving for the appropriate differential at equilibrium. The total differential for the price in dollars is

$$d\$P = \frac{b_2}{b_1 - xb_2} \quad (26)$$

Since the numerator is positive and the denominator is negative, a depreciation (a drop in x) results in a dollar price increase. The expression can also be stated in what the authors call the reduced-form elasticity of equilibrium price for the exchange rate (or, alternatively, the exchange rate elasticity of price) $E_{\$P,x}$:

$$E_{\$P,x} = \frac{-1}{1 - \frac{E_{QS}}{E_{QD}}} \quad (27)$$

where E_{QS} and E_{QD} are the elasticities of excess supply and excess demand, respectively. $E_{\$P,x}$ is bounded by 0 and -1, indicating the

percentage change in equilibrium price due to a change in the exchange rate will at most equal the latter in percentage terms. At this point there is not disagreement with Kost.

Next the authors derive the elasticity of the equilibrium quantity with respect to the exchange rate ($E_{q,x}$). Noting that the excess supply curve does not shift in response to a devaluation:

$$E_{q,x} = E_{\$P,x} \cdot E_{ES} = \frac{E_{ED} E_{ES}}{E_{ES} - E_{ED}} \quad (28)$$

This elasticity has an upper bound of zero but has no lower bound. Therefore, in contrast to Kost, the authors conclude that the change in equilibrium quantity may exceed the percentage change in the exchange rate. Through further algebraic manipulation the authors also note that if the elasticity of supply is greater than one and the elasticity of excess demand is not zero, the percentage change in quantity will exceed that of price in response to an exchange rate change. This result also contrasts with Kost's finding that the exchange rate will affect price primarily.

Bredahl and Gallagher emphasize that the elasticities of the excess relationships determine the quantity and price effects of an exchange rate change. These elasticities of excess demand and supply may be elastic even if the underlying domestic relationships are inelastic. Thus noting that U.S. agriculture has highly inelastic demand and supply is not sufficient reason to conclude, as Kost does, that excess demand and supply are inelastic. Furthermore, the authors show that the elasticity of export demand for a particular country's product (such as the U.S.) can be much larger than the excess relationships which, in turn, may be more elastic than the underlying domestic relationships.

The conclusion to be drawn from these theoretical findings is that the export sector of U.S. agriculture can be very responsive to a change in the exchange rate. Prices may not exhibit more than unitary elasticity, but export quantities may respond quite elastically. The exchange rate could be as important to the agricultural sector as Schuh suggested it could be.

A common result obtained by Kost [1976] and Bredahl and Gallagher [1977] is that the export price change due to an exchange rate change must be less than or equal to the exchange rate change (in percentage terms). Disputing this conclusion was a major purpose of an article by Chambers and Just [1979]. According to these authors, the source of the divergence of conclusions is the model presented in equations (23)-(25). In their view the excess demand relationship in equation (23) can be derived from standard neoclassical theory only under the assumption of zero cross-price elasticities between the traded commodity and all other goods for which prices are not constant.

Since neoclassical demand functions are obtained by maximizing an individual's preference function subject to a budget constraint, an individual's demand for a commodity is a function of the price of that commodity, income, and all other prices. Therefore, excess demand functions ought to be respecified as

$$QD = f(H, M) \quad (23a)$$

where H is a vector containing the prices of all commodities in the importing country, and M is income. Similarly, excess supply functions such as equation (24) ought to be respecified to include the prices of all alternative production possibilities:

$$QS = g(P) \quad (24a)$$

where P is a vector containing the prices of all commodities in the exporting country. The authors additionally invoke the law of one price:

$$G = xP \quad (29)$$

With these respecifications and assuming no change in income the authors arrive at a new term for the exchange rate elasticity of export price (derivation details appear in an appendix to Chambers and Just [1979]):

$$(E_{\$P,x})_n = E_{\$P,x} + \frac{E_{\$P,x}}{E_{ED}} [(E_{ED}^*)' (s + E_{\$P,x}^*) - (E_{ES}^*)' (E_{\$P,x}^*)] \quad (30)$$

where $(E_{\$P,x})_n$ = net exchange rate elasticity of export price in the n -commodity case,

E_{ED}^* = the vector of cross-price elasticities of excess demand,

s = a vector of ones,

$E_{\$P,x}^*$ = the vector of exchange rate elasticities of exporter's cross-prices,

E_{ES}^* = vector of cross-price elasticities of supply.

$(E_{\$P,x})_n$ can be larger in absolute value than $E_{\$P,x}$. If the latter has a lower bound of -1 , then it follows that in the n -commodity case a change in the exchange rate can cause a more than proportional change in export price. According to Chambers and Just, it is the overly restrictive assumptions of the single-commodity model which leads to the result that the change in price cannot be more than proportional.

In response to these findings, Bredahl et al. [1979a] also develop an n-commodity model. After lengthy development and manipulation, they arrive at what could be a surprising conclusion: "the restrictions suggested by the free trade simple [one-commodity] model are appropriate regardless of the number of commodities included in the model" [Bredahl, et al., 1979a, 15]. Regardless of the number of commodities the exchange rate elasticity of the export price is bound within the $[0, -1]$ interval.

Protection in Trade Models

The models discussed thus far have assumed free trade conditions which often do not describe actual conditions for agricultural trade. Some efforts have been made to examine the theoretical impact on U.S. agriculture of an exchange rate movement in the presence of market interference by government. Dobbins and Smeal [1979] have hypothesized exchange rate effects under two forms of market interference: price support and supply-management programs.

To determine the exchange rate effects under a price support program, assumptions need to be made about government stocks policy. A reasonable assumption is that government buys any excess supply produced domestically at the support price (P_s). Imports are banned at all lower prices. The government then has the option of either dumping its stocks on the rest of the world (ROW) at whatever price it can fetch or to release increasing quantities with increasing ROW prices. With the first policy export supply will be completely inelastic up to the support price and then it resumes a normal positive slope at higher prices; there is a discontinuity in export supply. With the second

policy export supply up to the support price has a positive slope determined by the government's decision on how much to sell in the ROW market at what price. If at the support price the government still holds stocks, then it will sell all at that price. At higher prices the normal positively sloped curve is resumed, reflecting the response of private producers.

It should be apparent that the trade effects of an exchange rate change will depend on the government's stocks policy and the magnitude of the exchange rate change. Possible situations are illustrated in Figures 7 and 8. Figure 7 represents a government dumping policy. Devaluations that create changes in ROW demand such as ED' will not affect quantity traded but will increase export receipts. Shifts such as ED'' result in ROW prices higher than the support price and quantity traded will increase. Figure 8 represents a government policy of higher releases with higher prices, assuming that there are remaining stocks at the support price and that government will exhibit a higher supply response to price than will private producers. Obviously, the effect of an exchange rate change will depend on its magnitude (i.e., the percent shift in ROW export demand).

An example of the second case, supply-management policies, is a scheme of land retirement. If government establishes a trigger price beyond which payments for land retirement cease, the long-run export supply will be almost completely elastic at that price until a level of output is reached which includes that of all the previously retired acreage. Export supply would then become less elastic at all higher output levels. The effect of a devaluation will depend on whether the higher resulting price reaches the land-release trigger price. Clearly,

Figure 7. Exchange Rate Effects on Trade Assuming Government Dumping of Excess Stocks

Figure 8. Exchange Rate Effects on Trade Assuming Government Sales Respond to Price and Government Stocks Remain at the Support Prices

there will also be short- and long-run effects since the retired acreage cannot produce instantaneously. A devaluation can increase price beyond the trigger point in the short run, but as planted acreage increases, there will be a subsequent downward pressure on price.

A third form of market interference is used by the European Economic Community (EEC). Bredahl and Womack [1977] have developed a model appropriate for this actual trade condition. The EEC explicitly restricts agricultural imports by imposing a variable levy. The Community establishes a minimum import price termed the threshold price. The variable levy is the amount by which the threshold price is greater than the price at which imports enter, c.i.f. Rotterdam. Under these conditions an appropriate model would be

$$QS = a_1 + b_1 \$P \quad (b_1 \geq 0) \quad (24)$$

$$QD = a_2 + b_2 TP \quad (b_2 \leq 0) \quad (31)$$

$$QD = QS \quad (25)$$

where TP is the threshold price, an exogenous variable. The Community-wide threshold prices are quoted in "units of account" which are defined in terms of gold. For agricultural products the value of a member country's currency is fixed in relation to the unit of account (the "green" exchange rate). The variable levy assures that changes in world prices that are under the threshold price (the usual case) do not affect the flow of goods into the Community.

A result from this trade policy is that a devaluation by a non-member country such as the U.S. will not affect equilibrium values. If the dollar devalues by 10 percent such that the c.i.f. price in units of

account drops 10 percent, then the variable levy increases by 10 percent. No further adjustments are necessary within the Community. On this basis, excess demand equation (31) can be rewritten

$$QD = a_2 + x b_2 (MCP/x) \quad (b_2 \leq 0) \quad (32a)$$

where MCP is the member country's price in its own currency. Changes in the exchange rate x cancel each other.

Another effect of the EEC's trade policy is that revaluations may have different effects from devaluations. The authors consider two cases of revaluation by an importing member country. The first involves a revaluation of a member country's currency against both the dollar and the unit of account. The second case is one of revaluation against the dollar only.

The mechanics of the first case can be better illustrated by again rewriting the excess demand equation to reflect the relationship of the member country's currency with the unit of account:

$$QD = a_2 + x b_2 ((UAP) (z)/x) \quad (b_2 \leq 0) \quad (32b)$$

where UAP is the threshold price in units of account and z is the member country's price of one unit of account. Since the dollar price is canceled out in (32b) and excess supply is a function of the dollar price, then excess supply plays no role in the determination of equilibrium; the differential of the excess demand function determines the change in equilibrium quantity which expressed as a reduced-form or net elasticity is

$$E_{q,z} = E_{QD} \quad (33)$$

This result contrasts with the analogous free trade condition (equation (28)):

$$E_{QD} \geq \frac{E_{QD} E_{QS}}{E_{QS} - E_{QD}} .$$

The member country revaluation in this case produces a larger change in equilibrium price than under free trade conditions.

The authors also derive the net elasticity of equilibrium price with respect to the revaluation:

$$E_{\$P,z} = \frac{E_{QD}}{E_{QS}} . \quad (34)$$

This result also contrasts with the analogous free trade condition (equation (27)):

$$\frac{E_{QD}}{E_{QS}} \geq \frac{-1}{1 - \frac{E_{QS}}{E_{QD}}} .$$

The revaluation also produces a larger effect in equilibrium price than under free trade conditions.

In the second case, where the member country currency revalues against the dollar but not against the unit of account, the variable levy does not change since the dollar price at Rotterdam has not changed. Nevertheless, the imports are cheaper to the revaluing country. The excess demand relationship must again be rewritten to reflect the now fixed variable levy:

$$QD = a_2 + b_2 \times ((\$P + VL \cdot z)/x) \quad (b_2 \leq 0) \quad (32c)$$

where VL is the variable levy. Now the dollar price enters again the excess demand equation so that equilibrium quantity and price must be

calculated in conjunction with excess supply (equation (24)) which is also a function of dollar price. However, the total differential of (32c) is identical with the differential of excess demand under free trade. Consequently, the result in this case is the same as under free trade.

Summary of Theoretical Studies

Schuh [1974] elicited much theoretical response on the issue of exchange rate effects on the U.S. agricultural sector. Although Schuh concentrated on the effect of a dollar overvaluation on the structure of U.S. agriculture, the response was mostly limited to the importance, in terms of output price and export quantity effects, of the devaluations of the early 1970s. Kost's [1976] conclusion that under free trade the percentage change in quantity exported must be less than or equal to the percentage change in the exchange rate has been subsequently refuted by the literature. However, the response of price to an exchange rate change has remained controversial. Chambers and Just [1979] assert that the restrictive assumptions of a one-commodity model lead to the conclusion that the exchange rate elasticity of price must be unitary or inelastic; a more realistic n-commodity case would not put lower bounds on the values of the elasticity. Bredahl et al. [1979a] answer that even the n-commodity case gives the result that the elasticity must be bound to the $(0, -1)$ interval.

Models of trade under market interference indicate that the interference can alter the response of export price and quantity to a movement in the exchange rate. They also show that the nature of the alteration in response depends on the nature of the interference, so

that no generalized conclusions can be made. Furthermore, in an environment of trade restrictions, the response to a devaluation will not necessarily be the opposite to that of a revaluation of an equal magnitude. Consequently, making more realistic assumptions about the conditions of agricultural trade complicate any theoretical corroboration of Schuh's arguments.

The Agricultural Economy and Discreet Dollar
Devaluations: Empirical Studies

The first empirical study to deal with the effects of the devaluations of the early 1970s on the U.S. agricultural economy was by Greenshields [1974]. The study consisted of estimating through ordinary least squares (OLS) procedures the Japanese demand for four American agricultural products: wheat, corn, soybeans, and sorghum. After estimating the parameters, he estimated predicted import demand in 1971-1973 by alternatively using actual exchange rates and constant 1970 rates. The difference in quantity demanded under the two alternatives was attributed to the exchange rate. Greenshields concluded that a 32-percent increase of the purchasing power of the Japanese yen in U.S. export markets in 1971-73 produced a three-percent increase in wheat sales, a seven-percent increase in soybean sales, and no significant response in sales of corn and sorghum. His findings did not lend empirical support to the importance of exchange rates to agriculture but were the subject of later criticism by Chambers and Just [1979]. They felt that to the extent that Japan could influence individual grain prices, OLS procedures were inappropriate and yielded biased results.

The first empirical response to Schuh [1974] was by Vellianitis-Fidas [1976]. One part of this reference included a cross-sectional

study using OLS with a stepwise procedure. Exchange rate changes were included as an independent variable. Its importance was judged by its level of significance and whether it was dropped by the stepwise procedure. Vellianitis-Fidas' first conclusion was that almost none of the variation in agricultural products exported from 1971 to 1973 can be explained by the variation in exchange rates, and that the U.S. did not export relatively more or less to countries whose currencies had changed the most in relation to the dollar.

The author also performed a time-series study which included trade in wheat, corn, cotton, tobacco, and oilseeds during the 1954 to 1969 period. The explanatory variables used were the exchange rate as a dummy variable and a trend variable as a "proxy" for all other structural variables. Her finding was that the majority of countries that imported these crops did not significantly change their level of trade with the U.S. or from the world after they had changed their exchange rates.

These findings minimize the importance of the exchange rate, but they, too, were the subject of criticism centered around the lack of theoretical basis for the models used. Indeed Vellianitis-Fidas [1976, 108] recognized as much: "the purpose of this analysis is not to build a model explaining agricultural exports, but simply to look at the significance of one variable--the exchange rate." Unfortunately, statistical procedures do not allow the proper estimation of one explanatory variable in isolation from other influencing variables. Accordingly, Schuh [1975, 698] responded to an earlier version of the paper by noting that the procedures were "'ad hoc'ery" of the worst sort. Her model does not have the power to discriminate an exchange

rate effect, and therefore her results should be taken with a grain of salt." Schuh also noted that representing reality in trade in the time-series model with a trend and a dummy variable would lead to meaningless conclusions. Chambers and Just [1979] levied similar criticisms.

Some of the later empirical models began to explicitly account for restrictions in agricultural trade. Among the first was a spatial world trade model presented by Johnson et al. [1977]. The model consisted of a) a set of demand equations, b) a set of price relations, and c) a set of market clearing equations:

$$Q_{ij} = f(P_{ij}^D, Z_i) \quad \text{for } i, j = 1, \dots, n \quad (35)$$

$$P_{ij}^D = rP_j^S + t_{ij} \quad (36)$$

$$w_{1j} Q_{1j} + w_{2j} Q_{2j} + \dots + w_{nj} Q_{nj} = S_j \quad \text{for } j = 1, \dots, n \quad \varepsilon_{wij} = 1. \quad (37)$$

where Q_{ij} = quantity consumed in country i of wheat originating in country j ,

P_{ij}^D = consumer price in country i of wheat from country j ,

Z_i = exogenous demand shifter for country i ,

P_j^S = supply price of country j ,

t_{ij} = exogenous shifters affecting difference between origin price and consumer prices,

r = exchange rate between i and j ,

w_{ij} = fraction of exports from country j that go to country i ,

S_j = exogenous supply in j .

The exogenous shifters are Z_i , S_j , and t_{ij} . The latter include all the important trade policy changes and changes in transportation costs. Although the model consists of six endogenous countries (U.S.A., Canada,

Australia, Argentina, EEC, and Japan) and an exogenous rest of the world, making 32 endogenous variables, the authors concentrate on how the domestic U.S. price of wheat is affected by a) a 10-percent dollar devaluation with respect to Europe and Japan, b) a lowering of the EEC variable levy (discussed in the previous section), c) higher export taxes by Canada and Australia, and d) a rise in transportation costs of U.S. exports to Europe and Japan due to restrictive U.S. shipping policy.

The authors concluded that the combined trade policies of the EEC, Canada, Australia, and Japan induced a 40.8-percent increase in the price of U.S. wheat. On the other hand, the 10-percent dollar devaluation produced a 7-percent increase in U.S. wheat price. (Findings were for the year 1972/73-1973/74.) They also estimated that a 30-percent rise in shipping costs due to U.S. shipping policy (a reasonable assumption in the authors' view) induced a 7-percent decrease in U.S. wheat price, thereby neutralizing the exchange rate effect. The conclusion drawn from the study was that the role of the exchange rate should neither be ignored nor exaggerated. Changes in trade policy had a much larger impact on wheat prices in the early 1970's than the dollar devaluations.

An empirical issue ancillary to the trade sector effects of exchange rate movements has been the magnitude of the elasticity of foreign demand for U.S. agricultural products. In support of his argument that the exchange rate is indeed important to agricultural trade, Schuh [1975] cited foreign demand elasticity computations by Tweeten [1967] which were quite large: a maximum of -15.85 under free trade and -6.42 under assumptions of restricted trade. Johnson [1977]

also produced large estimates of free trade elasticities, ranging from -2.8 for soybeans to -10.18 for feed grains. Bredahl et al. [1979b] consider these large estimates the result of improperly accounting for the price transmission effect, i.e., the adjustment of foreign prices in response to changes in U.S. prices. Domestic price insulation reduces or altogether eliminates price transmission effects and, in turn, reduces the elasticities of export demand. The authors estimate the elasticity of export demand for several crops by explicitly considering the effects of price insulation. They alternatively assume for each crop a maximum price transmission elasticity of 1.0 and a minimum of zero. The lowest estimate they obtained for an elasticity of export demand was -0.09 for corn while the maximum estimate obtained was -2.36 for sorghum. These relatively low estimates imply that the exchange rate effects on quantity traded may not be as large as Schuh [1974] had suggested.

Meyers et al. [1979] make use of the notion of price transmission effects to show how trade restrictions have an impact on exchange rate trade effects. They develop a model for the computation of these effects which includes a) the estimation of foreign internal demand elasticities, and b) the estimation of price transmission effects which make the exchange rate explicit. For the small country case the exchange rate effect on quantity exported in percentage terms (i.e., $E_{q,x}$) is

$$\frac{dQD_i}{QD_i} = (E_{d1i} E_{p1i} + E_{d2i} E_{p2i}) \frac{dr_i}{r_i} \quad (38)$$

where QD_i = total import demand,

E_{d1i} = own-price elasticity of demand,

E_{d2i} = cross-price elasticity of demand,

E_{p1i} = elasticity of price transmission for p_{1i} ,

E_{p2i} = elasticity of price transmission for p_{2i} ,

i = subscript for i th country,

r = foreign price of the dollar.

The authors make note of two implications of this model. First, in all countries which insulate all relevant prices ($E_{p1i} = E_{p2i} = 0$), no exchange rate effects should be expected. Regardless of the magnitude of the domestic price elasticities, the price transmission elasticities would be zero and there would be no change in import demand for that country. Second, even if demand is homogeneous of degree zero in prices, an exchange rate adjustment can have an impact if not all price transmission elasticities are of similar magnitude.

Meyers et al. [1979] estimate the effects of the appreciation of the Japanese yen in relation to the dollar. They apply the model to wheat, feed grains (corn and sorghum), and soybeans. Since Japanese prices for wheat and its substitute, rice, are fixed above the world price, the price transmission elasticities are zero for both commodities, and exchange rates would not be expected to have any impact on Japanese wheat imports. For soybeans and feed grains the Japanese domestic demand elasticities were estimated to be -0.23 and -0.44, respectively. The price transmission elasticities were 0.90 and 0.96 for feed grains and soybeans, respectively. Using the above small country model which provides maximum exchange rate effects, the authors compute the exchange rate elasticity for quantity traded to be -0.21 for feed grains and -0.42 for soybeans. The trade response to an exchange rate change is inelastic, contrary to Schuh's [1974] suggestions.

In further work along these lines, Collins [1980] estimated a) the foreign price effects in elasticity form of a change in the U.S. price of wheat, corn, and soybeans and b) the foreign price effect of a change in the exchange rate. These are the elasticity of price transmission and the now familiar exchange rate elasticity of price ($E_{\$p,x}$). The study included 47 countries. Collins found these estimates to run the whole range from zero to one. These findings complement the work by Bredahl et al. [1979b] who had used the price transmission extremes of zero and one to compute maximum and minimum estimates of elasticities of export demand.

Additional sophistication was brought to the issue by Collins et al. [1980] by including inflation in an analysis of exchange rate changes under free and restricted trade. The authors specified a world market equilibrium system for each of four commodities: wheat, corn, soybeans, and cotton. The system consisted of a domestic demand and supply relation for each country engaged in trade, a market clearing world equilibrium condition, and price linkage equations based on a numeraire country (U.S.):

$$D_i = D_i (P_i / OP_i) \quad (39)$$

$$S_i = S_i (P_i / OP_i)_{-1} \quad (40)$$

$$S_{us} - D_{us} = (D_i - S_i) \quad (41)$$

$$P_i = g_i (e_i P_{us}) \quad (42)$$

where D_i = domestic demand in country i ,

S_i = domestic supply in country i ,

P_i = own-price in country i ,

OP_i = general level of output prices in country i ,

-1 = one year lag,

S_{us} = supply of the U.S.,

D_{us} = demand of the U.S.,

$\sum_i$ = summation of operator excluding the U.S.,

e_i = value of i th country's currency per U.S. dollar,

P_{us} = U.S. price.

By taking the total differential of these four equations and solving for real (deflated) U.S. commodity price, the authors note that this price depends on a) changes in the general price levels and exchange rates in the current period and b) a supply effect due to price and exchange rate changes in the previous period.

The authors first use the model to compare the impacts of inflation-adjusted exchange rate changes in a world characterized alternatively by a) free trade, b) nominal-price insulating trade policies, and c) real-price insulating trade policies. They find that the impact of exchange rate changes is largest under nominal-price insulation conditions. They conclude from this exercise that if foreign countries had tried to hold real prices fixed during the 1970s, the inflation-adjusted exchange rate impact on U.S. prices would not have been different than if they had engaged in free trade.

Their next step is to decompose the inflation-adjusted exchange rate impact on real U.S. wheat prices into demand, supply, and nominal exchange rate effects in an environment of restricted trade. They find

that in five of the seven years between 1970 and 1978 the nominal exchange rate impact was negative, i.e., it reduced output price. This result is explained by the fact that much of U.S. wheat exports is destined to developing countries whose currencies depreciated against the dollar as the dollar depreciated in relation to other major currencies. The authors thus caution on the inappropriateness of using simple exchange rate measures to infer exchange rate impacts for individual commodities. In analyzing demand and supply effects, they conclude that the real exchange rate impacts during the 1970s depended on both current and past exchange rate changes and that the economic impact of these changes in any one year have been offsetting; e.g. an exchange rate movement last year might induce a supply effect this year which neutralizes a demand effect caused by a movement this year.

Finally, the authors compared the real exchange rate effects on U.S. prices for wheat, corn, cotton, and soybeans (under the trading conditions most appropriate to the individual commodity) with the actual, registered real price change. They concluded that real exchange rates had a minor role in the large registered increases in commodity prices during the period. For example, of the 108-percent increase in real wheat prices from 1972/73 to 1973/74 only 7 percent can be attributed to the change in the real exchange rate.

Lessons to be drawn from the study were among the authors' concluding remarks:

The alluring simplicity of being able to announce exchange rate impacts on trade, hence prices, as simply large or small is rejected. Their size depends on the crop, the year, the countries considered, the degree of government influence on markets, the underlying elasticities, the price variable that

is measured, whether real or nominal, the alternative prices considered, and importantly, the definition of the exchange rate effect. [Collins, et al 1980, 664]

A completely different form of empirical analysis--and not one adhering to the recommendations above by Johnson et al [1980]--was undertaken by Chambers and Just [1981]. Their focus was on the dynamic effects of an exchange rate change on both the domestic and the trade sectors of U.S. agriculture. For the purpose they built a simultaneous system of 15 equations for the corn, wheat, and soybean markets. The system included for each of the three crops a disappearance, inventory, production, export, and an identity equation. The latter merely states that production plus lagged inventory must equal (domestic) disappearance plus exports plus current inventory. The exchange rate is included as a simple SDR (Special Drawing Right)/dollar separate regressor in the export equations. This treatment implies that exports respond to the exchange rate independently of prices; the separate exchange rate regressor prevents the exchange rate from being a simple price deflator. Also, no attempt is made to discriminate between multiple exchange rate changes. No attempt is made to explicitly model restrictions in agricultural trade. However, the inventory and disappearance equations represent an attempt to measure the domestic impact of an exchange rate change and not just export quantity and price effects. The approach is more in line with the concerns originally expressed by Schuh [1974].

The authors derive three-stage least squares reduced-form estimates of the coefficients along with the elasticities of the different explanatory variables. Their results agree with the arguments made in Chambers and Just [1979]: they find that the exchange rate elasticity

of price is elastic in all cases. They thus cite a substantial effect of the exchange rate on grain prices. They estimate that between 1971 and 1975 about 70 percent of the increase in deflated wheat price can be explained by short-run adjustments to the exchange rate. The effects on export quantity are also large: the dollar depreciation over the period accounts for all of the increase in wheat and soybean exports and over 90 percent of the increase in corn exports. Regarding the domestic impacts, the authors note that the production impact of an exchange rate is nil. The wheat and corn markets respond to the rise in exports (caused by the depreciation) by drawing on inventories while the soybean market curtails domestic consumption relatively more.

The analysis of dynamic effects via dynamic multipliers lead the authors to conclude that peak effects are registered soon after a depreciation, generally during the first quarter. But the effects of later quarters add to the effects of earlier quarters. Therefore short-run elasticities are smaller than those of the long run. For example, the short-run exchange rate elasticities of wheat, corn, and soybean prices are -1.242, -1.903, and -2.643, respectively. The respective long-run elasticities are -0.790, -1.377, and -2.165. The authors note that corn and soybean prices remain elastic, while the long-run elasticity of wheat is similar to the estimate by Johnson et al. [1977].

These findings lend empirical support to Schuh [1974]. In the authors' words [Chambers and Just, 1981, 45]: "The results . . . imply that the devaluation and subsequent floating of the dollar may have had important allocational effects in the U.S. economy."

An earlier and simpler reference also lent support to the importance of exchange rates. Konandreas et al. [1978] simply estimated

the export demand for U.S. wheat from several regions of the world. Neither simultaneities nor wheat trade restrictions were modeled. Using the coefficient estimates, they calculate the exchange rate elasticity of export demand. They find that the demand for U.S. exports of wheat is responsive to currency realignments; the elasticity for each region is estimated to be greater than one in absolute value. They also find that the less developed the region, the greater is the response to currency changes.

Finally, Loseby and Venzi [1979] take a multinational approach to the measurement of exchange rate effects. On a worldwide basis they record the actual price effect of an exchange rate change between an exporter and an importer in the trade of six crops: wheat, cocoa, corn, coffee, cotton, and tea. Their focus of attention is the price movement after import demand and export supply adjust to the exchange rate change. These movements are categorized into three groups: a) movements that are ameliorated by the exchange rate change (e.g. an importer appreciates by 10 percent, and its import commodity price drops by 5 percent), b) movements that are reinforced by the exchange rate change (e.g. an importer appreciates by 10 percent, and its import price drops by 15 percent), and c) price moves contrary to expectations (e.g. an importer appreciates by 10 percent, and price increases by, say, 2 percent).

It is interesting to note that case b) implies that the exchange rate elasticity of price is positive, while case c) implies it is greater than one in absolute value. Both of these cases contradict the results of two-country models such as that of Bredahl et al. [1979a] where the elasticity is determined to be bound to the $(-1, 0)$ interval. Loseby and Venzi list conditions in a multinational environment which

can lead to results that fall in b) or c) (to which the reader can refer).

The authors find that out of 24 observations during 1973-76, two fit in category a), 14 in category b), and eight in category c). These results suggest that the exchange rate elasticity of price can include a large range of positive and negative numbers and contrast sharply with the results of previous models that have concentrated on U.S. trade with the rest of the world.

The empirical studies reviewed have mostly concentrated on the measurement of the export price and quantity effects of the dollar devaluations of the early 1970s. The indications obtained have been varied and contrasting. Generally, the studies which have considered the complications of agricultural trade--various forms of restrictions, divergent multilateral exchange rates, differential inflation rates between countries, restricted shipping--have found that the exchange rate plays a minor although not insignificant role in agricultural trade. Studies that have abstracted from these complications have tended to lend greater importance to exchange rates. One study with many importers and exporters reaches findings obtained by none of the others.

One can conclude that empirical research has not led to a synthesis of professional opinion on the effect of exchange rate changes on agriculture.

Flexible Exchange Rates and the Agricultural Economy

The articles reviewed above compose the bulk of exchange rate research in the agricultural economic literature. Despite their

disparate approaches and conclusions, they have had the common trait of having dealt with discreet changes in the exchange rate in an adjustable-peg environment. However, as indicated earlier, the real international monetary environment when all the articles were published was one of flexible exchange rates whose movements occur in continuous rather than discreet fashion. And more importantly, the section on exchange rate determination showed that these continuous changes occur much more at the behest of financial market forces than the discreet changes. In other words, flexible rates are endogenous to financial market conditions in the general economy.

This endogeneity implies that if the exchange rate affects agricultural trade, then the financial market forces that affect the exchange rate must also have an indirect impact on agriculture. The flexible exchange rate becomes one vehicle by which the financial forces of the general economy affect the agricultural economy.

The linkages between the national and agricultural sectors have been the subject of an increasing number of articles in the agricultural economics literature. However, few have recognized the flexible exchange rate as one of those linkages. The agricultural economics literature on macroeconomic linkages has taken three forms: a) no reference to exchange rates, b) treatment of the exchange rate as a financial factor that affects agricultural trade but one which is exogenous both to the agricultural and general economies, and c) treatment of the exchange rate as a financial factor that affects

agricultural trade and one which is endogenously determined in the general economy. Some examples for each type are described below.

Linkages with Exchange Rates Excluded

The examination of linkages is not a new activity. Doll [1958] looked at the efficacy of using an expansionary money policy to alleviate the cost-price squeeze induced by the recession of the late 1950s. He found for the ten previous years a poor relation between prices paid by farmers and money supply. He thus concluded that an expansionary policy was not an effective way of alleviating the cost-price squeeze. Gramm and Nash [1971] studied whether the general and agricultural economies responded differently to changes in monetary conditions. Using 1919-1966 data they find that both sectors respond in similar fashion to money stock changes; farm and nonfarm income experience equivalent changes as a result of changes in the money stock.

Neither of these studies considered the exchange rate as a possible vehicle of connecting monetary policy with the agricultural economy, but the omission was probably not important, since the studies were performed during the period of adjustable-peg exchange rates which were to a large extent determined by exogenous government decisions. However, some recent contributions to the linkage issue have also neglected proper consideration of the exchange rate. For example, Barnett et al. [1981] examine the causal linkage between the quantity of money in circulation and agricultural prices, using the quantity theory of money as a theoretical foundation. Consideration of flexible exchange rates is omitted, even though the quantity theory of money can certainly be related to exchange rate determination.

Perhaps it is this omission which leads to a puzzling conclusion. The authors find that during 1971-1979, U.S. prices follow reserves of developed countries by 16 months; i.e., there is a causal link between U.S. agricultural prices and changes in the money stock of developed countries. In an environment of fixed exchange rates, this result is understandable; increased money stocks abroad increase foreign demand for U.S. agricultural products whose prices rise accordingly. But in an environment of multilateral flexible exchange rates, price effects of foreign money supply changes tend to be offset by exchange rate adjustments [Balassa, 1979].

It also appears that sectoral models of U.S. agriculture are incomplete in terms of the treatment of exchange rates and the financial markets. In a review of agricultural models and the linkages to the general economy Subotnik [1981] laments that the models ignore foreign trade's effect on the exchange rate and that the theories of exchange rate determination have not yet been analyzed in the context of agricultural models.

Linkages with Exogenous Exchange Rates

This group probably composes the largest number of contributions dealing with macro-linkages. A sophisticated example is the work by Shei [1978]. He constructed a 24-equation general equilibrium model of the U.S. economy. The model included both the financial and goods markets and was sufficiently disaggregated to capture simultaneities between the agricultural sector and the general goods and financial markets. The model included a composite exchange rate (SDR/\$), but it was exogenously determined. With this model Shei could obtain a

measurement of the impact of monetary phenomena on the agricultural sector as the former affected interest rates but could not measure the additional impact of these phenomena as they express themselves via the exchange rate. As an exogenous variable, Shei found that the exchange rate did affect agriculture, but its effect was dominated both absolutely and proportionately by monetary effects.

In another contribution Gardner [1981] tried to gauge the significance for agriculture of macroeconomic events in the 1980s. In doing so he categorized the macroeconomic linkages to agriculture in three groups: a) "Walrasian" influences, b) "Marshallian" influences, and c) "Keynesian" influences. The Walrasian influences are the forces associated with the attainment of general equilibrium between sectors, especially the equalization of rates of returns in factor markets. The Marshallian influences are composed of standard shifters of demand and supply such as income and population. The Keynesian category was a catch-all for "nonstandard hypotheses" [Gardner 1981, 877]. In this category the author includes recessions and the exchange rate. The latter, merely regarded as an "export related variable" [Gardner 1981, 875], is again treated as exogenous to both the agricultural and general economies. In single-equation regressions intended to explain changes in farm prices received, the exchange rate is a separate regressor independently accompanying other regressors such as inflation. The implication is that there is no joint-dependence between farm prices, inflation, and the exchange rate. The exchange rate in this view is not a vehicle for transmitting financial market influences to the agricultural sector. Thompson [1981] noted and criticized this single-equation approach.

In another recent reference Grennes and Lapp [1981] try to determine whether the exchange rate affects real agricultural prices. Their approach is to consider the purchasing power parity condition:

$$P_A = b_0 P_A^* E^{b_1} E^{b_2} \quad (43)$$

where P_A and P_A^* are nominal U.S. and foreign agricultural prices and E is a trade-weighted exchange rate. The authors test whether purchasing power parity holds: $b_1 = b_2 = 1$ (products sell everywhere for the same price expressed in a given currency). The authors reject this hypothesis.

The validity of this test is questionable for two reasons. First, nominal prices are used in the estimation of the equation so that the latter can say little about real price behavior. Second, purchasing power parity, as expressed above, is at best an equilibrium identity. If tested as a behavioral equation, it implies that a) U.S. farm prices depend on foreign farm prices and the exchange rate, b) foreign farm prices do not depend on U.S. farm prices, and c) the exchange rate does not depend on U.S. farm prices; it is exogenous to the relation considered. It is difficult to imagine the real world satisfying all these conditions.

Linkages with Endogenous Exchange Rates

Schuh [1976, 1979, 1982] was the first to recognize the importance to agriculture of flexible exchange rates that are endogenous to financial market conditions. He has couched his arguments in terms of the instability that monetary policy can bring to agriculture via the exchange rate [Schuh, 1982, 84]:

The change in how monetary policy affects agriculture comes about because changes in monetary policy are reflected in changes in the value of the dollar. A tight monetary policy, other things being equal, leads to a rise in the value of the dollar and a decline in the competitiveness of the export sector in international markets. An easy monetary policy, on the other hand, leads to a decline in the value of the dollar and increased competitiveness. To put it simply, the trade sectors bear the adjustment of changes in monetary policy, and trade is now important to agriculture.

The argument made is that monetary policy affects agriculture not only through the effects on interest paid on operating capital, the level of business activity, etcetera. It also produces an impact by affecting agriculture's trading sector via induced movements of the flexible exchange rate. The magnitude of the impact will depend on the importance of the trade sector to agriculture.

To elucidate the difference in approaches between Schuh [1976, 1979, 1982] and most of the other references in agricultural economics, the simple two-country model of the other references in agricultural economics, the simple two-country model presented by Bredahl and Gallagher [1977] is useful. The model includes the standard demand and supply relations and a market-clearing condition.

Remembering that x is the foreign price of the dollar:

$$QD = a_2 + (b_2 x) \$P \quad (b_2 \leq 0) \quad (23)$$

$$QS = a_1 + b_1 \$P \quad (b_1 \geq 0) \quad (24)$$

$$QD = QS. \quad (25)$$

This set of equations indicate that a change in the exchange rate will cause a change in the trade flow, but nothing in the system of equations affects the exchange rate x . Following Schuh's reasoning, one more equation can be added:

$$x = f(M_i, M_{us}, F_i, F_{us}) \quad (44)$$

where M_i and M_{us} are foreign and U.S. foreign money supply and F_i and F_{us} are foreign and U.S. asset market variables. The exact choice of asset variables would depend on which theory of exchange rate determination one would wish to apply (e.g. monetary or portfolio-balance). Equation (44) serves to make the exchange rate endogenous to the financial conditions in the general economy. These financial conditions then affect the agricultural trade flow by producing an impact on the exchange rate x .

The effect of flexible exchange rates on the agricultural sector is also given special importance by Starleaf [1982]. The author traced the instability of farm income during the 1970s to the variability in farm prices (in contrast to farm output, which experienced relatively little change). He then highlighted a high positive correlation between money supply and farm prices. His explanation for the correlation follows Schuh: an expansion of the money supply leads to a depreciation of the dollar which boosts the price (in dollar terms) of the farm output with an export market.

Probably the most thorough theoretical work to date on the relationship between flexible exchange rates and the agricultural sector has been provided by Chambers [1982]. The author assumed a two-country world and a financial market very similar to that described by Branson et al. [1977]. To the financial market Chambers added an agricultural and a nonagricultural production sector for both the domestic and foreign countries. Agricultural stocks are also explicitly considered. Chambers' main deviation from the exchange rate determination models that predominate in the literature is that he allows the agricultural

goods market to achieve equilibrium in the short run. The usual assumption is that the financial and not the goods market is able to achieve short-run equilibrium. Under these assumptions six equilibrium conditions are derived:

$$f^*W^* + EfW = F^* \quad (45)$$

$$mW = \bar{M} + R \quad (46)$$

$$m^*W^* = \bar{M}^* + ER^* \quad (47)$$

$$\bar{S}_A + X_A - D_A - S_A = S_A^* + D_A^* - X_A^* - \bar{S}_A^* \quad (48)$$

$$p_N = C_N(q_L, q_K) \quad (49)$$

$$p_A = C_A(q_L, q_K) \quad (50)$$

where f = demand function for foreign securities,

F = supply of securities,

W = nominal private wealth,

E = the foreign/domestic exchange rate,

m = money demand function,

$\bar{M}$ = central bank liabilities,

R = country's reserve asset holdings,

$\bar{S}_A$ = agricultural stocks at the beginning of the period,

S_A = agricultural stocks at the end of the period,

X_A = agricultural production,

D_A = aggregate demand for agricultural products,

p = output price,

C = cost function,

q = input price,

A, N = subscripts for agricultural and nonagricultural sectors, respectively, and

K, L = subscripts for capital and labor, respectively.

Asterisks denote a foreign country variable. To perform a comparative statics analysis, Chambers also assumes that the law of one price (i.e., $p_A^* = p_A^E$) holds even in the short run. Most previous models make this assumption only for the long run.

The results of the model underscore the complexity of the interaction between the various markets and the difficulty in arriving at definite conclusions. In modeling the effects of a contractionary open market operations (OMO) by the domestic central bank the author finds that it is impossible to unambiguously establish whether the operation leads to an increase or decrease in the exchange rate E or in the foreign or domestic interest rates r^* and r . However, by assuming that a) a country's currency is a better substitute for its own bonds than for the other country's bonds and b) that an appreciation of the domestic currency does not create a permanent excess supply of the foreign currency, chambers establishes that the OMO raises E and r (the domestic currency appreciates) and probably decreases r^* . This OMO, in turn, pulls agriculture in two directions. The appreciation of E and the rise in r depress agricultural price and income. The fall in r^* boosts agricultural price and income. For the price strengthening effect of the fall in r^* to dominate, foreign stocks must play a dominant role in international price determination. Chambers believes this is not the case, and tentatively concludes that a contractionary OMO depresses agricultural price and income.

The first authors to endogenize the exchange rate in an empirical agricultural trade model were Chambers and Just [1982]. The model

contained three recursive blocks: a) an agricultural block with the wheat, corn, and soybean markets, b) a block for the current account trade balance net of the value of wheat, corn, and soybean exports, and c) a reduced-form model of exchange rate (SDR/\$) determination. This latter model follows ad hoc procedures rather than any specific theory of exchange rate determination appearing in the literature. The exchange rate is considered to be a function of the balance of trade, domestic credit, the discount rate, the general price level, and aggregate income. The agricultural block follows the procedures in Chambers and Just [1981]. The export equations are regarded as reduced-form equations that "do not represent either demand or supply of exports but rather the overall quantity of exports resulting from demand and supply interaction" [Chambers and Just, 1982, 237].

The authors analyze the results in terms of the dynamic, long-run impact of changes in domestic credit on agricultural exports and prices. They find an elastic long-run response in the exports of wheat and corn but an inelastic one for soybeans. They also find that grain prices are very responsive to fluctuations in the level of domestic credit. It is interesting to note, however, that the models of exchange rate determination explain the relationship between domestic credit and the exchange rate only in the short run. There is a lack of theoretical foundation for determining the long-run effects of domestic credit on agricultural trade via the exchange rate. Thus, these long-run empirical results need cautious interpretation. It is also interesting to note that the results of this empirical model contrast with the more ambiguous theoretical results found by Chambers [1982].

Van Duyne [1979] has been another of the few authors that have considered endogenous exchange rates in conjunction with agriculture. However, his focus was a problem that is a mirror-image of the problems usually treated by agricultural economists: whether shocks in the agricultural sector can have repercussions in the general economy.

To answer the question, Van Duyne constructs a theoretical two-country model with an agricultural and a manufactured good. Each country specializes in the export of one good. The three assets included were commodity stocks, domestic money, and foreign exchange. They are imperfect substitutes in portfolios, as asset holders allocate their wealth among the three assets. Since asset stocks are fixed in the short run, spot prices and the exchange rate have to adjust so that asset holders are willing to hold existing stocks. The exchange rate and prices are therefore determined simultaneously in asset markets and are subject to shocks such as bad harvests. Van Duyne finds that agricultural shocks of the magnitude of 1973-74 have significant effects on prices, exchange rates, and capital flows. These effects persist long after the initial shock. It should be noted, however, that the simplification that one country specializes in the export of one commodity reduces the applicability of the conclusions to a country such as the U.S. with a mix of agricultural and manufactured exports.

The articles cited in this section compose the few contributions which have explored the linkage between the financial markets and the agricultural sector which is provided by the exchange rate. The dearth of research in this area is the subject of a review by Chambers:

. . . perhaps too much time was spent arguing about the theoretically plausible size of the effect of the devaluation of the early 1970s on agricultural commodity trade. Altogether too

little time was spent on the next logical step in the progression--the investigation of the effect of the current determinants of the exchange rate on agricultural commodity trade. [1981, 935]

CHAPTER V INTERRELATION OF THE EXCHANGE RATE LITERATURE

The research areas of the articles covered in Chapters III and IV can be related in terms of a schematic diagram, Figure 9. The diagram contains four points of interest: a) monetary policy, b) fiscal policy, c) the financial markets, and d) the goods market. The latter has two subdivisions: the agricultural and the trade sectors. These two have a common area, namely, the agricultural trade sector. The arrows denote linkages between the points of interest and chart the flow of causation from the agent to the subject of change. The arrows are numbered to facilitate exposition.

The first three arrows refer to what is traditionally regarded as the "monetarist" view of macroeconomics. Arrow 1 indicates the effect of monetary policy on the financial markets. For example, a restrictive policy causes a shortfall of money relative to bonds. In order to maintain financial equilibrium, interest rates must rise to induce portfolios to hold bonds. Higher real interest rates cause a reduction in real activity, Arrow 2 (at least in the short run). Arrow 3 points to the "crowding out" effect of fiscal policy. Higher government deficits raise demand for available loanable funds, raising interest rates and reducing real activity.

Arrow 4 refers to the traditional "Keynesian" view of macroeconomics. The level of economic activity can be regulated by government via its fiscal policy. In case of an economic downturn due

Figure 9. Interrelation of the Exchange Rate Literature

to, say, reduced investment activity, government can take up the slack by increasing deficit spending. Conversely, inflationary impulses can be controlled by reduced deficits.

Arrow 5 is indicative of the elasticities approach to exchange rate determination as described by Sohmen [1969] and Yeager [1976]: the flow of goods in the trade sector determines the exchange rate. Negative net exports induce a balance of payments deficit which could be temporarily covered by finite foreign currency reserves. To correct a persistent deficit, the domestic currency must depreciate to make domestic goods cheaper relative to foreign goods both at home and abroad. The deficit is thereby shrunk. An equilibrium exchange rate is achieved when the deficit is zero. Causation flows from the trade sector to the exchange rate.

Arrow 6 encompasses the literature on exchange rate instability and how that instability may affect international trade. This issue involves the role of speculation in exchange rate determination and includes the work by Bernstein [1978] on destabilizing speculation, by Friedman [1953] on stabilizing speculation, and by McKinnon [1976] on insufficient stabilizing speculation. The topic also covers the practical issue of whether unstable flexible exchange rates are a detriment to international businesses as treated by Teck [1978], the econometric study by Hooper and Kohlhagen [1978], and the examination of movements in international prices and exchange rates by Balassa [1979].

Arrow 6 can also refer to the question of external adjustment under flexible exchange rates. Artus and Young [1979] discuss the reasons for Arrow 6 to represent a weak link in this regard: flexible rates did not facilitate adjustment as well as originally expected. McKinnon [1981]

also considers Arrow 6 to be a weak linkage and argues for the linkage represented by Arrow 7. He concludes from his analysis that in an open economy government savings are the most direct instrument for public officials to affect the trade balance; manipulating the exchange rate yields indeterminate results. Thus fiscal policy becomes an important determinant of the trade balance.

Arrow 8 refers to the question of whether flexible exchange rates promote inflation. Salant [1977] considers that the flow of causation as indicated by Arrow 8 is possible but unlikely. A more plausible flow would be indicated by Arrows 1 and 9 along with 8. For example, an expansionary money policy fuels domestic inflation (Arrow 1), which forces the exchange rate to depreciate (Arrow 9). This depreciation makes traded goods more expensive and aggravates inflation (Arrow 8). Willett [1977] was even more forceful in arguing that this flow of causation has been the one of relevance, and not Arrow 8 in isolation of the other two. (This part of the literature also included the issue of exchange rate variability and world inflation, but this topic cannot be encompassed by a schematic diagram of one national economy.)

The asset approach to exchange rate determination is a detailed examination of the linkage represented by Arrow 9. The different contributions in this field differ as to the assumptions made about the composition of the financial markets. The monetary school, e.g. Frankel [1979], assumes perfectly substitutable foreign and domestic interest-bearing assets, while the portfolio-balance approach, e.g. Branson et al. [1977], make the two imperfectly substitutable and requiring explicit treatment. Despite these differences all the models include the linkage represented by Arrow 1: monetary policy is regarded as a

primary factor determining conditions in the financial markets and, therefore, the exchange rates. The linkage denoted by Arrow 3 is usually disregarded.*

Arrow 10 represents the linkages treated by the bulk of the agricultural economics literature on exchange rates. The latter are treated as exogenous variables that move in discreet form and affect the agricultural trade sector. The different articles contained different theoretical and empirical approaches to the quantification of the linkage represented by Arrow 10. As has been previously discussed, the results have been contrasting and have depended on the assumptions made about exchange rates (e.g. whether they were treated as simple or multiple) and about agricultural trade (e.g. whether it was treated as restricted or free). Despite their widely different approaches, however, most of these studies have had the common element of studying the linkage of Arrow 10 in isolation of all the others; exchange rates were determined by an exogenous force.

Schuh [1976, 1979, 1982] suggests an approach more relevant in an era of flexible exchange rates. He suggests a linkage provided by Arrows 1, 9, and 10. That is, he first involves monetary policy and the financial markets (Arrows 1 and 9) in the determination of exchange rates that experience the constant incremental movements of the flexible system. Then he considers the exchange rate effects on agricultural trade (Arrow 10). This approach contrasts with the one taken by the

*A more precise diagram would need to include at least the monetary policy and financial market "boxes" of a foreign country, or more completely still, the whole diagram for a foreign country. However, it was deemed that the gains in precision would be outweighed by the loss of clarity.

bulk of the agricultural economics literature where rates are assumed to experience large (e.g. 10 percent) one-shot changes. But more congruous with the general economics literature which has been dealing with the problem of flexible exchange rate determination since soon after the adoption of the float. Chambers and Just [1982] provide an empirical analysis of this linkage.

This type of macro-linkage proposed by Schuh differs markedly from the sort usually suggested in the agricultural economics literature. For example, Doll [1958] and Gramm and Nash [1971] assume a linkage represented by Arrows 1 and 11. Monetary policy affects the financial markets, and these, in turn, affect the agricultural sector with no specific impact on the trade sector of agriculture. A tight money policy raises interest rates, which raise the cost of production, and consequently the agricultural supply curve shifts upward.

The more recent work by Gardner [1981] considers a variety of macro-linkages. The latter includes exogenous inflation which can be represented by Arrow 11 and exogenous exchange rates, Arrow 10. Again, the linkage between exchange rates and financial variables is disregarded. Gardner also considers other linkages such as nonfarm wages which lie beyond the scope of the diagram in Figure 9.

Finally, the federal agricultural commodity and research programs could conceivably be considered as part of fiscal policy (as Gardner [1981] seems to do) where money from the general economy is funneled into the agricultural sector. Treated as such, fiscal policy would then be directly linked to agriculture in a form represented by Arrow 12.

CHAPTER VI THE EMPIRICAL MODEL

The literature reviewed in the previous chapters suggests that very little empirical work has investigated the linkage between the financial markets and the agricultural sector that is provided by the flexible exchange rate. Following along the lines of the initial endeavor provided by Chambers and Just [1982], a model will be presented here which a) is more consistent with the literature on exchange rate determination, b) is more complete in the specification of an agricultural export equation, and c) addresses several issues excluded from their study.

The specific objectives of the present model are

- 1) to determine the usefulness of constructing an effective exchange rate for U.S. agricultural exports;
- 2) to measure the impact of exchange rate volatility on agricultural real export prices and export volume;
- 3) to measure the impact of changes in financial market conditions on agricultural exports, real export prices, and income;
- 4) to investigate the secondary effects on domestic consumption and stockholding as export flows change;
- 5) to investigate the delay, if any, of response in the agricultural trade sector to changes in financial market conditions;

- 6) to obtain an indication of the extent to which the exchange rate and the financial markets have contributed to instability in the agricultural sector after the adoption of flexible exchange rates.

Presentation of Equations

The model is composed of two recursive blocks. One block consists of a single equation for the determination of the exchange rate. The other block models the agricultural sector, and is composed of five equations with five endogenous variables.

The contemporary theories on the determination of the flexible exchange rate are generally limited to the short-run, largely because in the long-run the exchange rate and many of its determinants begin to affect each other: modeling becomes very complex. Thus any model that intends to explain the effects of the financial markets on the agricultural sector via the exchange rate should limit itself to the short run. The present model, in particular, limits itself to a time frame of one quarter.

This time frame limitation imposed by the state of the arts in exchange rate determination theory allows agricultural production to be treated as fixed and exogenous to the system. Since production in agriculture is a yearly event, the supply of agricultural products within any one quarter is considered predetermined.

Exchange Rate Determination

Although the literature on exchange rate determination has concentrated on bilateral rates, there have also been contributions on multilateral or effective exchange rates. These rates usually are

composites constructed by taking a weighted average of different exchange rates. The weights reflect the importance of different countries to a nation's trade. The model presented here is an adaptation of the work contributed by Larson [1980] and Porter [1979].

Following their arguments, movements in the exchange rate can be explained by four determinants: a) the supply of money M , b) the general price level P , c) aggregate real income Y , and d) the cumulative current account deficit. The reasoning for this conclusion follows monetary lines.

All currencies in circulation are held in the wealth portfolios of individuals. The proportions in which people hold the currencies of different countries in their portfolios depend on their needs and desires based on present and future economic conditions. The exchange rate is an important factor behind the mix of currencies they will want to hold in their portfolios: they will want to hold currencies they expect not to depreciate so that they will not suffer a loss in wealth. As the exchange rate changes, people's expectations about which currencies will appreciate or depreciate may change. Therefore, people may want to readjust the currency mix in their portfolios. An equilibrium exchange rate is achieved when people are willing to hold the existing stock of each money; i.e., no one wants to adjust their currency mix further [Larson, 1980].

With this portfolio approach the determination of the exchange rate can be explained fairly simply. Consider the demand and supply of cash balances. The demand is partly determined by people's income and the general price level. The higher incomes and prices are, the higher is the demand for money. More cash is needed to meet transaction needs at

higher incomes and prices. This need can be met by obtaining dollar cash balances through the sale of foreign currencies. The movement out of foreign currencies drives down their value relative to the dollar. The relative value of the dollar rises until people become unwilling to sell off more foreign currencies. Following this reasoning, aggregate income Y and the general price level P are positively related to the exchange rate [Larson, 1980].

Conversely, the supply of money M is negatively related to the exchange rate. An increase in the money supply finds people holding more dollars than they desire. They attempt to sell dollars for other currencies, precipitating a fall in dollar prices. The fall will continue until people are satisfied with the value of the stocks of dollars and foreign currencies they hold. A long-run model would need to consider the feedback effects of changes in the money stock on prices and income but are assumed unimportant within the one-quarter framework of the present model.

If the United States begins to run a current account deficit, financial wealth is transferred to foreigners who have less need than Americans to hold dollar cash balances (relative to total financial wealth). Since the people receiving dollars are less willing to hold them, they attempt to sell. The price of the dollar is driven down until everyone is again satisfied with the dollar content of their portfolios. Thus the current account balance CCA is positively related to the value of the dollar. However, a lagged effect can be expected, since an outflow of dollars must first occur before foreigners begin to feel they are holding too many dollars.

It can also be hypothesized that the interest rate paid on dollar accounts affects the willingness to hold dollars. As the dollar interest rate rises, people in search of higher returns will try to buy dollars, driving up its price. At the same time, however, higher interest rates induce people to economize on cash balances. This reluctance to hold dollars adversely affects the exchange rate. It can also be argued that the interest rate is a variable that represents the demand and supply conditions in the money market, conditions which are already explicitly treated in the model. The effect of international interest differentials, namely, the international transfer of capital is also captured by the current account balance. Thus the interest rate may be considered a superfluous variable which can be safely excluded.

Larson's [1980] model basically follows a monetary approach, since it does not include foreign or domestic interest-bearing assets. The implicit assumption is that these assets are perfectly substitutable by foreign and domestic money. The model can be further generalized by assuming imperfect substitutability and including the net outflow of capital as an explanatory variable. An increased net outflow can be expected to depreciate the dollar.

The level of the exchange rate in the previous period is also included. It is assumed that the financial market conditions which made an exchange rate "high" or "low" are not quickly reversed. Therefore, a high exchange rate in the previous quarter is associated with a high rate in the current quarter and vice versa. The coefficient should have a positive sign.

The resulting equation for the determination of the exchange rate ER in the current time period t is

$$ER_t = f \left(\overset{-}{M}_t, \overset{+}{P}_t, \overset{+}{Y}_t, \overset{+}{CCA}_{t-1}, \overset{-}{B}_t, \overset{+}{ER}_{t-1} \right) \quad (51)$$

where the sign over the argument indicates an expected negative or positive partial derivative.

Two alternative measures of the exchange rate are used. One is the effective dollar exchange rate FEDER published by the Federal Reserve Bank (Federal Reserve Bulletin).^{*} The other is an effective exchange rate for U.S. agricultural exports AGER which has been constructed for the purpose of the present study. This exchange rate is a weighted average of the nine largest importers of U.S. agricultural products which have had floating currencies in relation to the U.S. dollar since the inception of the float.^{**} The weights are calculated by the value of exports to each country as a proportion to the total for the nine countries. These weights change yearly to reflect changes in the export pattern.

The reason for constructing this effective exchange rate for agricultural exports is that agricultural trade flows are often very different from the flow of trade in nonagricultural products. For example, in 1973-81 Japan represented 15.3 percent of the total U.S. agricultural export market but only 8.0 percent of the nonagricultural export market [ERS, several years]. With differences in the relevant weights an effective exchange rate for agricultural exports may differ

^{*}For details on the computation of this exchange rate, see Federal Reserve Bulletin (1978):700.

^{**}The countries included are Japan, Netherlands, United Kingdom, France, West Germany, Italy, Canada, Spain, and Belgium. See the data appendix for the values computed.

markedly from the usually published effective rates and may yield different results in agricultural trade models.

The Agricultural Sector

The agricultural block consists of a simultaneous system of three structural equations and two identities. The three equations are for domestic disappearance, domestic stocks, and export demand. The five endogenous variables are the quantities demanded for domestic disappearance, domestic stocks, and exports plus the current real export price and the exchange rate. Agricultural commodities are aggregated into a single variable with a single price. The aggregation is done in order to determine whether anything meaningful can be said about the effects of the financial market on agricultural trade as a whole rather than the trade in particular products. The aggregate consists of wheat, corn, soybeans, barley, oats, rye, and rice. Livestock products are excluded from the model, but this group composes a small fraction of total exports. For example, animal and animal product exports totaled only 10.8 percent of total agricultural exports in 1979 [ERS, 1980].

An important deviation from previous modeling efforts is that importance is placed on the possible influence of price and exchange rate values in previous periods on current quantities demanded. This influence may exist for two reasons. One is the prevalence of contractual agreements for future delivery, especially in international trade. Current market price, whether spot or futures, will influence the terms of the current contract, even though delivery may not take place months into the future. For the same reason the current exchange rate can also influence future deliveries.

This market friction explains the observed J-curve effects in the general international economy: because the levels of current exports have been precontracted, a depreciation of a nation's currency actually aggravates that nation's balance of trade in the short run. Export receipts remain steady because neither the precontracted quantity nor the export price changes. Yet more must be paid for the (precontracted) imports. This worsening of the trade balance is gradually alleviated with time as new contracts are signed. The effect plotted on a graph with the trade balance on the vertical axis and time on the horizontal axis takes the shape of a "J," hence its name.*

The second reason why previous prices can affect current quantity demanded is the role of price expectations. These expectations may be especially relevant in a sector like agriculture where production generally occurs only annually and (grain) commodities are storable. For example, if current price has increased because of an apparent harvest failure, then quantity demanded for storage may also increase with the expectation of even higher future prices. Likewise, price developments in previous periods (as well as the current period) can play a role in the formation of expectations about future prices.

These expectations are relevant not only for domestic stocks but also for exports, since export demand in the current period can be destined both for current foreign consumption and for foreign stocks.

In line with the above arguments the equations will contain a price series for one year which includes the current period and each of the

*For empirical work on J-curve effects see Dornbusch and Krugman [1976] and Spittaller [1980].

three past periods. The inherent assumption is that neither contracts nor expectations are formed with more than a year's anticipation.

Domestic disappearance

Domestic disappearance in the current period QD_t is considered to be a function of current real export price PRI_t and price in the past three periods. In this equation expectations are not considered relevant, but contracting may impose frictions. The expected sign is negative for the price coefficients in all periods. Livestock and livestock prices are deemed to also play a role in domestic disappearance. As livestock prices $COWPRI$ increase, slaughter rates increase and the quantity of feed grain demanded decreases. A countervailing influence might be an increase in feeding rates. The number of livestock on feed $CATTLE$ is expected to play a positive role in the demand for feed [Meilke and de Gorter, 1978]. The U.S. population $USPOP$ should also play a positive role, as should real U.S. aggregate income Y . However, Chambers and Just [1981] have argued that once use in feed has been accounted for, grains might be an inferior good (implying a negative relationship with domestic disappearance). Seasonal shifters are also included in the model to allow for seasonal variability in demand. The resulting equation for the current period t is

$$QD_t = g(\overset{-}{PRI}_t, \overset{-}{PRI}_{t-1}, \overset{-}{PRI}_{t-2}, \overset{-}{PRI}_{t-3}, \overset{-}{COWPRI}_t, \overset{+}{CATTLE}_t, \overset{+}{POPUS}_t, \overset{+}{Y}_t, \overset{+}{WN}_t, \overset{-}{SP}_t, \overset{-}{SM}_t) \quad (52)$$

where WN, SP, SM represent the seasonal shifters for winter, spring, and summer, respectively.

Domestic stocks

Current stocks $STOCKS_t$ are taken to be a function of the stock level in the previous period, assuming stock adjustment is not instantaneous. A high level in the previous period results in a high level in the current period, and vice versa. Thus, a positive relationship is expected. Because of expectations and future prices, the equation includes price in the current and the previous three periods. The signs of the particular price coefficients cannot be expected a priori, but all coefficients cannot be positive. (The implication of the latter would be that stockholders always sell off at lower prices.) The pattern of signs on the price coefficients will depend on how expectations are formed. The interest rate INTR should have a negative sign, since it represents a cost of holding stocks. Seasonal variability can also be expected in the demand for stocks because of the seasonality in agricultural production. The resulting equation for the demand for stocks in the current period t is

$$STOCKS_t = h(STOCKS_{t-1}^+, PRI_t^+, PRI_{t-1}^+, PRI_{t-2}^+, PRI_{t-3}^+, INTR_t^-, WN_t^+, SP_t^+, SM_t^+) \quad (53)$$

Export demand

One of the goals of the present model is to specify a more complete export equation than that specified by Chambers and Just [1982]. The specification in the present model is for the demand for U.S. agricultural exports. This demand is the variable affected by

fluctuations in the exchange rate and, thereby, the determinants of the exchange rate.

As with the previous equations, export demand is expected to be influenced by price in the current period and the three previous periods. This friction can occur because of international contracting and by the formation of expectations by foreign holders of agricultural stocks who may import on a speculative basis. No signs can be expected a priori on the particular price coefficients, but, again, all of them should not be positive.

Since the local foreign price depends not only on the U.S. price but also on the exchange rate, the current rate and the rates for the last three periods are also included. No specific signs are expected on the coefficients a priori. In any given period the price and exchange rate coefficients may have different signs if the formation of exchange rate expectations differ from price expectations. For example, if foreigners expect a trend in the exchange rate to have a shorter duration than a trend in price, they may be willing to wait for a more favorable trend in the exchange rate but may not be willing to wait for a change in price trend. The model will use the two exchange rate measures already described: the Federal Reserve Bank measure FEDER and the effective exchange rate for agricultural exports AGER.

A largely unexplored issue in agricultural economics has been the effect of exchange rate volatility on agricultural trade. Following the arguments made by Hooper and Kohlhagen [1978], the price risk faced by an importer of U.S. products will depend on changes in the U.S. price and the dollar exchange rate. As the exchange rate becomes more volatile, a risk-averse importer will ceteris paribus lower the quantity

he imports. However, the demand-depressing effects of exchange rate volatility can be attenuated by the use of risk-reducing tools such as forward markets. A negative relationship can be expected between export demand and the exchange rate risk ERV.

Another important factor affecting export demand is the level of per capita agricultural output in the rest of the world WOP. Since export demand reflects an excess demand in the rest of the world, an increase in output can be expected to decrease excess demand abroad and the need for U.S. exports. The coefficients for WOP should thus have a negative value.

The price value of competitors for the foreign market FORPRI can also be expected to play a role in the demand for U.S. exports. As the price in a competing country rises, foreign customers are diverted to U.S. exporters in search of a better price. Thus the level of U.S. exports should be positively related with the agricultural export price level in countries competing with the United States for the international market.

Foreign real income levels FORY and seasonality should affect export demand. As foreign incomes rise, the foreign demand for agricultural products rises, creating an increase in excess demand. This higher excess results in an increased demand for U.S. agricultural exports. Thus FORY should have a positive coefficient. Finally, seasonality can also be expected in export demand, since foreign agricultural production is also seasonal. Foreign harvest periods should be associated with a lower need to demand U.S. exports.

The resulting equation for the demand for U.S. agricultural exports in the current time period t is

$$\begin{aligned}
 \text{EXPORTS}_t = & k(\overset{+}{\text{PRI}}_t, \overset{+}{\text{PRI}}_{t-1}, \overset{+}{\text{PRI}}_{t-2}, \overset{+}{\text{PRI}}_{t-3}, \overset{+}{\text{AGER}}_t, \overset{+}{\text{AGER}}_{t-1}, \\
 & \overset{+}{\text{AGER}}_{t-2}, \overset{+}{\text{AGER}}_{t-3}, \overset{+}{\text{FORY}}_t, \overset{-}{\text{ERV}}_t, \overset{-}{\text{WOP}}_t, \overset{+}{\text{FORPRI}}_t, \quad (54) \\
 & \overset{+}{\text{WN}}_t, \overset{+}{\text{SP}}_t, \overset{+}{\text{SM}}_t).
 \end{aligned}$$

The identities

The agricultural block contains an identity which relates exports, domestic stocks, and domestic disappearance to the fixed level of production PROD:

$$\text{PROD}_t = \text{STOCKS}_t - \text{STOCKS}_{t-1} + \text{QD}_t + \text{EXPORTS}_t. \quad (55)$$

The second identity consists of the exchange rate as an equality using the independently estimated coefficients of the exchange rate determination equation (51). This equality serves to incorporate the determination of the exchange rate into the model of the U.S. agricultural sector.

Table 3 presents the complete system of equations in compact form. To simplify notation, the time subscripts have been suppressed, and the magnitude of the lags is appended to each variable.

Data and Model Estimation

All data have been obtained from a variety of secondary sources. Appendix A contains the definition for each variable used in the model and the source for its data series.

An assumption of the model is that the agricultural market does not affect the values of the determinants of the exchange rate. This

Table 3. Empirical Model Linking the Determinants of the Exchange Rate to the Agricultural Sector

Exchange Rate

$$ER = f(M, P, Y, CCA1, F, ER1) = \hat{\beta}_0 + \hat{\beta}_1 M + \hat{\beta}_2 P + \hat{\beta}_3 Y + \hat{\beta}_4 CCA1 + \hat{\beta}_5 F + \hat{\beta}_6 ER1 + \hat{U}$$

Agricultural Market Block

$$QD = q(PRI, PRI1, PRI2, PRI3, COMPRI, CATTLE, POPUS, Y, WN, SP, SM)$$

$$STOCKS = h(STOCKS1, PRI, PRI1, PRI2, PRI3, INTR, WN, SP, SM)$$

$$EXPORTS = k(PRI, PRI1, PRI2, PRI3, ER, ER1, ER2, ER3, FORY, ERV, WOP, FORPRI, WN, SP, SM)$$

$$PROD = STOCKS - STOCKS1 + QD + EXPORTS$$

^aThe estimates of $\hat{\beta}_i$ are independently obtained through the regression of the exchange rate determination equation.

assumption seems reasonable in light of the small size of the agricultural economy in relation to the general economy. The assumption allows the two blocks, i.e., the exchange rate and the agricultural market blocks, to be estimated independently [Pindyck and Rubinfeld, 1976, 269]. The exchange rate equation can be estimated through ordinary least squares (OLS) procedures while the system of equations in the agricultural block is estimated via three-stage least squares (3SLS).

The quarterly data used for estimation covered the period from 1973 II to 1981 IV. This period reflects the era of exchange rate flexibility and the availability of data up to the time of estimation.

The empirical results are presented in several sections. First, the estimates of the exchange rate measures (AGER and FEDER) are reported. Then the estimation of the structural equations of the agricultural block are presented, followed by the presentation of the reduced-form estimates. Again, there are two sets of structural and reduced-form equations: one for each measure of the exchange rate. A final section relates the empirical estimates to the objectives of the study as presented in this chapter.

Empirical Estimates

The Exchange Rate Equations

The effective exchange rate for agricultural exports was computed as described in the present chapter under the subheading "Exchange Rate Determination." To facilitate a comparison between the two exchange rates, the agricultural rate was indexed with the same base month (March 1973) as the Federal Reserve Board's effective rate. A plot of the two

appears in Figure 10. It seems evident from the plot that AGER and FEDER have followed similar paths since the inception of the float (roughly since March 1973). An exception appears to be the inflationary period during the late 1970s. The AGER exchange rate began a recovery while FEDER continued to depreciate. Both experienced a sharp appreciation beginning in 1980. It is interesting to note that the general rate FEDER experienced a much sharper depreciation than AGER when the currencies began to float. The indication is that in the early 1970s the exchange rate of more relevance to agricultural exporters was less overvalued than for those engaged in the trade of nonagricultural products.

The exchange rate determination equations for both AGER and FEDER were estimated in double-log form with OLS procedures. However, Durbin's "h test" indicated the presence of first degree autocorrelation.* A Cochrane-Orcutt procedure was then used, and the results are presented in Table 4.

The general conclusion from the estimated equations is that the coefficient estimates are quite similar in both equations. This result might be expected from the close association over the sample period of the two exchange rates as suggested earlier. This association might be explained by the fact that Europe, Canada, and Japan are major buyers of both U.S. agricultural and nonagricultural exports.

All coefficients in both equations have the expected signs. The coefficient for the net change in U.S. assets abroad (B) was not significant at standard levels in both equations. This result coupled

*The usually reported Durbin-Watson statistic is biased toward rejecting autocorrelation when a lagged endogenous variable is used as a regressor [Maddala, 1977, 371].

Figure 10. Plot of the Effective Exchange Rate for U.S. Agricultural Exports (AGER) at the Federal Reserve Bank's Effective Exchange Rate

Table 4. Estimates of the Models for the Determination of the Agricultural and Federal Reserve Effective Exchange Rates

$$\text{LAGER}^a = 1.353_b - 0.362\text{LM} + 0.206\text{LP} + 0.324\text{LY} + 0.037\text{LCCA1} - 0.035\text{LB} + 0.418\text{LAGER1}$$

$$(1.34) \quad (2.13) \quad (2.28) \quad (2.07) \quad (3.83) \quad (1.08) \quad (3.43)$$

$$R^2 = 0.8279$$

$$\epsilon = 0.007$$

$$\text{LFEDER} = 1.147 - 0.409\text{LM} + 0.129\text{LP} + 0.35\text{LY} + 0.032\text{LCCA1} - 0.003\text{LB} + 0.507\text{LFEDER1}$$

$$(1.065) \quad (2.19) \quad (1.48) \quad (1.92) \quad (3.27) \quad (0.12) \quad (4.25)$$

$$R^2 = 0.8448$$

$$\epsilon = 0.194$$

^aAn "L" before a variable indicates a log value.

^bThe absolute value of the T-ratios are reported in parentheses.

with the statistical significance of the remaining explanatory variables indicates that the "monetary" rather than the "asset" approach provides a better explanation of U.S. effective exchange rates during the period of the float.

The results presented in Table 4 also indicate that, although important, the role of the money supply (M) in the determination of the agricultural exchange rate can be exaggerated. During the period studied in this paper, the average quarterly change in M was 1.53 percent whereas the average change in AGER was 3.1 percent. Using the estimate of the elasticity of AGER with respect to M(.36), it can be shown that changes in the money supply accounted for about 18 percent of the average change registered in AGER. Thus, the other variables--the inflation rate, the real GNP, and the cumulative current account balance--also played a role in the determination of the effective agricultural exchange rate.

The results of the exchange rate equations show that variables in the financial market can help explain a variable of relevance to U.S. agricultural exporters, i.e., the value of the dollar in relation to the value of the currencies of the countries to which they export. The next step in the study is to determine the degree of importance that this exchange rate has for agricultural exports. This task is an objective of the system of equations in the agricultural block.

The Structural Equations

The estimates of the structural equations are presented in Tables 5 and 6. Table 5 reports the estimates when AGER is used as the exchange rate measure, and Table 6 contains the estimates with the FEDER measure. Comments will concentrate on the export equation.

The results reported in Table 5 are revealing. The price coefficients for the current and previous periods in the export equation are positive while those for periods $t-2$ and $t-3$ are negative. However, only the current and the $t-3$ periods are significant (at the 95-percent level). These estimates suggest that there are frictions in the agricultural export market; price in a previous period affects current exports. Moreover, the positive sign for the current price coefficient indicates that a rise in current price must lead to an expectation of an even higher future price and an increase in exports, presumably for foreign stock holding. The negative coefficient for $PRI3$ indicates that a price rise three periods ago resulted in export quantity contracted for delivery in the current period. $PRI1$ and $PRI2$ do not seem to play a significant role in current exports.

The coefficients for $AGER$ imply that the exchange rate does play a role in export demand: $AGER$ is negative and significant while $AGER1$ is positive and significant.* An appreciation in the current period will decrease export demand in the current period; the response is quick. However, this appreciation will increase exports in the next period. This result suggests that a one-shot change in the exchange rate can delay or advance the decision to import but will not tend to affect demand permanently. Today's appreciation reduce today's exports while importers hope for a depreciation in the following quarter. But given no further changes in any of the variables, including the exchange rate, exports will increase in the following quarter.

*The equations were estimated with $AGER$ and $FEDER$ in log form. The implicit assumption is that as the magnitude of change in the exchange rate increases, its incremental impact on exports becomes smaller.

Table 5. Estimates of Structural Equations using AGER Exchange Rate Measure

$$QD = -41722.90 + 9248.012PRI + 5155.021PRI1 - 3440.7PRI2 - 1504.00PRI3 - 5.977Y + 0.317CATTLE$$

(1.99) (1.89) (1.57) (1.07) (0.55) (1.20) (1.88)

$$- 1701.18COMPRI + 219.565POPUS - 1021.95WN - 1512.42SP - 628.44SM$$

(2.45) (1.91) (2.65) (5.72) (2.70)

$$STOCKS = 8571.221 + 0.756STOCKS1 + 76.953INTR - 1152.243PRI - 10718.10PRI1 + 9134.647PRI2$$

(5.74) (6.22) (0.63) (0.39) (2.69) (2.25)

$$- 4358.50PRI3 - 6942.59WN - 6694.45SP - 4913.38SM$$

(1.47) (10.12) (17.80) (17.04)

$$EXPORTS = -1253.48 + 0.001FORV - 1013.58LAGER + 1210.118LAGER1 + 472.345LAGER2 - 334.367LAGER3$$

(0.45) (1.10) (2.78) (2.20) (0.78) (0.69)

$$+ 1197.519PRI + 919.192PRI1 - 95.978PRI2 - 932.325PRI3 - 6.212ERV - 5299.26WOP + 5.946FORPRI$$

(2.43) (1.69) (0.18) (2.17) (0.99) (2.85) (2.77)

$$- 117.627WN - 149.129SP - 144.459SM$$

(3.03) (4.09) (4.09)

$$PROD = STOCKS - STOCKS1 + QD + EXPORTS$$

$$LAGER = 1.353 - 0.362LM + 0.206LP + 0.324LY + 0.37LCCA1 - 0.035LF + 0.418LAGER1$$

T-values are reported in parentheses.

Table 6. Estimates of the Structural Equations using FEDER Exchange Rate Measure

QD = -312373 + 6319.613PRI - 5329.279PRI1 - 3393.03PRI2 - 1124.73PRI3 - 3.9372Y + 0.2508CATTLE	
(1.46) (1.27) (1.63) (1.06) (0.42) (0.77) (1.46)	
- 1279.99COWPRI + 163.2473POPUS - 894.9112WN - 1456.14SP - 628.8527SM	
(1.80) (1.38) (2.29) (5.50) (2.72)	
STOCKS = 8691.522 + 0.7431STOCKS1 + 89.3300INTR + 1131.411PRI - 10742.2CROPRI1 + 9004.708PRI2	
(5.84) (6.15) (0.73) (2.70) (2.22)	
- 4384.83PRI3 - 4384.83WN - 6686.96SP - 4916.93SM	
(1.48) (10.13) (17.78) (17.09)	
EXPORTS = -101.009 + 814.8196PRI + 854.5308PRI1 + 237.365PRI2 - 1344.14PRI3 - 1002.7LFEDER	
(0.05) (1.37) (1.50) (0.38) (2.92) (2.27)	
+ 1517.623LFEDER1 - 632.9244LFEDER2 + 392.9712LFEDER3 - 0.00007FORY - 3.4608ERV - 4790.77WOP	
(1.96) (0.76) (0.55) (0.07) (0.40) (2.95)	
7.9077FORPRI - 135.3515WN - 133.1370SP - 129.5447SM	
(2.84) (3.42) (3.39) (3.56)	
PROD = STOCKS - STOCKS1 + QD + EXPORTS	
LFEDER = 1.147 - 0.409LM + 0.129LP + 0.35LY + 0.032LCCA1 - 0.003LF + 0.507LFEDER1	

T-values are reported in parentheses.

The insignificant coefficients for AGER2 and AGER3 suggest that exports respond with less friction to the exchange rate than to price. This result is congruous with the fact that agricultural prices are to a large extent the function of supply which is affected by annual harvests. Agricultural price trends can be expected to have a longer duration than exchange rate trends which respond quickly to changes in the financial market. Thus, an exchange rate movement today is less indicative of a future exchange rate movement than today's price movement is of a future price. Considering this fluidity of the foreign exchange market, it is not surprising that AGER2 and AGER3 are insignificant.

The coefficient for exchange rate risk ERV has the expected negative sign, but it is insignificant. This statistically insignificant impact of exchange rate risk on agricultural trade implies that traders are probably using risk-reducing tools for foreign exchange (see Chapter II: "International Trade and Investment").

Although Gupta [1980, 66-107] has extensively justified the measure of exchange rate risk employed in the present analysis, other equally acceptable measures are conceivable. Therefore, the obtained results must be interpreted as an initial empirical finding on a previously unexplored subject in agricultural trade.

Per capita world output has the expected negative coefficient and is significant. This result indicates that export demand for U.S. agricultural products is definitely an excess demand that depends on the level of agricultural output abroad. Agricultural trade models that fail to incorporate this variable would appear to be incomplete in their specification.

Foreign price has the expected positive sign and is also significant. It appears that foreign buyers are willing to substitute agricultural exporters if there is a price incentive.

The positive but insignificant foreign income coefficient suggests that either a poor proxy was used (see Appendix A) or that the demand for foreign exports has a fairly low income elasticity. If increases in foreign incomes are reflected in increases in demand for livestock products, perhaps the number of livestock abroad would be a more suitable variable to be included in export demand. As livestock numbers increase, the need for feed grain imports may also increase.

Finally in the export demand equation, the significant seasonal variables indicate that there is seasonality in export demand.

The estimate of the domestic stocks equation shows that the price measures that significantly affect stock holding are those for periods $t-1$ and $t-2$. Price increases in the last quarter but not in the current quarter, induce profit-taking and stock reductions. Stock levels in the previous period also appear to influence current levels; adjustments do not occur instantaneously. The seasonal variables indicate a strong seasonality in stockholding. An unexpected result is the positive but insignificant coefficient for the interest rate; a negative coefficient was expected, since interest rates reflect a cost for stock holding. If stock adjustments occur with a delay, as suggested by the negative and significant coefficient for $PR11$, perhaps the interest rate in the previous period would be a relevant variable to include in the stocks model.

The domestic disappearance equation gives a very weak performance. All price coefficients are insignificant and those for the current and

t-1 periods are unexpectedly positive. The only significant coefficients are those for livestock price and the seasonal variables. This weak result is not surprising given that domestic disappearance was calculated from an identity (equation 55) and would collect errors from the other variables. The estimated model obviously cannot be used to accurately explain domestic disappearance.

Table 6 reports the results obtained with the FEDER measure of the exchange rate. This measure appears to yield results similar to AGER but somewhat weaker. There are no sign reversals for any of the coefficients, but the T values are generally lower when FEDER is used. Indeed COWPRI in the disappearance equation and PRI in the export equation become insignificant. In terms of these structural equations AGER seems to perform better than FEDER even though the two rates have followed similar paths during the period of exchange rate flexibility.

These structural estimates present a fairly complex picture of U.S. agricultural exports even in the short run. They highlight the prevalence of frictions in the marketplace and the ability of events in previous periods to affect export flows in the current period. For example, they support the conclusion by Chambers and Just [198]] that current exchange rates have an inverse elastic impact on current exports. However, they also indicate that the exchange rate in the previous quarter has a positive elastic impact on exports. The results support the conclusion by Collins et al. [1980] that previous exchange rate levels affect current exports. However, these authors emphasized friction in supply whereas the present model indicates friction in demand; supply is exogenous.

The present results also lend support to Collins et al. [1980] in indicating the importance of foreign agricultural production in determining their demand for U.S. exports. This variable was not emphasized by Chambers and Just [1981]. The latter authors' findings of seasonality in both the domestic and international economics are further evidenced by the present findings.

The insignificant estimates for ERV suggest that the failure in previous studies to consider the issue of exchange rate volatility in exchange rate agricultural markets does not appear to be a serious omission.

Reduced-Form Equations

The estimates of the reduced-form equations using AGER and FEDER are reported in Tables 7 and 8, respectively. These equations treat the endogenous variables as a function of all predetermined variables (exogenous and lagged endogenous). One of the several available measures for detecting how well a reduced-form equation explain the endogenous variable is the root mean percent error (RMPE) (Pindyck and Rubinfeld, [1976]).* The RMPE statistic is also reported in Tables 7 and 8. As might be expected, the equation for domestic disappearance does poorly while the equations for stocks, exports, and price have an error of less than or equal to ten percent. Since AGER and FEDER were estimated independently, their "reduced-form" is the same as reported in Table 4. Their goodness-of-fit are measured by their respective R^2 statistic.

*

$$RMPE = \left[\frac{1}{N} \left(\frac{y^p - y^a}{y^a} \right)^2 \right]^{\frac{1}{2}}$$
 where N is the number of observations and y^p and y^a are the predicted and actual values of the endogenous variable.

Table 7. Estimates of the Reduced-Farm Equations using the AGER Exchange Rate Measure

Endogenous Variables	Predetermined Variables									
	INTERCEPT	PRI1	PRI2	PRI3	LAGER1	LAGER2	LAGER3	Y	CATTLE	
QD	-13196.8	8858.04	-7904.9	3914.6	-627.149	-376.646	266.623	-1.211	0.0641	
STOCKS	12125.4	-10256.7	8578.49	-3683.43	-78.139	-46.928	33.220	0.598	-0.032	
EXPORTS	1071.38	1398.69	-673.992	-230.731	705.288	423.57	-299.842	0.617	-0.033	
PRI	3.0856	0.4004	-0.4837	0.5859	-0.0678	-0.0407	0.0288	0.0005	0 ^a	
AGER	1.3408	0	0	0	0.4179	0	0	0	0	

	COWPRI	POPUS	STOCKS1	INTR	FOR	ERV	WOP	FORPRI	PROD	
QD	-344.667	44.489	0.195	-61.362	-0.001	4.954	4225.61	-4.791	0.797	
STOCKS	169.013	-21.814	0.780	69.308	-0.0001	0.617	526.48	-0.591	0.099	
EXPORTS	175.654	-22.671	0.0252	-7.946	0.001	-5.571	-4752.09	5.332	0.103	
PRI	0.1467	-0.0189	0 ^a	-0.0066	0 ^a	0.0005	0.4569	-0.0005	0.0001	
AGER	0	0	0	0	0	0	0	0	0	

	LM	LP	LY	LCCA1	LB	WN	WP	SM	RMPE	
QD	-292.183	166.891	261.857	29.704	-28.029	2422.73	5150.62	3905.77	0.2841	
STOCKS	-36.404	20.794	32.626	3.701	-3.492	-6139.62	-5864.28	-4348.45	0.1009	
EXPORTS	328.587	-187.685	294.482	-33.405	31.522	716.890	713.663	442.673	0.0849	
PRI	-0.0316	0.0180	0.0283	0.0032	-0.0030	0.6969	0.7204	0.4903	0.0947	
AGER	-0.3615	0.2065	0.3240	0.0368	-0.0347	0	0	0	--	

^aThe estimate is zero up to four decimal places.

Table 8. Estimates of the Reduced-Farm Equations using FEDER Exchange Rate Measure

Endogenous Variables		Predetermined Variables								
		INTERCEPT	PRI1	PRI2	PRI3	LFEDER1	LFEDER2	LFEDER3	Y	CATTLE
QD	-12895.0	8814.37	-7684.88	4115.22	-839.886	483.898	-300.444	-0.927	0.059	
STOCKS	11975.4	-10118.3	8204.11	-3446.71	-150.336	86.633	-53.789	0.539	-0.034	
EXPORTS	919.621	1303.89	1303.89	-339.227	-668.51	990.252	-570.531	354.233	-0.025 ^a	
PRI	2.9024	0.5515	-0.7076	0.8292	-0.1329	0.0766	-0.475	-0.0005	0	
FEDER	1.1465	0	0	0	0.5074	0	0	0	0	

COMPRI		POPUS	STOCKS1	INTR	FORY	ERV	WOP	FORPRI	PROD	
QD	-303.382	38.438	0.196	-68.297	0.0001	2.466	3622.75	-6.046	0.766	
STOCKS	175.202	-22.345	0.778	77.103	0 ^a	0.474	655.749	-1.082	0.1369	
EXPORTS	126.18	-16.093	0.025	-8.806	-0.0001	-3.121	-4318.5	7.128	0.099	
PRI	0.1549	-0.0197	0 ^a	-0.0108	0 ^a	0.0004	0.5796	-0.0016	0.0001	
FEDER	0	0	0	0	0	0	0	0	0	

	LM	LP	LY	LCCA1	LB	WN	SP	SM	RMPE	
QD	-277.141	158.299	248.175	28.715	-26.586	5150.73	4857.64	3710.26	0.2848	
STOCKS	49.617	28.341	44.467	5.044	-4.761	-5794.90	-5538.59	-4140.15	0.0985	
EXPORTS	326.758	-186.64	-292.843	-33.219	31.346	644.163	680.951	429.891	0.0792	
PRI	-0.0434	0.0250	0.0393	0.0045	-0.0042	0.9566	0.9991	0.6866	0.1315	
FEDER	-0.4087	0.1295	0.3502	0.0323	-0.0035	0	0	0	--	

^aThe estimate is zero up to four decimal places.

By measuring the effect of all the predetermined variables on the endogenous variables the reduced-form equations can provide an estimate of the impact of the determinants of the exchange rate on agricultural exports and price. Their impact on disappearance and stocks are also reported. However, because of the poor performance of the domestic disappearance equation, its results have to be interpreted with caution.

Table 9 reports other impact elasticities of selected predetermined variables. They are calculated at the mean of all variables and are obtained by interpreting the reduced-form coefficients as impact multipliers [Intrilligator, 1978].

The impact elasticities yield interesting results. They are suggestive of a complex relationship between the endogenous variables and previous prices. The magnitude of the price elasticities for disappearance, stocks, and exports decreases as the time interval between variables increases. This result might suggest that a geometric lag distribution is relevant in these demand functions. However, the impact elasticities for the price equation increase in magnitude as the time interval increases; the lag distribution is completely different than for the other variables. The price equation also indicates friction in the agricultural market; a one-percent increase three quarters ago raises current price by 0.6 percent.

The relationship between current and past variables is also complicated by the varying patterns of the signs of the elasticities for price in previous periods. The price and domestic disappearance endogenous variables have negative elasticities for prices in periods $t-2$ and $t-3$. Stocks have a negative elasticity for price in $t-1$ and positive in $t-2$ and $t-3$. This pattern is reversed for exports which

Table 9. Impact Elasticities of Selected Predetermined Variables on the Agricultural Endogenous Variables

Endogenous Variables	Predetermined Variables							
	PRI1	PRI2	PRI3	AGER1	WOP	FORPRI	M	P
QD	2.639	-2.355	1.187	-0.331	2.515	-0.321	-0.154	0.088
STOCKS	-1.010	0.845	0.363	-0.013	0.101	-0.013	-0.0006	0.0006
EXPORTS	0.847	-0.408	-0.140	0.737	-5.604	0.708	0.343	-0.196
PRICE	0.406	-0.489	0.597	-0.117	0.913	-0.109	-0.054	0.031

have a positive elasticity for price in $t-1$ but negative for periods $t-2$ and $t-3$.

The elasticities for $AGER1$ indicate that the exchange rate in the previous period has a marked effect on current exports. A one-percent appreciation in the previous quarter increases current exports by 0.74 percent. This effect is probably indicative of the delay in the decision to import with the expectation of a future depreciation. The variable $AGER1$ has an understandably much smaller impact on the other endogenous variables.

The impact elasticity for exports with respect to world per capita agricultural output is instructive. This variable has been excluded from many previous modeling efforts, e.g. Chambers and Just [1981,1982]. Yet the indication from the present model is that the variable has a large impact on U.S. agricultural exports: a one-percent increase in world output decreases exports by 5.6 percent. This loss of export market is apparently alleviated by increases in domestic disappearance, since its elasticity with respect to per capita world output is 2.5 while for stocks it is only 0.10.

The export elasticity with respect to $FORPRI$ suggests that there is some substitution of sources of supply by foreign buyers. An increase in the foreign price increases U.S. exports. The inelastic response suggests that the substitutability is not perfect.

The structural elasticity of exports with respect to the current exchange rate is estimated at -1.13; exports respond elastically to an exchange rate movement. However, it is important to recall that the impact elasticity of exports with respect to the exchange rate in the previous period is 0.73. The effects of an exchange rate movement in the current quarter are largely counteracted in the following quarter.

A puzzling result is that the signs of the price elasticities with respect to the nonprice variables are opposite to those that would be expected. An appreciation in the exchange rate decreases exports in the current period but decreases price. An increase in world output decreases current exports but increases price. Another feature is that although the price elasticities are inelastic, their magnitudes (i.e., the absolute value of the elasticities) have a positive relationship with the magnitudes of the export elasticities. As the effect on exports increases, the effect on price also increases.

An explanation for these results lies with both the short-run nature of the model and the positive price coefficient obtained in the structural equation for domestic disappearance. In the short run expansions and reductions in the export market have to be taken up by changes in stocks and domestic disappearance. The elasticities show that disappearance tends to respond more elastically than stocks. The obtained positive price coefficient forces price to move in the same direction as disappearance. Thus an increase in domestic disappearance due to a decrease in results in a higher price. However, because the positive coefficient for current price in the structural domestic disappearance equation runs counter to a priori expectations, the model's results for price cannot be emphasized.

Dynamic multipliers are not reported because the theoretical underpinning of exchange rate determination being limited to the short run make an economic interpretation of these multipliers tenuous. In a time framework longer than one quarter the variables in the exchange rate equation (51) begin to assume mutual dependence. For example, over several quarters money supply can affect the general price level as can

movements in the exchange rate. Thus equation (51) is inadequate for describing exchange rate movements in the long run. Although dynamic multipliers could be mechanically computed from the reduced-form estimates, it would be difficult to attach economic meaning to them. Meaningful multipliers will be feasible only with the advent of determination theories that can successfully explain the exchange rate over a longer time framework, e.g., two to eight quarters.

Empirical Estimates and Objectives of the Study

The empirical estimates reported in the previous pages can be related to the specific objectives of the study as listed at the beginning of the chapter. The first objective was to determine the usefulness of constructing an effective exchange rate for U.S. agricultural exports. The results indicate that there are no clear advantages. Although FEDER performed more poorly in the structural equations, some of the reduced-form equations performed better with FEDER than with AGER. The Federal Reserve Bank effective rate is apparently a good measure to use for an effective exchange rate in agricultural trade models. A possible explanation for this result is that Europe, Japan, and Canada are the United States' major trade partners in both agricultural and nonagricultural trade.

The second objective of the study was to measure the impact of exchange rate volatility on agricultural trade. The estimates of the structural equations showed volatility to have little or no impact on exports. The estimates carried the hypothesized sign (negative) but were statistically insignificant. These results are consistent with empirical studies on general trade, e.g., Gupta [1980] and Hooper and

Kohlhagen [1978]. If agricultural traders are risk averse they are apparently availing themselves of risk-reducing tools such as currency futures. This result is an initial empirical finding using one well-substantiated measure of exchange rate risk. Further exploration of this issue may use other acceptable measures of exchange rate risk.

The third objective of the study was to measure the impact of changes financial market conditions on agricultural exports, prices, and income. The results show that a one-percent change in the agricultural exchange rate will lead to a -1.13 percent change in agricultural exports. The results for this exchange rate effect is a middle ground for results obtained in previous studies for specific commodities. The study of trade with Japan by Meyers et al. [1979] found the absolute value of the exchange rate elasticity to be 0.21 and 0.42 for feed grains and soybeans, respectively. On the other hand, Chambers and Just [1981] found short-run exchange rate elasticities for wheat, corn, and soybeans to be 2.045, 5.227, and 1.311, respectively. The only other empirical study to date that has explained the impact of money supply on exports, Chambers and Just [1982], unfortunately does not report reduced-form elasticities. Reduced-form coefficients are not directly comparable since this study used a double log function to estimate the exchange rate determination equation.

Since the reduced-form equation for agricultural price possessed signs contrary to a priori expectations, the empirical results do not shed light on the relationship between financial market variables and agricultural prices and income. Thus the model was able to meet only part of the third objective.

The fourth objective was to investigate the secondary effects on domestic consumption and stockholding of changes in the financial markets. It is important to emphasize that the effects considered here are only those caused via the export sector; i.e., the line of causation is from the financial variables to the flexible exchange rate to the export sector to domestic consumption and stockholding. Financial variables can also impact the agricultural sector through domestic effects such as interest rates and credit availability which are excluded from this study. The present results indicate that in a one-quarter time period changes in export flows have a larger impact on domestic consumption rather than stockholding. Commodities which in the short run do not find a foreign market tend to find a domestic destination although stocks also increase some.

The fifth objective was to investigate the possible delay of response in the agricultural trade sector to changes in the financial markets. The different current theories of exchange rate determination have the common element of assuming a fast-clearing financial market. It is clear from the estimated exchange rate equations that financial market changes in the current quarter affect the current exchange rate. The estimated structural equations show that the exchange rate also affects agricultural trade quickly, i.e., in the current quarter. Thus no delay of impact is detected between the financial markets and the agricultural sector. However, it is indicated that an opposing effect appears in the following quarter. An export-increasing depreciation in the current quarter becomes export-inhibiting in the following quarter. This result indicates that a one-shot change in the exchange rate serves to advance or delay the decision to import but does not tend to

permanently alter the pattern of export demand. This view is consistent with the notion that the flexible exchange rate is a constantly changing value and may not represent a permanent price change for agricultural imports from the importing country's perspective.

The last objective of the study was to obtain an indication of the extent to which the flexible exchange rate and the financial markets have contributed to income instability in the agricultural sector. The results indicate that a one-shot change in the exchange rate has a bumpy, unstable impact on exports. However, this impact seems to account for only a relatively small portion of the registered fluctuations in exports. The average quarter-to-quarter change in exports during the study period was 12.1 percent. The average change of the agricultural exchange rate was 3.1 percent which, using the estimated exchange rate elasticity, can be estimated to induce an average change in exports of 3.5 percent. Regarding monetary policy in particular, the average change in money supply (M1) was 1.5 percent from quarter to quarter, inducing an average impact on exports of 0.52 percent. One can conclude that somewhat over a fourth of the historic fluctuation in exports can be attributed to the current exchange rate and less to changes in monetary policy. Since the exchange rate in the short run can affect agricultural price and income only via export demand, one can also conclude that the current exchange rate has been responsible for only about a fourth of the total income instability that can be attributable to fluctuations in export flows. An even smaller impact has been exerted by monetary policy via the exchange rate. The results are complicated by the fact that the exchange rate in the previous quarter also affects current exports. The effect is opposite

to the effect in the current period. This result suggests that the total exchange rate effect on exports and income will be greater in periods of successive appreciations and depreciations than in periods where movements occur in only one direction. Using the elasticities for the current (t) and previous ($t-1$) periods, it is estimated that the total exchange rate impact averaged 4.1 percent from quarter to quarter. Thus the total exchange rate impact accounts for about a third of the registered fluctuation in agricultural exports.

CHAPTER VII SUMMARY AND CONCLUSIONS

This study has investigated the relationship between flexible dollar exchange rates and the U.S. agricultural sector. A preliminary part of this investigation was a review of the exchange rate literature as it applies both to the general and the agricultural economies. The review of the literature on exchange rate flexibility reveals that the flexible system adopted in 1973 has performed neither as well as its proponents as first suggested nor as poorly as its critics first feared. Much of the registered instability in exchange rates can be ascribed to unstable underlying economic conditions, but bandwagon speculative effects may have amplified the oscillations in rates. Flexible rates can insulate a country from world inflation but only if output and employment effects are disregarded in the formulation of monetary policy. Flexible rates reduce the need for compensatory financial flows but add international dimensions to the already complex world of fiscal and monetary policy-making.

Another important conclusion to be drawn from the flexible exchange rate literature is that financial market forces now to a large extent determine exchange rates, whereas they were largely determined by governmental decree under the Bretton Woods system. Although there are several different coexisting hypotheses as to exactly how exchange rates are determined in the marketplace, there is general agreement that in the short run the financial rather than the goods market has a decisive role in determination and that these markets are fast-clearing.

A review of the exchange rate issues in the agricultural economic literature reveals that the main topic of concern has been the role of the dollar depreciations during the early 1970s in the rapid expansion of U.S. agricultural exports during the same decade. The literature does not arrive at a consensus on the importance of these devaluations. Generally speaking, authors who took account of the restrictions prevalent in agricultural trade tended to downplay the importance of these devaluations. Authors whose models abstracted from trade restrictions tended to report a more influential role for exchange rates.

The issue of U.S. agriculture in a world of exchange rate flexibility attracted attention only belatedly and by only a few authors. The review of this issue yields the interesting result that the flexible exchange rate serves as an additional vehicle by which monetary policy and financial market conditions can affect the agricultural sector. Heretofore financial market conditions were seen as possibly affecting agriculture only through domestic variables such as the cost and availability of production credit. However, since financial market conditions also affect the flexible exchange rate and the latter affects the ability to sell in foreign markets, exchange rate flexibility has added a new link between the agricultural sector and the macroeconomy. Obtaining an indication of the importance of this link was among the empirical objectives of the study.

The principal tool used for the empirical analysis was a two-block recursive system of equations. One block consisting of a single equation was estimated using ordinary least squares followed by Cochrane-Orcutt procedure. The second block containing five equations

including two identities was estimated via three-stage least squares. The entire system was estimated twice, once for each of two alternative measures for an effective exchange rate.

The empirical findings of the study include

- a) The Federal Reserve Board's effective exchange rate appears to be an appropriate effective exchange rate measure to use in agricultural trade models. No special advantages were found in constructing an effective exchange rate for agricultural exports;
- b) Consistent with findings for the general economy, exchange rate volatility was found to have no significant impact on agricultural exports. The indication is that risk-averse agricultural traders are using risk-reducing tools such as billing in dollars or using the forward exchange markets;
- c) Changes in agricultural export flows are largely absorbed by changes in domestic disappearance in the short run with a minor role played by changes in stocks;
- d) The flexible exchange rate and its determinants are found to affect agricultural export flows. However, these variables account for only a minor portion of the registered fluctuation in export flows during the study period;
- e) There was no perceptible delay in response in the agricultural export market to changes in financial market conditions. Financial market changes in the current quarter affect exports in the current quarter via the exchange rate.

Conclusions

Both the review of the literature and the empirical analysis that form this study support the argument that exchange rate flexibility is an issue deserving the attention of agricultural economists. No longer can the exchange rate be treated as an exogenous variable determined solely by governmental entities. Any future analysis that uses the exchange rate as an explanation of some economic event will immediately lead to the issue of the determinants of the exchange rate as the ultimate explanatory factors. The linkage between the agricultural trade sector, the exchange rate, and the latter's determinants should not be analytically fractured so long as the flexible exchange rate system remains in place.

However, another conclusion that can be derived from this study is that the importance to agriculture of the exchange rate and its determinants can be overstated. Other variables such as world agricultural output and seasonal variability account for the larger portion of the quarterly fluctuation in U.S. agricultural exports. Exporters should be concerned about the variables that make the exchange rate change, but traditional points of attention such as developments in foreign agriculture remain important.

Of the contributions which have focused on the impact of the determinants of the flexible exchange rate on U.S. agriculture, almost exclusive emphasis has been placed on money supply. Perhaps this emphasis has been placed because money supply to a large degree is the product of public policy-making. Yet the results of this study indicate that money supply plays only a partial role in the determination of the exchange rate. Attention should also be paid to other relevant

economic indicators, i.e., national income, the current account balance, and the general price level.

The general conclusion that can be drawn is that exchange rate flexibility has added another dimension to the already complex nature of agricultural trade. The traditional explanatory variables for trade remain important, but exchange rate flexibility interjects all the determinants of the exchange rate as additional pertinent variables. Interposed is also the theoretical mechanism by which these variables are deemed to determine the exchange rate; a theory of exchange rate determination has to be considered before the particular determinants can be discerned.

Variables which could previously be disregarded in the analysis of agricultural trade and financial market relationships which could previously be ignored must now enter the analysis. The adoption of exchange rate flexibility has multiplied the difficulties facing international agricultural economists.

Suggestions for Further Research

This study obtained an indication needing much further exploration: frictions in the agricultural export markets. It was found that price two and three quarters previous affect exports in the current quarter. Some friction was also detected with the exchange rate. Although frictions in the international market has attracted the attention of the general economic literature, agricultural economics seems to have paid little attention to this issue. An elucidation of the nature of these frictions and their sources would be a noteworthy contribution to the body of knowledge about trade in agricultural commodities.

A concomitant analysis would be the determination of the current U.S. agricultural price level. An export-dependent U.S. agricultural economy may have agricultural prices determined to a large extent by events in the international economy. The presence of frictions at the international level would indicate that events in previous periods can affect current prices. The exploration of the validity of incorporating a time dimension to price determination may be a fruitful exercise in future research efforts.

APPENDIX
VARIABLE DEFINITIONS AND DATA SOURCES

AGER

The effective exchange rate for agricultural exports calculated by taking a weighted average of the U.S. dollar exchange rates of Canada, Japan, Italy, France, West Germany, Belgium, Netherlands, Spain, and the United Kingdom. The (yearly) weights were calculated as the proportion of each country's imports of U.S. agricultural products with respect to total imports for the group. These countries were the largest importers with floating currencies. Sources: International Financial Statistics, U.S. Foreign Agricultural Trade.

B

Net outflow of capital measured by the net change in U.S. assets abroad minus the net change in foreign assets held in the United States. A constant of 30,000 was added to all observations to allow estimation in log form. Source: Survey of Current Business.

CATTLE

Number of cattle and calves on feed (1,000 head). Source: Livestock and Meat Statistics.

CCA

Cumulative balance on the current account since 1981 I (million dollars). A constant of 30,000 was added to all observations to allow estimation in log form. Source: Survey of Current Business.

COWPRI

The real price of livestock proxied by the U.S. livestock price index deflated by the producer price index. Source: Agricultural Prices.

ERV

The exchange rate risk. The calculation of risk followed suggestions made by Gutpa [1980]:

$$ERV = \left[\frac{1}{12} \sum_{i=1}^{12} (AGER_{t-i-1} - AGER_{t-i})^2 \right]^{\frac{1}{2}}$$

where t refers to the current month. The monthly figures were averaged for each quarter. An identical procedure was followed with FEDER.

Sources: International Financial Statistics, Federal Reserve Bulletin.

SM

Dummy variable for the third quarter of the year.

STOCKS

Ending stocks of wheat, barley, oats, corn, soybeans, and rice (million bushels). Source: Survey of Current Business, Fats and Oils Situation.

WN

Dummy variable for the first quarter of the year.

WOP

Per capita world agricultural output calculated by subtracting U.S. production from world cereal production (million metric tons). Total production was divided by world population (millions) minus U.S. population. Sources: Agricultural Production Yearbook, UN Monthly Bulletin of Statistics.

Y

Gross national product in constant 1972 dollars. Source: Survey of Current Business.

FORPRI

Foreign agricultural prices were proxied by the Canadian agricultural export price index (1975=100). Lack of availability of aggregate export price composites for other countries prevented use of a more encompassing measure. Source: Statistics of Foreign Trade Monthly Bulletin (OECD).

FORY

Real foreign income proxied by the sum of the real incomes of Canada, Japan, Real France, Germany, Italy, and the United Kingdom. Each currency was converted to U.S. dollars using a constant exchange rate (1976 IV). The restricted number of countries keeping quarterly income statistics prevented the construction of a more encompassing measure. Source: Quarterly National Accounts Bulletin (OECD).

INTR

The real interest rate calculated by the interest paid on the 12-month T-Bill, deflated by the producer price index. The average of monthly rates was taken for each quarter. Source: Federal Reserve Bulletin.

M

M1 definition of money supply (billion dollars). Monthly figures were averaged for each quarter. Source: Federal Reserve Bulletin.

POPUS

Population of the United States (millions). Source: "Population Estimates and Projections."

P

Producer price index for all commodities (1967=100). Source: Survey of Current Business.

PRI

The real price of agricultural exports proxied by the U.S. crop price index (1977=100) deflated by the producer price index. Source: Agricultural Prices.

SP

Dummy variable for the second quarter of the year.

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