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Monetary approach to the competition of U.S. soybean exports in the world market

Hwang, Tsorng-Chyi, Ph.D.
The Ohio State University, 1989

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Monetary Approach to the Competition of U.S. Soybean Exports in the World Market

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
Tsorng-Chyi Hwang, B.A., M.S.

The Ohio State University
1989

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Department of Agricultural Economics and Rural Sociology
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1989
Tsorng-Chyi Hwang
DEDICATION

To my parents
ACKNOWLEDGEMENTS

The completion of this research is impossible without my advisers, some department professors, and my friends. I wish to express my gratitude to these people who assist me in my graduate study here at the Ohio State University.

I wish to express my sincere appreciation to Dr. Cameron S. Thraen who has guided my graduate studies and researches for six years in this department. It is pleasant to work with him as a student or sometimes as a brother. My appreciation is also to Dr. Donald W. Larson who puts lots of efforts on the assistance of the research and encourages all my outside presentations. We had so much pleasure in doing this research work.

I wish to extend my appreciation to Dr. Leroy J. Hushak for his patient reading and useful comments of the expression of this research. With his efforts, this output has been improved a lot.

I am grateful to the Department of Agricultural Economics and Rural Sociology, the Ohio State University for the financial support of this project. It also provides a nice research environment for graduate students to work as a team.

My appreciation also extends to my best friend Russel Smith who has been my buddy for six years. We followed similar steps toward this final part of the Ph.D. program and I wish to see his successful future.

Special Thanks are for the department secretary Judy who is one of my best friends during the six years. Tears and Smiles are part of this friendship. I wish to see her best future life.

- iii -
Finally, I wish to thank my family in Taiwan. They encourage my works during this graduate study. The moral support from them is so greatful for the completion of this research work.
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51st Annual Symposium of the Institute for International Economic
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Radford University, Radford, Virginia, April
30 - May 1, 1988.

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FIELDS OF STUDY

Major Field: Agricultural Marketing and Econometrics


TABLE OF CONTENTS

Dedication ................................................................. ii
Acknowledgements ...................................................... iii
VITA ................................................................................ v
Table of Contents ........................................................ vii
FIGURES .......................................................................... ix
TABLES .......................................................................... xi

CHAPTER I: INTRODUCTION .......................................... 1
  Problem Statement ...................................................... 1
  World Soybean Market Background .......................... 5
    U.S. Soybean Industry .............................................. 5
    Macroeconomic Policies Affecting U.S. Soybean Exports 13
    Trade Barriers in the World Soybean Market .............. 18
    Competitiveness of World Soybean Trade ................ 20
  Hypotheses ............................................................... 23
  Objectives ................................................................. 23

CHAPTER II: LITERATURE REVIEW .............................. 24
  Monetary Approach to Exchange Rate Determination .... 24
  Exchange Rate Effects on Agricultural Trade .............. 30
  The Monetary-Exchange Rate Linkage with Trade ........ 32
  Comments ................................................................. 34

CHAPTER III: MATHEMATICAL METHOD AND ECONOMETRIC MODEL .... 36
  Monetary Approach to the Determination of the Exchange Rate 36
  Trade-Competition Model .......................................... 39
  Elasticities of Monetary Effects on Trade Competition .... 45
CHAPTER IV: EMPIRICAL RESULTS ................................................................. 56
  Estimation of The Monetary Equations .................................................. 57
  Estimation of The Soybean Trade Competition Model ............................ 73
  Elasticities of Monetary Effects on Soybean Trade ................................. 85
    Elasticities in World Soybean Trade (1965-1985) ................................. 87
    Elasticities in World Soybean Meal Market (1965-1985) ..................... 90

CHAPTER V: CONCLUSIONS ................................................................. 95

Appendix A: Domestic Supply, Demand, and Exports of Soybeans, by country... 99

Appendix B: The Derivation of Elasticity Conversion ................................. 102

Appendix C: The Calculation of Elasticities ............................................... 105

Bibliography .............................................................................................. 106
FIGURES

1. Three-Country and One-Commodity Trade Model .................................................. 50
2. Expansionary U.S. Monetary Policy Impacts on Importer Exchange Rate ... 52
3. Expansionary U.S. Monetary Policy Impacts on Both Importer and Foreign Exporter Exchange Rates. ......................................................... 54
4. Actual and Estimated Exchange Rate: (Soybeans - EC-12 and Japan) .... 64
5. Actual and Estimated Exchange Rate: (Soybeans - Brazil and Argentina) ......................................................... 65
6. Actual and Estimated Exchange Rate: (Soymeal - EC-12 and Japan) .... 67
7. Actual and Estimated Exchange Rate: (Soymeal - Brazil and Argentina) ......................................................... 68
8. Predicted Sample Comparison (Soybeans - EC-12 and Japan) ............... 69
9. Predicted Sample Comparison (Soymeal - EC-12 and Japan) ............... 70
10. Predicted Sample Comparison (Soybeans - Brazil and Argentina) ........ 71
11. Predicted Sample Comparison (Soymeal - Brazil and Argentina) ........ 72
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>U.S. Soybean Exports and Macroeconomic Factors</td>
<td>7</td>
</tr>
<tr>
<td>2.</td>
<td>Soybeans, area harvested and production by country</td>
<td>9</td>
</tr>
<tr>
<td>3.</td>
<td>Export Shares of U.S. and Brazil and Argentina in the EC-12 and Japan Market</td>
<td>21</td>
</tr>
<tr>
<td>4.</td>
<td>The Exchange Rate Equations, 1972-1985, A Test</td>
<td>58</td>
</tr>
<tr>
<td>5.</td>
<td>The Exchange Rate Equations, 1972-1985</td>
<td>60</td>
</tr>
<tr>
<td>6.</td>
<td>Elasticities of the Exchange Rate w.r.t. U.S. Monetary Growth</td>
<td>63</td>
</tr>
<tr>
<td>7.</td>
<td>The Soybean Trade-Competition Model, 1965-1985</td>
<td>77</td>
</tr>
<tr>
<td>8.</td>
<td>The Trade-Competition Model, 1975-1985</td>
<td>81</td>
</tr>
<tr>
<td>9.</td>
<td>Price Elasticities of Trade, by country and products</td>
<td>83</td>
</tr>
<tr>
<td>10.</td>
<td>Elasticities of Trade and Price w.r.t. U.S. Monetary Growth</td>
<td>86</td>
</tr>
<tr>
<td>11.</td>
<td>Domestic Supply, Demand, and Exports of Soybeans, by country</td>
<td>99</td>
</tr>
<tr>
<td>12.</td>
<td>Domestic Supply, Demand, and Exports of Soymeal, by country</td>
<td>100</td>
</tr>
<tr>
<td>13.</td>
<td>Domestic Supply, Demand, and Exports of Soyoil, by country</td>
<td>101</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

1.1 Problem Statement

World agricultural commodity trade has moved into a highly competitive era among major exporting countries. The U.S., as a major agricultural commodity exporting country has experienced the loss of market share for certain commodities due to changing forces in world markets. An understanding of competitive forces and impacts of world competition on U.S. agricultural commodity exports is a most important and urgent issue of U.S. farm trade policy. Soybean exports, occupying more than a quarter of export earnings of U.S. agricultural commodity exports, thus become an important sector to be examined.

In the world soybean market, there are reasons specifically attributed to the changing market forces confronted by U.S. exporters. First, increasing world demand for high-protein animal feed and vegetable oils due to economic development and growing population increases the demand for soybeans. The U.S. as a major producing country has responded to this increased demand by increasing production and exports. In addition, other countries which can produce soybeans have also increased production and moved into the world market as new suppliers. Brazil increased soybean production to support its rapidly growing domestic poultry industry beginning in 1973 and became

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1 Soybean crushing produces nearly 80 percent of high-protein meal for animal feed and 18 percent of edible oil, the highest output ratios among all other oilseed crushings.
an important world soybean supplier in 1975. In Argentina, soybean production was not a significant activity until 1972. However, by 1976 production and exports from Argentina became significant in the world soybean market.

Second, the unreliable supply of U.S. soybean exports resulted in a shift of major importers toward other potential suppliers. The U.S. soybean embargo in 1973, caused by a domestic supply shortage, created the opportunity for the European Community (EC) and Japan to import some soybeans and soybean products from Brazil. Brazil began to have significant increase of its market share in 1973. A lasting result of this trade partner shift has been the growth of Brazil and Argentina as important alternative exporters other than the U.S. in the world soybean market.

Third, the low level of tariff and non-tariff protection of agricultural commodity trade also contributed to world soybean competition. Major importing countries in EC-12 and Japan support domestic production by deficiency payments but their soybean production remains negligible. Unlike other edible fats and oils such as butter and palm oil, trade barriers have been minimal in the EC for the entrance of soybeans and soybean products. Japan, as the most important importer of raw soybeans, has free entrance of bulk soybeans. Imports of high value-added processed products are generally prohibited. On the supply side, the U.S. maintains no export taxes and minimum subsidies for soybean production while Brazil and Argentina adopt differential export taxes to collect government revenue and to favor the exports of value-added processed products over raw soybeans. These countries have minimum support prices at a level normally below the equilibrium market price. In addition, low costs of soybean production

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2 Current European Community includes Denmark, United Kingdom, Ireland, Netherlands, Belgium-Lux, France, West Germany, Spain, Portugal, Italy, Greece, and Norway. These 12 countries are known as EC-12.
and subsidized credits maintain the profitability of after-tax exports in Brazil and Argentina. Since the tax rates have been reduced in recent years, the competition between Brazil/Argentina and U.S. soybean exports may increase especially in the soybean by-product markets. ³

Fourth, the macroeconomic policies and exchange rate intervention among trading partners may affect the volatility of the exchange rates. This volatility is then transmitted into world commodity prices. Since the 1970s, Brazil and Argentina have been devaluing their currencies against the dollar to promote export competition and foreign earnings. The U.S. experienced an expanding export market in the 1970s but tight monetary policy in the early 1980s increased the value of the dollar against currencies of major importing countries. Low interest rates in the European countries and Japan, due to low level of government spendings and stable monetary policy, further increased the value of the dollar in the early 1980s. The high value of the dollar resulted in market shares being lost to Brazil and Argentina significantly in the 1980s. The long-run effect has been the substantial decrease of U.S. market share. Moreover, the recent decline in the dollar value against currencies of major industrial countries since 1985 may not keep the market share of U.S. soybean exports from decreasing. This is due to major soybean export competing countries maintaining low values of their currencies against the dollar.

The linkage between macroeconomic policies and agricultural commodity trade has become a major research issue after Schuh addressed the importance of the exchange rate in commodity trade research in 1974. Recent research has focused upon the effects

³ More detailed descriptions on past and current tariff and non-tariff protection will be discussed in the next section.
of U.S. monetary policy on the volatility of agricultural prices and export trade. In defining this research the linkage between two structural relationships is paramount: i) the effects of U.S. monetary growth on the agricultural commodity trade-weighted exchange rate, and ii) the responsiveness of agricultural commodity prices and U.S. exports to exchange rate movements.

A careful estimation of the two structural relationships becomes critical. A theory of exchange rate determination must take into account macroeconomic policies and agricultural commodity trade among trading partners in order to estimate the two relationships. Moreover, a formula to link the two relationships must be built in order to determine the effects of U.S. monetary policy upon U.S. competitive power in world agricultural commodity markets.

This research investigates the effects of U.S. monetary growth on U.S. export competition with Brazil and Argentina through trade-weighted exchange rates in the world soybean market. A monetary approach to the determination of the exchange rate is adopted as the basis for analysis. The monetary and exchange rate policies among exporting and importing countries are taken into consideration. Results will include the effects of U.S. monetary growth on the soybean trade-weighted exchange rates and the responsiveness of soybean prices, U.S. and Brazil/Argentina exports, and EC-12/Japan imports to exchange rate movements. Finally, the effects of U.S. monetary growth on the competitiveness of U.S. soybean exports through the exchange rates can

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be resolved by linking the two relationships.

1.2 World Soybean Market Background

This section offers a comparative analysis of world soybean trade. This analysis covers the period from 1960 to 1985. Relevant domestic farm and trade policies will be introduced. Finally, the competitive situation of current world soybean trade will be summarized.

1.2.1 U.S. Soybean Industry

Commercial exports are an important component in the U.S. economy. The real value of U.S. total merchandise exports averaged 79 billion dollars in the 1960s (1982 dollars), or 3.9 percent of the real average U.S. gross national income (GNP). This study uses 1982 as a base year for valuing real dollars. In the 1970s, the real value of U.S. total merchandise exports averaged 159 billion dollars, or 5.6 percent of the real averaged U.S. GNP. From 1980 to 1985, the ratio of U.S. exports to GNP averaged 6.4 percent, or an average of 212 billion real dollars.

Agricultural exports have been an important part of total U.S. exports. The real value of U.S. agricultural exports averaged 17 billion dollars in the 1960s, or 22 percent of the real U.S. merchandise exports. In the 1970s, the real value of U.S. agricultural exports averaged 32 billion dollars, or 20.3 percent of the real average U.S. total merchandise exports. From 1980 to 1985, the ratio of U.S. agricultural exports to total merchandise exports decreased to an average of 17.7 percent, yet increased to 38 billion dollars in real terms.
Regarding U.S. agricultural exports, the soybean industry has been one of the most important sectors. Aggregate soybean exports comprise the export of soybeans and by-products of soybean meal and oil. The real value of aggregate U.S. soybean exports averaged 2.5 billion dollars, or 14.6 percent of agricultural exports, in the 1960s. The proportion of aggregate U.S. soybean exports to agricultural exports averaged 22.5 percent in the 1970s. This represents 7 billion real dollars. Between 1980 and 1985, the portion of U.S. soybean exports to agricultural exports averaged 20 percent, or 7.5 billion real dollars.

In the 1960s, the real value and quantity of aggregate U.S. soybean exports increased steadily while the market share of U.S. to world soybean exports remained stable, Table 1. The U.S. soybean exports increased from 1.5 billion real dollars in 1961 to 3 billion real dollars in 1969. The quantity of aggregate U.S. soybean exports increased from 4.5 million metric tons in 1961 to 12 million metric tons in 1969. However, the market share of U.S. to world soybean exports remained within the range of 83 and 85 percent between 1962 and 1969.

The real value and quantity of aggregate U.S. soybean exports and U.S. market share fluctuated during the 1970s. The real value of U.S. aggregate soybean exports increased from 4.2 billion dollars in 1970 to 9.3 billion dollars in 1974. A domestic shortage in 1973 decreased the export value substantially. However, aggregate soybean exports increased steadily from 6.4 billion real dollars in 1975 to 10 billion real dollars in 1979. The quantity of aggregate U.S. soybean exports increased from 16 million metric tons in 1970 to 19.5 million metric tons in 1974. After 1974, the quantity increased from 16.6 million metric tons in 1975 to 28 million metric tons in 1979. However, the market share of U.S. to world soybean exports dropped from 84.6 percent
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<th>Year</th>
<th>Real Value of Soybean Exports/a (billion dollars)</th>
<th>Quantity of Soybean Exports (MT)</th>
<th>Market Share of Soybean Exports (%)</th>
<th>U.S. Monetary Growth (M1)** (%)</th>
<th>U.S. Monetary Growth (M2)** (%)</th>
<th>U.S. Federal Deficits (billion dollars)</th>
<th>Real Net Capital Inflow/b (billion dollars)</th>
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Source: Foreign Agricultural Trade of the U.S. and Economic Report of the President.

a: The real value is in 1982 dollars deflated by GNP deflater, 1982 = 100.
b: The negative sign represents surplus or outflow.
*: Soybean exports include the exports of beans, oil, and meal.
The market share is U.S. exports relative to world exports, an approximation only because of rounding among importing countries.
**: M1 includes Currency and Checkable Deposits.
***: M2 includes M1, Time and Savings Deposits, MMMFs, MMDAs, etc.
in 1970 to 70 percent in 1974. The U.S. market share fluctuated within the range of 62 and 67 percent between 1975 and 1979.

In the early 1980s, the U.S. experienced decreases in the real value and quantity of soybean exports and market share. U.S. soybean exports decreased from 9.6 billion real dollars in 1980 to 4.5 billion real dollars in 1985, a 53 percent decline. The quantity of U.S. soybean exports decreased from 29.9 million metric tons in 1980 to 29 million metric tons in 1981. The quantity dropped from 32.7 million metric tons in 1982 to 26 million metric tons in 1985. While the 1984 and 1985 soybean exports were only slightly lower than the level of exports in the late 1970s, the market shares were significantly lower than the shares in the late 1970s. The market share of U.S. to world soybean exports decreased from 62 percent in 1980 to 58 percent in 1981. Moreover, the U.S. market share dropped from 62 percent in 1982 to 50 percent in 1985.

One possible cause of changing real value, quantity, and market share of U.S. soybean exports may be the changes of the supply schedule in the world soybean market. The major world soybean production is concentrated in the U.S., Brazil, and Argentina. The steadily increased world demand for soybean products in the 1960s increased U.S. soybean production and exports while Brazil and Argentina were producing only small quantities. However, the significant increase of world demand for soybean products in the 1970s increased the incentive for soybean expansion in the U.S., Brazil, and Argentina, especially after 1973.

In the U.S., soybean acreage and production had an upward trend in the 1970s, Table 2. This is due to substantial increase of soybean price and increasing world demand during this period. However, domestic supply shortage of soybeans and soybean
Table 2. Soybeans, area harvested and production by country
(1000 HA & 1000 MT)

<table>
<thead>
<tr>
<th>Year</th>
<th>U.S. Area Harv.</th>
<th>U.S. Production</th>
<th>Brazil Area Harv.</th>
<th>Brazil Production</th>
<th>Argentina Area Harv.</th>
<th>Argentina Production</th>
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<td>340</td>
<td>323</td>
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<tr>
<td>1964</td>
<td>12461</td>
<td>19076</td>
<td>360</td>
<td>305</td>
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<td>14</td>
</tr>
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<td>1965</td>
<td>13941</td>
<td>23014</td>
<td>432</td>
<td>523</td>
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<td>25270</td>
<td>491</td>
<td>595</td>
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<td>1967</td>
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<td>26575</td>
<td>612</td>
<td>716</td>
<td>17</td>
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</tr>
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<td>42108</td>
<td>3615</td>
<td>5009</td>
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<td>33062</td>
<td>5140</td>
<td>7876</td>
<td>334</td>
<td>496</td>
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<td>1975</td>
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<td>6416</td>
<td>11227</td>
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<td>695</td>
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<td>47948</td>
<td>7070</td>
<td>12513</td>
<td>660</td>
<td>1400</td>
</tr>
<tr>
<td>1978</td>
<td>25763</td>
<td>50860</td>
<td>7782</td>
<td>9541</td>
<td>1150</td>
<td>2500</td>
</tr>
<tr>
<td>1979</td>
<td>28557</td>
<td>61723</td>
<td>8331</td>
<td>10235</td>
<td>1600</td>
<td>3700</td>
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<tr>
<td>1980</td>
<td>27461</td>
<td>48772</td>
<td>8774</td>
<td>15156</td>
<td>2030</td>
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<tr>
<td>1981</td>
<td>26858</td>
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<td>8485</td>
<td>14978</td>
<td>1880</td>
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<tr>
<td>1982</td>
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<td>12836</td>
<td>1986</td>
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<tr>
<td>1983</td>
<td>25303</td>
<td>44519</td>
<td>8137</td>
<td>14582</td>
<td>2281</td>
<td>4000</td>
</tr>
<tr>
<td>1984</td>
<td>26755</td>
<td>50645</td>
<td>9421</td>
<td>15541</td>
<td>2910</td>
<td>7000</td>
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<td>24922</td>
<td>57114</td>
<td>10153</td>
<td>18278</td>
<td>3269</td>
<td>6500</td>
</tr>
</tbody>
</table>

Source: Foreign Agricultural Production Yearbook.
products between 1973 and 1975 induced decreased acreage and production in 1974 and 1976. Since 1976, the increasing oversupply of domestic crops in the U.S. has caused large participation in set-aside programs. Soybean production on set-aside land, however, has not been prohibited. Thus, corn acreage in mid-west states has given way to soybean acreage. The increasing practice of double-cropping soybeans with wheat in the Plains and Southern states further increased U.S. soybean production in the late 1970s, Hacklander and Gardiner (1984).

In Brazil, soybean acreage kept expanding in the 1970s. The rapidly growing domestic poultry industry encouraged production expansion beginning in 1973 (Table 2). The increase of double-cropping soybeans with wheat in the southern states and new land available in the northern states increased Brazilian production significantly since 1973. However, a severe drought caused a decline in Brazilian soybean production in 1978 and 1979.

In Argentina, soybean acreage expanded in the 1970s at a growth rate significantly greater than the growth rate in the U.S. and Brazil (Table 2). Soybean production started to increase in 1973 to support domestic demand in Argentina. The policy of encouraging agricultural commodity exports in order to earn foreign exchange and government tax revenue increased Argentine soybean production significantly after 1976.

In the 1980s, U.S. soybean acreage and production fluctuated in response to unstable soybean price. In 1980, the expected price decline, due to the expected increase in Brazilian production, decreased U.S. soybean production significantly. The expected increase in crop prices in the early 1980s increased crop competition for land. However, soybean production in the U.S. increased between 1980 and 1982. The unexpected low soybean price in 1982 decreased the incentive of soybean production in 1983. The sig-
significant decrease of 1983 acreage and production was also reflected by the payment-in-kind (PIK) program which prevented soybeans from being planted on conservation acreage. As a result, the decreased supply of soybeans increased soybean price in 1983. U.S. soybean acreage and production were increased in 1984. In 1985, the expected decrease in soybean price decreased soybean acreage. However, the steadily improved yield maintained the increase of U.S. soybean production in 1985.

In Brazil, unstable climate situation and the expansion on the use of new land created the unstable soybean production in the 1980s. The bad weather condition reduced Brazilian soybean acreage harvested and production in the early 1980s (Table 2). However, the growth of new land supply in the central-west part of Brazil increased soybean acreage and production between 1982 and 1985. The competition of soybean acreage with wheat acreage was an insignificant factor regarding soybean production in Brazil.

In Argentina, soybean production followed an upward trend in the 1980s. Soybean production maintained a high level despite the decrease of acreage in 1981. In 1984, soybean production was doubled compared to the level in 1980. Bad weather reduced soybean production in 1985 but the level of production remained higher than the level of production before 1984.

World soybean production not only reflects farm policies, prices, and weather condition, but also comparative advantage between producing countries. Comparative advantage in agricultural production is mainly induced by relative costs of production between countries. Although U.S. land supply is restricted, U.S. soybean acreage can be increased through double-cropping soybeans with corn or wheat. The value of these principle lands for crops is high relative to Brazil and Argentina where there exists an
excess supply of land. The use of fertilizer and herbicide is more intensive in the U.S. than the use of these inputs in Brazil and Argentina. Moreover, the labor cost in the U.S. is substantially greater than the labor cost in Brazil and Argentina. These high costs of inputs in the U.S. may have depressed land expansion for soybean production.

Brazil and Argentina have a comparative advantage in soybean production over the U.S. In Brazil, land cultivation in the central-west and northern regions has been free but the soil condition and transportation have been not efficient, Williams and Thompson (1984b). Recent improvement of soil condition has increased soybean production in these regions. Since high transportation costs are not subsidized, producers are in favor of selling their soybeans to the Brazilian government at support price which is normally below domestic market price. The use of fertilizer and herbicide is not encouraged in both Brazil and Argentina. The low land cost and little amount of inputs in Brazil and Argentina have created a comparative advantage in soybean production over the U.S. These different supply structures have contributed in part to the changing market forces in the world soybean market. U.S. soybean industry thus faces potential disadvantages in soybean production and consequently exports as compared to competitors.

In the world agricultural commodity market, exchange rate changes have served as the key factor for the competitiveness of trade. Prices of soybeans and soybean products are determined by world supply and demand conditions. However, importing countries have to convert their currencies to the U.S. dollar through exchange rates to pay for imports. The change of the exchange rate in the export competing country may alter the amount of currency paid by the importing country to import the same amount of product. Thus, the competitive positions among exporting countries are
affected by the fluctuations of the exchange rates. Under the managed floating exchange system, however, the exchange rates are determined by macroeconomic policies or exchange rate intervention among exporting and importing countries. Thus, exchange rate intervention become especially important for the analysis of U.S. exports.

1.2.2 Macroeconomic Policies Affecting U.S. Soybean Exports

U.S. exchange rate intervention may or may not determine the competitiveness of U.S. soybean exports. Under the gold standard system which prevailed in the U.S. prior to 1972, exchange rates were not affected directly by macroeconomic policies. U.S. macroeconomic policies were used for the adjustment of domestic interest and inflation rates. Exchange rates were fixed by agreement among members of the International Monetary Fund (IMF) under this fixed exchange rate system. Thus, the volatility of commodity prices in the world market were not affected by the exchange rates. The relative amount of currencies paid to different exporting countries from importing country were fixed due to this fixed exchange rates.

However, U.S. exchange rate intervention is expected to affect the competitiveness of U.S. soybean exports under the managed floating system. At the outset of the managed floating system, the U.S. dollar remained as an important official reserve in the world. Many countries pegged their currencies to the dollar after the adjustments of new commitments to the IMF. The 1971 and 1973 devaluations of the U.S. dollar against most currencies did lower the price of U.S. exports paid by many importers, causing U.S. agricultural commodity exports to become attractive. After 1973, the slow adjustment of many countries toward a flexible exchange system maintained the competitiveness of U.S. agricultural commodity exports. The expansion of U.S. monetary
growth between 1974 and 1978 also served, in part, to keep the value of the dollar from substantially increasing. As a result, the U.S. agricultural sector experienced an expansionary period through most of the 1970s and very early 1980s.

U.S. monetary and fiscal policies are expected to affect the relative value of the dollar to other currencies. An expanding fiscal budget deficit or a decreasing growth rate of money supply may increase real U.S. interest rates and cause capital inflow. Capital inflow increases the demand for the dollar in the foreign exchange market and appreciates the dollar if the U.S. does not change its official reserves. The appreciation of the dollar would increase the price of U.S. exports and lower the competitiveness of U.S. exports. Decreasing the fiscal budget deficits or expanding the growth rate of money supply will have the opposite effects on the competitiveness of U.S. exports.

The 1971 and 1973 devaluations of the dollar directly increased the competitiveness of U.S. soybean exports. The devaluations, the increasing world demand, and the lack of competition in the world soybean market in the early 1970s increased revenue from U.S. soybean exports. The real value of U.S. soybean exports increased by 106 percent between 1972 and 1974 (Table 1). The quantity of U.S. soybean exports increased from 16 million metric tons in 1972 to 19.5 million metric tons in 1974. During the same time period, the growth rate of money supply was decreased from 9.2 percent in 1972 to 4.4 percent in 1974. Thus, the decreased growth rate of money supply did not hurt U.S. agricultural commodity exports. The growth rate of money supply in 1974, however, was not low compared to the average of 4.9 percent growth rate of money supply between 1965 and 1969. Nominal U.S. Federal deficits decreased from 23.4 billion dollars in 1972 to 6.1 billion dollars in 1974. Tight fiscal policy moderated domestic interest rates and decreased foreign capital inflow. The net capital
flows turned from 7 billion nominal dollars of inflow in 1972 to 24 billion nominal dollars of outflow in 1975.

While the 1973 devaluation was still having an effect, the 1973 to 1975 temporary soybean embargos, caused by domestic shortage of supply, reduced U.S. soybean exports significantly despite U.S. exchange rate intervention. The real value of U.S. soybean exports decreased from 9.3 billion dollars in 1974 to 6.4 billion dollars in 1975, a 31 percent decrease. The quantity of U.S. soybean exports declined from 19.5 million metric tons in 1974 to 16.6 million metric tons in 1975. During the same time period, the growth rate of money supply increased from 4.4 percent in 1974 to 4.9 percent in 1975. Nominal U.S. Federal deficits increased from 6 billion dollars in 1974 to 53 billion dollars in 1975.

After 1975, the U.S. monetary and fiscal policies became more important for U.S. soybean exports. The nominal value of U.S. Federal deficits decreased from 74 billion dollars in 1976 to 40 billion dollars in 1979. The growth rate of money supply increased from 6.6 percent in 1976 to 8.3 percent in 1978 and decreased to 7.2 percent in 1979. Net capital flows turned from 14.8 billion nominal dollars of outflow in 1976 to 2.9 billion nominal dollars of inflow in 1978, only to become a net capital outflow of 25.6 billion nominal dollars in 1979. Brazil's drought in 1978 and 1979 decreased its exports and increased the competitiveness of U.S. soybean exports in late 1970s. Moreover, the increasing strength of the Euro-banking system depressed the demand for the dollar as official reserves. In 1977, the share of Euro-dollars in global official reserve dollars became 36 percent. As a result, the value of the dollar depreciated against most soybean importing countries. The real value of all U.S. exports increased 57 percent between 1975 and 1979 while the quantity of U.S. soybean exports increased 69 percent.
U.S. soybean exports did not fully benefit from the devalued dollar since the dollar was devalued only with respect to importing countries in the world soybean market. Brazil and Argentina pegged their currencies to the U.S. dollar within a certain range. Deflating the nominal exchange rate by the relative inflation of the two countries, the real exchange rate is obtained. Brazil pegged the cruzeiro to the dollar at an averaged real rate of 150 between 1970 and 1974. Between 1975 and 1979, Brazil pegged the cruzeiro to the dollar at an averaged real rate of 143. Argentina pegged its peso to the dollar at an averaged real rate of 1.2 between 1976 and 1979. In nominal terms, however, Brazil has adopted small and continuous devaluations of its currency since 1973 to assure that its exports are not hurt by domestic inflation.

In the 1980's, U.S. exchange rate intervention also had important effects on the competitiveness of U.S. soybean exports. Between 1980 and 1983, the federal deficits increased significantly more than monetary growth. As a result, domestic interest rates increased and capital inflow increased. Capital inflow caused an appreciation of the dollar which in turn caused a decrease in the real value of U.S. soybean exports. The federal deficits during these years increased by 181 percent while monetary growth increased by only 49 percent (Table 1). The resulting increase in interest rates caused the real net capital inflow to increase from -32.7 billion dollars in 1980 to 28.2 billion dollars in 1983. This capital inflow appreciated the dollar which caused a decrease of 2 billion dollars in soybean exports (Table 1).

Between 1983 and 1984, there was a further increase in inflow of capital. However, this capital inflow was due to monetary growth decreasing by more than the decrease in the federal deficits. For these years, monetary growth decreased by 41 percent and the federal deficits decreased by 11 percent. Thus, interest rates remained high, causing capital inflows.
Between 1984 and 1985, both monetary growth and federal deficits increased, just as witnessed from 1980 to 1983. However, between 1984 and 1985, monetary growth was larger than the increase in the federal deficits. Theoretically, interest rates would decrease causing capital outflow. This result did not come about until late in 1985, therefore statistical data on capital inflow and soybean exports reflect previous policies in 1983 and 1984. The end result was a net capital inflow increase of 24 percent. Due to capital inflow, the appreciated dollar caused a 32 percent decrease in the real value of soybean exports (Table 1).

Another possible reason for the quantity fluctuation in U.S. soybean exports was the response of export competing countries with regard to their exchange rate against the dollar. Brazil and Argentina pegged their currencies to the dollar in most of the 1970s. However, Brazil devalued the cruzeiro against the dollar by 18 percent in 1980 and by 27 percent in 1983. Argentina devalued the peso against the dollar by 58 percent in 1982. It can be concluded that the effects of U.S. exchange rate intervention on U.S. soybean exports may depend on the changes of the relative value of the dollar to the currencies of major importing and export competing countries. When importing countries float their currencies against the U.S. dollar, U.S. exchange rate intervention has an effect on soybean exports. But, there will be no effects on U.S. soybean exports if importing countries peg their currencies to the U.S. dollar. When export competing countries peg their currencies to the dollar within a small range, U.S. exchange rate intervention may affect U.S. soybean exports but the magnitude of the affect may be small. However, U.S. exchange rate intervention is expected to become a serious concern for U.S. soybean exporters whenever export competing countries devalue their currencies against the dollar.
1.2.3 Trade Barriers in the World Soybean Market

The U.S. as the world’s largest soybean producing country has some advantages and disadvantages in soybean production. There have been problems of oversupply in the production of crops other than soybeans in the U.S. High participation in set-aside programs caused corn and wheat acreage to give way to soybean acreage. The increasing world demand for high-protein animal inputs has further encouraged U.S. soybean production since the 1970s. Some conservation and idle lands were used to increase soybean outputs. Moreover, soybeans have never been subject to an acreage reduction program. Producers receive the market equilibrium price of soybeans, a price above the support price level. In fact, U.S. soybean production has not enjoyed explicit subsidies. Although the 1973 embargo, caused by a domestic food shortage, hurt the U.S. image as a reliable supplier, USDA (1988). U.S. embargoes were only temporary and extended only for short periods of time.

Unlike the U.S., Brazil has had a history of complex farm programs affecting soybean production and exports. Input subsidies and subsidized credits for production and storage sharply increased total soybean area planted in the southern part of Brazil despite decreasing world price between 1975 and 1985. Disbursement and repayment programs essentially benefit large farmers. Moreover, a farm processing program decreases farm prices but encourages investment in the soybean processing industry. The program includes depressing domestic soybean prices in order to support crushing and differential export taxes on soybeans and soybean products. As a result, exports of soybean products were encouraged while production and exports of soybeans were retarded, Williams and Thompson (1984b).
Brazil also maintains a soybean price support with the level set generally below the current market price. This program does not benefit soybean production in the southern part of Brazil. However, this support price program has resulted in the recent expansion of soybean production in the Mato Grosso of the central-west part of Brazil. Although this region is far from markets and transportation costs are high, production costs are low enough to make the low government support price attractive, USDA (1988).

In recent years, a shortage of foreign exchange combined with a serious drought in 1986 have influenced the trade and consumption oriented farm policies of Brazil. Since the 1978 drought, soybean imports from the U.S. for domestic crushing purposes have been permitted. But the imported quantities have been relatively small. With large untapped resources of arable land, cheap labor, well-trained agronomists, and a need for foreign exchange, Brazil has endeavored to increase its soybean production and exports. The targeted soybean production increase for 1986-90 is 28 percent.

Argentina, as the second largest soybean exporting country in the world market, also has differential taxes on soybean exports. Agricultural exports account for nearly 80 percent of foreign earnings or 10 percent of government revenue which is mostly used to support the domestic manufacturing sector. Low fertilizer usage plus low wage rates have made soybean production in Argentina relatively low cost when compared to other countries. The large difference between farmgate and export prices leads to increasing production of soybeans despite a low world price. The after-tax export price is about 70 percent of the world price, making Argentine exports attractive.

In major importing countries, trade barriers of soybeans and soybean products have been minimal. In most EC countries, soybeans and soybean products have not been sub-
ject to tariffs and quotas. Only Spain and Portugal have imposed quotas on the imports of soybean oil. Substitutable edible oils and fats such as butter and palm oil have not escaped tariffs and quotas. In addition, there are substantial subsidies on domestic production causing the supported farm price to be well above market price. However, soybean production in EC countries has been negligible.

In Japan, deficiency payments are available for soybean producers, while soybean import tariffs and duties are waived under bulk commodity trade policy, USDA (1987). The limited available lands and a shift toward consumption of more meat, vegetables, and fruits than cereal stuffs have reduced the limited production of soybeans in Japan over time. Japan has a large capacity of mill plants near ports for crushing and therefore restricts imports of high value-added processed products.

High commodity prices in Japan are maintained by insulating Japan's agriculture from international competition. To support production of crops for self-sufficiency, Japan imposes high subsidies on producers and passes the costs onto consumers. However, the market prices are controlled by the government at a high but stable level.

1.2.4 Competitiveness of World Soybean Trade

Major competition in world soybean trade started in the early 1970s. Primary importers are EC-12 and Japan. In the EC-12/Japan soybean market, U.S. market share decreased from 90 percent in the early 1970s to 79 percent in the late 1970s. By 1985 the U.S. market share was nearly 65 percent, Table 3. In the EC-12/Japan soybean meal market, Brazil and Argentina follow the policy of encouraging their crushing industry and thus their market share increased from 30 percent in the early 1970s to 60 percent in the late 1970s. By 1984 the Brazil/Argentina share of soybean meal
Table 3. Export Shares of U.S. and Brazil and Argentina in the EC-12 and Japan Market. * (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>Soybeans Brazil &amp; U.S.</th>
<th>Soybeans Argentina</th>
<th>Soymeal Brazil &amp; U.S.</th>
<th>Soymeal Argentina</th>
<th>Soyoil Brazil &amp; U.S.</th>
<th>Soyoil Argentina</th>
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<td>1965 - 69</td>
<td>97.11 2.89</td>
<td>91.09 8.91</td>
<td>na</td>
<td>na</td>
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<tr>
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<td>89.99 10.01</td>
<td>69.48 30.52</td>
<td>36.36</td>
<td>63.64</td>
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<td></td>
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<td>1975 - 79</td>
<td>79.35 20.65</td>
<td>39.15 60.85</td>
<td>1.93</td>
<td>90.07</td>
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<td>1980</td>
<td>78.99 21.01</td>
<td>36.51 63.49</td>
<td>0.12</td>
<td>99.88</td>
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<td></td>
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<tr>
<td>1981</td>
<td>82.59 17.41</td>
<td>29.51 70.49</td>
<td>1.86</td>
<td>98.14</td>
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<td></td>
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<tr>
<td>1982</td>
<td>89.10 10.90</td>
<td>31.32 68.68</td>
<td>2.84</td>
<td>97.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>85.36 14.64</td>
<td>29.54 70.46</td>
<td>0.27</td>
<td>99.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>74.02 25.98</td>
<td>14.94 85.06</td>
<td>0.33</td>
<td>99.67</td>
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<tr>
<td>1985</td>
<td>64.93 35.07</td>
<td>15.69 84.31</td>
<td>0.15</td>
<td>99.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: U.S. Department of Agriculture and Foreign Agricultural Trade of the U.S.  
* : na represents data not available.  
Brazil/Argentina exports are proxy data.
market was 85 percent. In the EC-12/Japan soybean oil market, Brazil and Argentina dominated the market in the 1970s and the 1980s.

Many agricultural economists have focused on tight monetary policy in the early 1980s as being the major factor depressing U.S. market competitive positions for agricultural commodities. Between 1974 and 1978, the U.S. maintained an expansionary monetary policy. In 1979, U.S. Federal Reserve officials started a new course of monetary policy, that of relatively tight monetary growth. However, U.S. market shares of soybeans and soybean products have continued to decline since the early 1970s. The declining market share implies a decrease in the competitiveness of U.S. soybean exports. Through exchange rate intervention, export competing countries undervalued their currencies against the U.S. dollar. Such exchange rate intervention may be the key factor for the competitiveness of exports in the world market. Major export competitors, Brazil and Argentina, have artificially devalued their currencies against the dollar since the mid-1970s. Their domestic macroeconomic policies are set to control domestic inflation rates which indirectly affect the degree of necessary devaluations. This important exchange rate intervention of export competitors in the 1970s has been ignored by previous analyses.

To understand the competitive position of U.S. soybean exports, the relative exchange rate intervention between countries must be taken into account. A competition model has to be defined properly to show the fluctuations of market shares affected by the exchange rate fluctuations. Some policy variables and economic shocks such as an embargo also have to be considered.
1.3 Hypotheses

The hypothesis of this research can be stated as:

$H_0$: An expansionary U.S. monetary policy will not increase U.S. competitive power in the world soybean market, and

$H_1$: An expansionary U.S. monetary policy will increase U.S. competitive power in the world soybean market.

1.4 Objectives

The general objective of this research is to investigate the effects of U.S. monetary policy or U.S. monetary growth rate on the competitiveness of U.S. soybean exports. The specific objectives are:

1. to identify and describe the market structure of current world soybean trade;
2. to identify and develop a quantitative model for the explanation of competitive world soybean trade among U.S., Brazil, Argentina, and major importing countries in EC-12 and Japan; and
3. to estimate and evaluate the effects of U.S. monetary policy from 1965 to 1985 on U.S. soybean exports in the world market.
CHAPTER II
LITERATURE REVIEW

Previous research has focused on either the effects of U.S. monetary policy on the exchange rates or the responsiveness of agricultural commodity prices and U.S. exports to exchange rate movements. Most of these past studies ignore the connection between the two relationships. This chapter will first review past studies on the relationship between U.S. monetary policy and the exchange rate. A review of the relationship between the exchange rate and U.S. agricultural exports is the second major portion of this chapter. Finally, previous studies regarding the connection of the two relationships are reviewed.

2.1 Monetary Approach to Exchange Rate Determination

The monetary approach to the determination of the exchange rate has two major assumptions regarding the asset market. First, there are no barriers, such as substantial transaction costs or capital controls, to the flow of capital between countries. This is the assumption of perfect capital mobility. Under the assumption, the interest rate on a domestic bond plus the forward premium on foreign exchange is equal to the interest rate on a similar foreign bond if there are no risks other than the exchange premium and is referred to as the covered interest parity. Second, domestic and foreign bonds

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5 Covered interest parity may not hold if one considers the tax treatment, default risk, or other factors. However, aggregating the interest rates of many countries will not be obtained if one differentiates among treasury bill rate and other coun--
are assumed to be perfect substitutes in investor demand functions or there is only one bond in the world. Perfect substitutability would imply that the interest rate on a domestic bond plus the expected rate of appreciation of domestic currency is equal to the interest rate on a foreign bond and is referred to as the uncovered interest parity. In other words, the expected rate of return on the two countries' bonds is the same and asset holders are indifferent to the composition of their bond portfolios.

Under the assumption of perfect substitutability, portfolio shares of asset holders are highly correspondent to expected rates of return. Thus uncovered interest parity must hold and bond supplies become irrelevant. The major factor determining the exchange rate thus shifts to the money markets. This argument becomes the monetary approach to exchange rates and focuses on the monetary market balance.

The monetary approach model is built based not only on the asset market assumptions but on similar assumptions of the goods market. There are no barriers, such as transaction costs and trade control, to the flow of goods between countries. Also, domestic and foreign goods are perfect substitutes in consumer demand functions. In other words, there is only one good in the world. The one good assumption implies that the foreign price level is equal to the domestic price level times the exchange rate and is referred to as purchasing power parity.

The unobservable expectations result in difficulty of testing the uncovered interest parity. However, the uncovered interest parity (perfect substitutability) can be tested by given the market efficiency. See Cumby and Obstfeld (1979) and Frankel (1982).

This research assumes that the soybean trade-weighted prices and exchange rates will hold the purchasing power parity to simplify the analysis. Further tests on the purchasing power parity may be performed by assuming the additive or multiplicative relationships among the exchange rate and factors other than the prices. One important factor may be the inflation expectations.
The long-run perspective of the monetary approach assumes further that the price level is perfectly flexible. This assumption and the above assumption serve as the starting point for the development of the monetary approach model. It has been developed by Frenkel (1976, 1977, 1980), Mussa (1976), Girton and Roper (1977), Hodrick (1978), and Bilson (1978a, b).

The monetary approach model states the assumption on the money market equilibrium in the following way.

\[ MS = P Y^\phi e^{-\lambda i} . \]  

(2.1)

MS is the level of money supply which equals the level of money demand expressed as the right-hand-side function. The domestic nominal price and real income are represented by \( P \) and \( Y \), respectively. The exponential operator is \( e \) in the money market equilibrium equation. The domestic short-run interest rate is \( i \). The coefficients \( \phi \) and \( \lambda \) are the elasticity parameters.

Taking the logarithm of equation (2.1), the money demand function becomes:

\[ m = p + \phi y - \lambda i , \]  

(2.2)

where all the variables in lower case are in logarithm form except \( i \). Assuming that the foreign money demand function is similar to equation (2.2), the difference of the two countries' money demands functions becomes the relative money demand function and expressed as follows.

\[ (m - m') = (p - p') + \phi (y - y') - \lambda (i - i') . \]  

(2.3)

Asterisks denote foreign variables and the parameters are assumed the same in both countries.

The one-bond assumption implies uncovered interest parity:

\[ i - i' = E(\Delta e) , \]  

(2.4)
where $E(\Delta e)$ represents the expected appreciation of the domestic currency. Combining equations (2.3) and (2.4), the relative price level becomes:

$$(p - p') = (m - m^*) - \phi (y - y^*) + \lambda E(\Delta e).$$  

(2.5)

The one-good assumption implies purchasing power parity:

$$e = p - p^*,$$  

(2.6)

where $e$ denotes logarithm of the spot exchange rate, defined as the value of domestic currency in terms of foreign currency. The expected appreciation thus equals the expected inflation differential:

$$E(\Delta e) = E(\Delta p) - E(\Delta p^*).$$  

(2.7)

Combining equations (2.5), (2.6), and (2.7), the monetary approach model of the exchange rate determination becomes:

$$e = (m - m^*) - \phi (y - y^*) + \lambda [E(\Delta p) - E(\Delta p^*)].$$  

(2.8)

Where the relative value of currency $e$ is a function of relative level of money supply, relative level of real income, and relative expected inflation rate. An increase in the supply of domestic money causes a proportionate depreciation. An increase in domestic income or a decrease in the expected inflation rate raises the demand for domestic money and thus causes an appreciation. Hodrick (1978), Bilson (1978a), and Meese and Rogoff (1983) provided evidence that money supply changes influence the nominal value of the bilateral exchange rate.

Assuming that expectations are rational, income growth is exogenous, and the system is stable, then the expected inflation rate will equal the rationally expected monetary growth rate if the monetary growth follows a random walk process. If the level of the money supply, instead of the change in the money supply, is a random walk,
then the last term of equation (2.8) becomes zero. The level of the exchange rate is perfectly correlated with the level of the relative money supply. However, the existence of secular inflation and its effect on money demand should not be ignored.

In the short-run prospective, purchasing power parity may not be a good approximation. The rigidity of the wage rate, imperfect information, and inertia in consumer habits induces the stickiness of price adjustments over time. Under the assumption of sticky prices, changes in the nominal money supply are the same as changes in the real money supply. Thus, nominal changes in money supply have real effects especially on the exchange rate.

The sticky-price monetary model originated from Mundell (1963) and retains the one-bond assumption while relaxing the one-good representation of trade. Mundell assumes that the expected spot rate change is static: the expected future spot rate is equal to current spot rate. This assumption is viewed as out-of-date issue. Thus, modifications of the Mundell model focus on the expectations specification.

Rational expectations was introduced into Mundell model by Dornbusch (1976). Dornbusch assumes that the expected future spot rate is less than unit-elastic with respect to current spot rate. Thus, uncovered interest parity is when domestic interest rate is equal to foreign interest rate plus the expected change in spot rate. In the short run, a monetary expansion has the liquidity effects in the model because of sticky prices. The interest rate falls causing capital outflow, which generates the instantaneous currency depreciation more than in the long run. The degree of the depreciation is equal to the rationally expected future appreciation, which cancels out

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8 Some recent empirical studies are Isard (1977), Genberg (1978), and Krugman (1978).

9 The existence of risk premium has been tested as true by Hodrick (1981) and Mark (1985).
the interest differential. This is a phenomenon referred as "overshooting" for the sticky-price monetary approach.

The only difference between the sticky-price and flexible-price monetary models is the specification of uncovered interest parity. In the short run, it is expected that the exchange rate will move at the speed \( \theta \) toward its equilibrium path. Thus, the short-run expected depreciation becomes:

\[
E(\Delta e) = -\theta (e - \bar{e}) + E(\Delta p) - E(\Delta p^*),
\]

where \( \bar{e} \) is the long-run equilibrium exchange rate. Combining equations (2.4) and (2.8), the short-run deviation of the exchange rate from the equilibrium path turns into:

\[
e - \bar{e} = -\theta [i - E\Delta p - (i^* - E\Delta p^*)].
\]

The deviation of the exchange rate from its equilibrium value is proportional to the real interest differential. The spot exchange rate becomes:

\[
e = \bar{e} - \theta [i - E\Delta p - (i^* - E\Delta p^*)].
\]

Combining equation (2.11) with the long-run monetary equilibrium represented by equation (2.8), a general monetary equation of exchange rate determination becomes:

\[
e = (m - m') - \phi (y - y') + \lambda (E\Delta p - E\Delta p^*)
- \frac{1}{\theta} [i - E\Delta p - (i^* - E\Delta p^*)] .
\]

The fourth explanatory variable in equation (2.12) will show a zero coefficient in a regression if the flexible-price monetary model is correct. Hodrick (1978) provided evidence that the mark/dollar rate satisfies the general monetary equation with the assumption that the level of money supply is a random walk. Frankel (1979b) supported the general monetary model by estimating the mark/dollar rate from July 1974 to February 1978.
2.2 Exchange Rate Effects on Agricultural Trade

Many theoretical and empirical studies have modeled the export demand functions confronted by the U.S. agricultural commodity. Schuh (1974) assumes that the United States faces an infinitely elastic export schedule as a price taker and concluded that past research may have ignored the exchange rate as an important explanatory variable. Following Schuh's arguments, Kost (1975) and Bredahl and Gallagher (1977) use a one-traded good and two-country trade framework to analyze the effects of a devaluation on agricultural trade graphically. They show that theoretically the exchange rate is an important variable especially in the excess supply and demand schedules.

Many empirical works provide evidence of a significant link between exchange rates and agricultural commodity prices and exports. Johnson et. al. (1977) build a multiple-region spatial equilibrium trade model and derive the impact multiplier on the internal U.S. price of wheat. The multiplier calculated according to the change in the difference between the U.S. support price and foreign demand prices. As a result, a 10 percent devaluation of the dollar against all currencies will result in an increase in the U.S. wheat prices of 6.9 percent.

Chambers and Just (1979) criticize three major weaknesses of Johnson's paper. First, restricting the flexibility of exchange rate elasticity in the analysis would be misleading. It implies that endogenizing the exchange rate in the analysis of the effects of the exchange rate on agricultural price will eliminate the problem of the enforced restrictions. Second, the cross-price effect must not be ignored. Since the supply side is treated as exogenous, the cross-price effect exists in the demand schedules because wheat can be treated as the differentiated product across countries. Third, demand systems derived from weakly separable utility functions may be useful in constructing a
trade model. It implies that all other prices except the own price need to be grouped using the exchange rates as the weights and be treated as a separate explanatory variable. However, this may not be appropriate because there is no simple way to compare different exchange rates in terms of any common numeraire such as the dollar.

Chambers and Just (1981) put the predetermined exchange rate variable in the export equations of wheat, corn, and soybeans. The other system equations are grouped as the disappearance equations, the inventory equations, the production equations, and the identities. Three-Stage Least Square (3SLS) and Zellner's Seemingly Unrelated Regression techniques are applied to estimate the reduced forms. The dynamic multipliers are formed for lag periods of one to twelve quarters. The estimated results show that the exchange rates are statistically significant except in the soybean export equation. It is concluded that the impact multipliers, measuring the effect of a depreciation, exhibit a strong upward push on prices and exports. By looking at the long-run elasticity of domestic wheat price with respect to the exchange rate change, Chambers and Just find that this elasticity is similar to that suggested by the work of Johnson, Grennes, and Thursby. Finally, the short-run elasticities are concluded to be greater than unity for all domestic prices and exports except the soybean exports.

Collins, Meyers, and Bredahl (1980) specify a world market equilibrium system for wheat, corn, soybeans, and cotton. Their model assesses the effects of exchange rate changes, inflation, and price insulation policies in late 1970s on real U.S. commodity prices. Arguments of the exchange rate effects on U.S. commodity prices focus on the importance of the exchange rate change adjusted for differential inflation rate. The world market equilibrium system contains functions of domestic demand, the supply relation of each country, the world equilibrium condition, currency linkages based on a
numeraire currency, and price linkage equations based on a numeraire count. As a result, the impacts of the exchange rate changes on domestic real price under free trade are the smallest compared to those under other price insulation policies. By comparing the results with the real actual change of prices, Collins, Meyers, and Bradahl indicate that much of the variability in commodity prices may be attributed to factors other than the unstable exchange rate.

Based on the above model, Longmire and Morey (1983) introduce the Cobweb theory, rational expectation and Nerlove’s expectation in the analysis of wheat, corn, and soybeans. The method used is similar to Collins, Meyer, and Bredahl yet results are found by comparing price changes from base-year prices. The authors conclude that a 20-percent rise in the value of the dollar will cause farm exports to drop by 16 percent.

The studies discussed above provide evidence of a strong link between exchange rates and agricultural prices and trade. However, the exchange rate is treated as exogenous in these studies. Other important macroeconomic variables such as real income and monetary policy are ignored. These variables may have direct or indirect impacts on commodity prices and trade through the exchange rate and the general price level.

2.3 The Monetary-Exchange Rate Linkage with Trade

Chambers (1981) first analyzed the effects of the monetary instrument, that is the interest rate, on agricultural trade. The methodology consisted of graphical illustration and partial derivatives of endogenous trade variables taken with respect to interest rate. The elasticity of world agricultural price and exports with respect to the monetary instrument are derived to evaluate the importance of the monetary instrument on agricultural trade. However, there is no empirical support of this analysis.
Chambers and Just (1982) introduce an exchange rate equation into the analysis. Explanatory variables are lagged exchange rate, current balance of trade and its lags, domestic credit, discount rate, whole price index, and seasonal dummy variables. Basically, the seemingly unrelated regression is adopted to estimate the block recursive model which includes the blocks of the agriculture, the aggregate export, and the reduced form of the exchange rate. The exchange rate becomes partially endogenous. The results suggest that performance of U.S. exports of wheat, corn, and soybeans since the mid-1970s has been highly correlated with the money supply (M2). Batten and Belongia (1983) criticize that Chambers and Just model does not include a link between the U.S. money supply and commodity prices or between foreign money supply and the exchange rate. Gardner (1981) put the word "implausible" on the Chambers and Just results and suggests that a simple trade model to include the macroeconomic variables instead of a complex multi-sector macroeconomic model may be appropriate for analytical purpose in agricultural trade.

Shei and Thompson (1981) build an intricate model to link U.S. macroeconomic policies with the agricultural sector. They analyze the relationship between inflation and agriculture combining the monetarist and structuralist points of view. The goods market and the money market are disaggregated into several subsectors. Results suggest that money supply is an important variable in agriculture and inflation. A tight monetary policy in the early 1980s implies that the agricultural prices would have been depressed relative to prices in other subsectors.
2.4 Comments

The monetary approach to exchange rate determination suggests that the exchange rate must estimated by combining the money market equilibrium condition in two countries. The relative level of money supply, the relative real income, the relative nominal interest rate, and the inflation differential are the important explanatory variables in the exchange rate model. The monetary approach is especially important for the analysis of the effects of monetary policy on agricultural trade. It provides not only theoretical background but also provides testable hypotheses with regard to the relationship between the monetary instrument and the agricultural trade-weighted exchange rate.

Theoretical and empirical models that estimate the effects of exchange rates or monetary policies on agricultural trade have several important implications for future research. First, the export demand function should not ignore the cross-price effects. Second, the deviations of empirical results of exchange rate effects on agricultural trade may be caused by misspecifications of the trade model. Third, the exchange rate may have to be treated as one important explanatory variable in the export demand estimation. Fourth, there are other macroeconomic factors that may have greater impacts on agricultural trade than the exchange rate. Fifth, the monetary factor is important to agricultural trade and the possible quantitative impacts need to be examined more explicitly.

Moreover, there are several important points one needs to be cautious about when studying the agricultural trade phenomenon. First, the two-country trade model tends to create an aggregation problem. Under this specification, all importing and export-competing countries are aggregated into one net importing region. Such a technique
ignores structural and policy differences among countries, also, world demand and supply responses to changes in the value of the dollar become unclear. Second, the calculation of the trade-weighted rate index will have different effects on its use in estimating agricultural trade. As Belongia (1986) points out the arithmetic and geometric means of the index tend to have opposite effects when currencies fall against the dollar or rises against the dollar. Third, the link between monetary policy and world agricultural trade needs to have an explicit formula that connects the relationship between monetary policy and exchange rate and between exchange rate and agricultural trade.
CHAPTER III
MATHMATICAL METHOD AND ECONOMETRIC MODEL

This section uses mathematical expressions and graphical explanations to address the effects of U.S. exchange rate intervention on the competitiveness of U.S. soybean exports. The exchange rate intervention of U.S. monetary policy affects the relative world soybean price received by the U.S. and other countries which, in turn, affects the competitiveness of U.S. soybean exports. A three-country trade model is adopted. It is assumed that the world soybean market is perfectly competitive and no transaction costs and trade barriers are involved in the world soybean trade. A partial equilibrium model is then applied.

3.1 Monetary Approach to the Determination of the Exchange Rate

Following the derivation of the exchange rate equation (2.8) in Chapter 2, the agricultural trade-weighted exchange rate model is formed. The flexible-price monetary model assumes that prices are perfectly flexible in the long run and is represented by equation (2.8) as

$$e = (m - m') - \phi (y - y') + \lambda (E_AP - E_A')$$,

where the spot exchange rate was defined as the price of domestic currency in terms of foreign currency. The parameters $\phi$ and $\lambda$ represent the money demand elasticities with respect to income and the interest rate, respectively. Asterisks denote foreign
variables and $E$ is the expectation operator. To express the consistent definition of the spot exchange rate with the trade-competition model in next section, the exchange rate, $e_j$, is defined as log of the price of foreign currency in terms of domestic currency. In other words, the relationship between $e$ and $e_j$ can be expressed as: $e_j = \frac{1}{e}$. Subscript $j$ denotes the $j$th foreign country. Thus, equation (2.8) can be rewritten as:

$$e_j = (m^* - m) - \phi(y^* - y) + \lambda (E\Delta p^* - E\Delta p)$$

(3.1)

Where

- $m^*$ = log of foreign money supply,
- $m$ = log of the domestic money supply,
- $y^*$ = log of foreign real income,
- $y$ = log of domestic real income,
- $p^*$ = log of foreign price level,
- $p$ = log of the domestic price level,

Restricting the flexibility of the price will result in a fixed-price monetary model. In the short run, the price is assumed to be sticky and the general monetary equation of exchange rate determination is obtained as:

$$e_j = (m^* - m) - \phi(y^* - y) + \lambda (E\Delta p^* - E\Delta p)$$

$$- \frac{1}{\theta} [(i^* - E\Delta p^*) - (i - E\Delta p)]$$

(3.2)

which is just a restatement of equation (2.12) under the newly defined exchange rate, $e_j$. The fourth explanatory variable is the real interest rate differential and its coefficient is expected to be zero in a regression if the data used proves to be acceptable for a long-run analysis. This will imply that the flexible-price monetary model is correct.
in the sense that the long-run price is perfectly flexible. However, the existence of secular inflation and its effect on money demand can not be ignored.

Equation (3.2) suggests a possible "overshooting" of the short-run exchange rate from a macroeconomic policy change. An increase in the domestic money supply causes the exchange rate to deviate from the equilibrium path in the short run because of the stickiness of price. The domestic currency may depreciate more than what it does in the long run. In the long run, price is perfectly flexible and purchasing power parity holds. The fourth term of equation (3.2) disappears, equation (3.2) becomes identical to equation (3.1).

For the purpose of testing whether this is a long-run analysis based on the annual data, the coefficient of the real interest rate in equation (3.2) will be examined. If the coefficient is zero, it implies that the speed of the exchange rate adjustment toward its equilibrium path is infinite when the secular inflation is not considered. In other words, the exchange rate series has the time length for full price adjustment as proposed in the theoretical long-run situation. If the coefficient is not zero, the short-run "overshooting" property exists in the annual exchange rate series. One can not conclude that the length of time in a time series data such as annual exchange rate will have a long-run or short-run property without statistical test. However, the consideration of secular inflation will require estimating the exchange rate equation in the following form:

\[ e_j = (m^* - m) - \phi(y^* - y) - \frac{1}{\theta}(i^* - i) + \left( \lambda + \frac{1}{\theta} \right)(E\Delta p^* - E\Delta p). \]  

The long-run inflation differential disappears if the movements of money supply in the two countries are statistically a random walk. The expected relative monetary
growth will be zero, implying a zero change in the differential expected inflation. The general monetary equation of exchange rate determination becomes:

\[ e_j = (m^* - m) - \phi (y^* - y) - \frac{1}{\theta} (i^* - i). \] (3.4)

However, it is not expected that other groups of countries will follow the same money supply process as the U.S.

The elasticity of the exchange rate with respect to U.S. monetary growth can be derived from equation (3.3). Assuming that U.S. money supply follows a first-order autocorelation process, Appendix A gives us the elasticity of the exchange rate with respect to U.S. monetary growth:

\[ \frac{E_{MX}^E}{E_{Ms}^E} = \frac{MS_t - MS_{t-1}}{MS_t} \frac{(MS_t - MS_{t-1})}{(MS_{t-1} - \frac{1}{\delta} MS_t)}. \] (3.5)

where \( E_j \) represents the elasticity of variable \( j \) with respect to variable \( i \). The nominal exchange rate is denoted by \( EX \). The U.S. monetary growth rate is represented by \( M \) while the U.S. money supply is represented by \( MS \). The parameter \( \delta \) is the multiplier of U.S. money supply process and represents the underlying increase of the level of money supply across time. The subscript \( t \) represents time and \( t-1 \) is a lagged time period.

### 3.2 Trade-Competition Model

Extending the trade competition model of Haley (1986), a three-country and one-product model is built. Brazil and Argentina are grouped as one export competing country faced by the U.S. (Brazil/Argentina). The EC-12 and Japan represent the group of importing countries in the world soybean market. Prices and income used in this model are in real dollar terms to account for inflation effects.
The exchange rate is defined as the amount of foreign currency that can be exchanged for one unit of the U.S. dollar in this competition model. It is defined in this way for the purpose of converting the world price into local currency used in this model. The exchange rate between the U.S. and the rest of the world's exporters is expressed as:

$$EX_b = \frac{\text{the ROW currency}}{\text{the U.S. dollar}}$$

(3.6)

and the exchange rate between the U.S. and the importer country is expressed as:

$$EX_m = \frac{\text{the Importer currency}}{\text{the U.S. dollar}}$$

(3.7)

When U.S. exchange rate intervention, say monetary policy, appreciates the dollar against the currency of the rest of the world exporter and importer, then $EX_b$ and $EX_m$ increase.

The net exporting country has to satisfy domestic demand for soybeans and soybean products and exports the residual. The simple expected export function can be expressed as:

$$EXP = XS(\frac{DP}{CPI}, \frac{OP}{CPI}, I) - XD(\frac{DP}{CPI}, Y),$$

(3.8)

where $EXP$ is the expected exports which is the difference between domestic supply, $XS$, and domestic demand, $XD$, in the exporting country. Domestic supply is a function of the domestic price, $DP$, other prices, $OP$, and other non-price variables. The other prices, $OP$, may include the world market price, the competing or substitutable product price, and the input prices. The non-price variable may include policy variables, quantity variables, and dummy variables. The domestic demand is a function of the domestic market price and the real income, $Y$. All prices are deflated by the consumer price index, CPI.
Equation (3.8) can be rewritten as an excess supply function:

\[ EXP = ES\left( \frac{DP}{CPI}, \frac{OP}{CPI}, I, Y \right). \]  

(3.9)

As domestic market price increases, domestic supply will increase and consumption will decline. If the world price increases at the same time, the change in the excess supply will depend on the relative magnitude of domestic and world price elasticities.

Equation (3.9) can be converted by incorporating a new variable, named the export capacity. By putting the export capacity into the expected export function is to blend domestic structures of supply and demand into one variable. This transition will allow the focus on factors in the international markets. The export capacity can be defined as the relative level of domestic supply to domestic demand. Along with the variable in the excess supply function, only international prices and other non-price variables will be included. As a result, equation (3.9) can be rewritten as:

\[ EXP = ES\left( \frac{WP}{CPI}, CAP, Z \right), \]  

(3.10)

where WP is the nominal world price. The export capacity, CAP, is defined as total domestic supply over total domestic demand. Total domestic supply includes the production and the stocks for the agricultural commodity. Total domestic demand includes domestic use for consumption or other purposes.

For most agricultural commodities, the exports are constrained by the nature of time, especially the yearly harvested crops. In any period of time, actual volumes of exports may not adjust completely to the desired level. Lack of knowledge, technical constraints, and other items might responsible for the possible partial adjustment, Pindyck and Rubinfeld (1981). It is assumed that soybean exports have the adjustment process of adaptive expectations in the form of:
\[ X P_t - X P_{t-1} = \gamma(EXP_t - XP_{t-1}), \quad 0 < \gamma < 1, \quad (3.11) \]

where \( \gamma \) is the adjustment speed and \( XP \) is the actual exports. Substituting equation (3.10) into (3.11), the actual exports become a function of the form as:

\[ XP_t = ES\left(\frac{WP}{CPI_t}, CAP_t, Z_t, XP_{t-1}\right). \quad (3.12) \]

For the net importing country, the simple expression of the expected importing function can be defined as:

\[ EMP = MD\left(\frac{DP}{CPI}, Y\right) - MS\left(\frac{DP}{CPI}, \frac{OP}{CPI}, J\right), \quad (3.13) \]

where the expected import quantity is \( EMP \) which is the difference between the functions of domestic demand, \( MD \), and domestic supply, \( MS \). All other variables have the same definitions as in equation (3.10) with only the country difference. Since world demand is increasing stably over time, it is assumed that there is no partial adjustment on the consumption part.

Assuming that the importing country has little production and a high price support program for soybeans, the world price may be highly correlated with the domestic price. Equation (3.13) can be expressed as an excess demand function:

\[ EMP = ED\left(\frac{WP}{CPI}, Y, MZ\right), \quad (3.14) \]

where \( MZ \) represents other exogenous variables. The actual imports will have less adjustment problem. Most importing country takes the expected world supply as given information. Moreover, the multiple suppliers can hasten the adjustment speed from the expected to actual imports. Thus, there is no lagged dependent variable specified in the actual import function which has the equality as \( EMP = MP \). However, it suggests the possible correlation between the disturbance terms of export and import func-
tions. Finally, total world excess supply must equal total excess demand. The equilibrium condition may be written as:

\[ XP = MP. \]  \hspace{1cm} (3.15)

Equations (3.10) to (3.15) may be extended to a three-country trade model. The three-country trade model was first explicitly developed by Haley (1986). Two exporting countries and one importing country were proposed in his paper. This research employs this idea in order to develop a trade-competition model.

The purpose of this research is to estimate the effects of U.S. monetary policy on the competitiveness of U.S. exports in the world soybean market. Two excess supply equations, one excess demand equation, and the market clearing condition are expressed as follows:

1. the aggregate U.S. soybean exports to EC-12 and Japan:

\[ USXP = ES^A \left( \frac{WP}{CPI_a}; CAP_a, Z_a \right). \]  \hspace{1cm} (3.16)

2. the aggregate Brazil/Argentina soybean exports to EC-12 and Japan:

\[ BAXP = ES^B \left( EX_b \times \frac{WP}{CPI_b}; CAP_b, Z_b \right). \]  \hspace{1cm} (3.17)

3. the aggregate EC-12/Japan soybean imports from the two exporting countries:

\[ EJMP = ED \left( EX_m \times \frac{WP}{CPI_m}; y_m, Z_m \right). \]  \hspace{1cm} (3.18)

4. total soybean exports of the U.S., Brazil, and Argentina:

\[ TXP = USXP + BAXP, \]  \hspace{1cm} (3.19)

5. the market equilibrium condition:

\[ TXP = EJMP. \]  \hspace{1cm} (3.20)
Where ES and ED represent the excess supply and demand functions, respectively. The nominal world price (WP) is the U.S. dollar import price per metric ton at the port of the importing country. CPI stands for the consumer price index. The subscripts represent different groups of countries, a for the U.S., b for Brazil and Argentina, and m for EC-12 and Japan. CAP denotes the export capacity and is defined as the total domestic supply over domestic use. The total domestic supply is the sum of domestic production and the carry-over stocks. The variable Z represents a vector of other exogenous variables such as policy variables and competing product prices.

In the system of equations from (3.16) to (3.20), the world price in local currency faced by excess supplier is positively related to the country's exports. If the dollar depreciates against the currency of the export competing country, $EX_b$ decreases and the world price in the export competing country currency decreases which will depress foreign competition with U.S. exports. If the dollar depreciates against importer currency holding the other exchange rate ($EX_a$) constant, U.S. exports will increase against its competitor. If the dollar depreciates against both currencies of export competing countries, U.S. exports will exceed the level of the above two cases.

In the early 1980s, the dollar appreciated with respect to the currencies of most developed countries due to tight monetary policy and appreciates against the currencies of developing countries due to exchange rate intervention in these countries. U.S. exports has lost competitiveness to the export competing countries due to appreciated dollar.

In a more complex situation, the competitive position of U.S. soybean exports becomes obscure. If the dollar depreciates against the currency of an importing country and appreciates against the currency of an export competing country, the competitive position of U.S. exports depends on the relative magnitude of the export and import


3.3 Elasticities of Monetary Effects on Trade Competition

Combining the general exchange rate equation (3.3) and the trade competition system (3.16) to (3.20), the effects of U.S. monetary policy on the world price and U.S. soybean exports can be derived in elasticity forms, Chambers (1981). By taking partial derivatives of equations (3.16), (3.17), and (3.18) with respect to U.S. monetary growth rate (M), the results can be shown as:

\[
\frac{\partial ES^A}{\partial M} = \frac{\partial ES^A}{\partial (WP/CPI_a)} \frac{\partial (WP/CPI_a)}{\partial M}, \tag{3.21}
\]

\[
\frac{\partial ES^B}{\partial M} = \frac{\partial ES^B}{\partial (EX\_b\_WP/CPI_b)} \frac{\partial (EX\_b\_WP/CPI_b)}{\partial M}, \tag{3.22}
\]

\[
\frac{\partial ED}{\partial M} = \frac{\partial ED}{\partial (EX\_m\_WP/CPI_m)} \frac{\partial (EX\_m\_WP/CPI_m)}{\partial M}, \tag{3.23}
\]

where \( \partial \) is the sign of partial derivation and \( M \) is the rate of U.S. monetary growth. The results are obtained by using chain rule theory. Other explanatory variables not shown in these three equations are treated as independent of U.S. monetary policy.

The above three equations can further be disaggregated by using chain rule. They become:

\[
\frac{\partial ES^A}{\partial M} = \frac{\partial ES^A}{\partial (WP/CPI_a)} \left( \frac{\partial (WP/CPI_a)}{\partial WP} \frac{\partial WP}{\partial M} + \frac{\partial (WP/CPI_a)}{\partial CPI_a} \frac{\partial CPI_a}{\partial M} \right), \tag{3.24}
\]
Equation (3.24) partitions U.S. monetary impacts on U.S. exports into the impacts on the world price and on domestic price. Equations (3.25) and (3.26) partition U.S. monetary impacts on foreign exports and imports into the impacts on exchange rates and on the world price.

Equations (3.24) to (3.26) can be converted into elasticity forms. By multiplying U.S. monetary growth rate and the reciprocal of total excess supply or demand on both side of the three equations, the left hand side of above three equation becomes:

\[
\frac{\partial ES^a}{\partial M} = \frac{\partial ES^b}{\partial (EX_b^* WP/\text{CPI}_b)} \left( \frac{\partial (EX_b^* WP/\text{CPI}_b)}{\partial EX_b} \frac{\partial EX_b}{\partial M} \right) + \frac{\partial (EX_b^* WP/\text{CPI}_b)}{\partial WP} \frac{\partial WP}{\partial M},
\]

(3.25)

and

\[
\frac{\partial ED}{\partial M} = \frac{\partial ED}{\partial (EX_m^* WP/\text{CPI}_m)} \left( \frac{\partial (EX_m^* WP/\text{CPI}_m)}{\partial EX_m} \frac{\partial EX_m}{\partial M} \right) + \frac{\partial (EX_m^* WP/\text{CPI}_m)}{\partial WP} \frac{\partial WP}{\partial M},
\]

(3.26)

where \( TXP = USXP + BAXP = EJMP \) is defined in equations (3.19) and (3.20). Further, multiplying by one on each term of the right hand side of equations (3.24), (3.25), and (3.26), the results become:

\[
\frac{\partial ES^A}{\partial (WP/\text{CPI})} \frac{\partial (WP/\text{CPI})}{\partial WP} \frac{\partial WP}{\partial M} \frac{\partial M}{\partial TXP} \frac{\partial ES^A}{\partial EJMP} + \frac{\partial ES^A}{\partial (WP/\text{CPI})} \frac{\partial (WP/\text{CPI})}{\partial CPI} \frac{\partial CPI}{\partial M} \frac{\partial M}{\partial TXP} \frac{\partial ES^A}{\partial EJMP}.
\]
The elasticity forms of equations (3.24), (3.25), and (3.26) become:

\[ \frac{\partial E_s^b}{\partial (E_x^b \cdot WP/CPI_b)} + \frac{\partial E_s^b}{\partial WP} \cdot \frac{\partial E_x^b}{\partial WP} \] 

The same partial derivative technique can be applied in equation (3.19) and has the form:

\[ \frac{\partial E^M}{\partial M} = \frac{\partial E_{M}^{EP}}{\partial M} + \frac{\partial E_{M}^{EP}}{\partial M} \] 

where \( E_i \) is the elasticity of variable \( j \) with respect to variable \( i \). \( F_a \) and \( F_b \) are the market shares of country A (the U.S.) and country B (the export competing country), respectively.

The same partial derivative technique can be applied in equation (3.19) and has the form:

\[ \frac{\partial E^M}{\partial M} = \frac{\partial E_{M}^{EP}}{\partial M} + \frac{\partial E_{M}^{EP}}{\partial M} \] 

Combining the elasticity forms from equation (3.28) to (3.30) and the equation (3.31), the market equilibrium condition expressed in the elasticity form becomes:
Where equation (3.32) is derived by taking equation (3.31) into the elasticity transformation.

From equation (3.32), one can derive the elasticities of the world price and U.S. exports with respect to U.S. monetary growth:

\[
E_{EM}^{WP} = \frac{[X]}{E_{EX}^{ED} \cdot WP/CPI_m - F \cdot E_{EX}^{ESA} \cdot WP/CPI_a}.
\]

where the numerator \([X]\) equals:

\[
F \cdot E_{EX}^{ESA} \cdot WP/CPI_a - F \cdot E_{EX}^{ESA} \cdot WP/CPI_b
\]

and the elasticity of U.S. soybean exports with respect to its monetary growth becomes:

\[
E_{EM}^{E} = \frac{[Y]}{F \cdot E_{EX}^{ESA} \cdot WP/CPI_a - F \cdot E_{EX}^{ESA} \cdot WP/CPI_b}
\]

The numerator \([Y]\) equals:

\[
E_{EX}^{DE} \cdot WP/CPI_m (E_{EM}^{EX} + E_{EM}^{WP}) - F \cdot E_{EX}^{ESA} \cdot WP/CPI_b (E_{EM}^{EX} + E_{EM}^{WP})
\]

Where \(E_i^j\) represents the elasticity of variable \(j\) with respect to variable \(i\). The U.S. monetary growth rate is represented by \(M\). \(F_a\) and \(F_b\) are the shares of U.S. and Brazil/Argentina soybean exports, respectively. The elasticity of U.S. exports with respect to the export capacity is not included in the two equations because there is no direct linkage between the export capacity and the monetary growth rate. The signs of the numerator and denominator of equation (3.33) are possibly all negative depend-
ing on the relative magnitude of the elasticities of export competing country’s exchange rate and importing country’s exchange rate with respect to U.S. monetary growth. The magnitudes of these relevant elasticities must be determined empirically. The sign of equation (3.34) depends on the relative magnitude of the elasticities of the world price and exchange rates with respect to U.S. monetary growth. This sign must also be determined empirically.

To complete all calculations of the elasticities of exports and imports with respect to U.S. monetary growth, the same technique can be adopted. The elasticities of Brazil/Argentina exports with respect to U.S. monetary growth rate become:

\[ E_{EM}^{EB} = \frac{[Z]}{F_b}, \]  

and where the numerator \([Z]\) equals:

\[ E_{EX}^{ED} \frac{\text{XP} / \text{CPI}_a}{E_{EX}^{EB} \text{XP} / \text{CPI}_b} - F_a E_{WP}^{ES} (E_M^{WP} + E_M^{1/CPI_a}). \]

The elasticity of EC-12/Japan imports with respect to U.S. monetary growth rate becomes:

\[ E_{EM}^{ED} = F_a E_{WP}^{ES} (E_M^{WP} + E_M^{1/CPI_a}) + F_b E_{WP}^{ES} (E_M^{Ex_a} + E_M^{WP}). \]  

The signs of these elasticities need to be determined empirically as well.

The above trade model may be explained by graphical expressions. In Figure 1, the left two panels represent the U.S. (A) and the export competitor (B). It is assumed that the export competitor has less quantity of supply than the U.S. The third panel is the world market with the excess supply, ES, and excess demand, ED, schedules which determine the world equilibrium price, quantity, and market share.
Figure 1: Three-Country and One-Commodity Trade Model
The ES schedule is derived from the exporting country by subtracting its domestic demand from supply. The ED schedule is obtained by subtracting domestic supply by demand in the importer country. The right panel is the domestic supply, $S'$, and demand, $D'$, schedules of the importer. The total world excess supply of soybeans or soybean products is $ES^T$, which is the sum of $ES^A$ and $ES^B$. In an open international economy, the world equilibrium price, $WP$, and quantity are obtained in the world market. The quantity of U.S. soybean exports is $q_a$ and the quantity of foreign competitor soybean exports is $q_h$, while the total trade is $q$ in the world market.

In Figure 2, one can trace the effects of the dollar depreciation against the importer country but not against the export competitor country. An expansionary U.S. monetary policy depreciates the dollar against importer currency and $EX_a$ decreases. The importing country faces a decreased real world price in local currency which gradually induces more excess demand over time. In the long run, the supply schedule of the importing country shifts to the left and the demand schedule shifts to the right so excess demand increases. As a result, the excess demand schedule in the world market shifts rightward to $ED_1$. In the U.S., an expansionary monetary policy may cause domestic price to increase. An expansionary monetary policy will induce price adjustment in the U.S. It is assumed that the induced price adjustment is slower than the changes in other nominal terms. Accompanying the assumption of secular inflation, domestic price will increase in the year with the expansionary money supply in the U.S. Thus, the real price faced by U.S. consumers and producers declines to $\frac{WP}{CPI_a}$.

In the long run, the demand schedule shifts to the right and the supply schedule shifts to the left. The excess supply schedule in the world market thus shifts to the left.
Figure 2: Expansionary U.S. Monetary Policy Impacts on Importer Exchange Rate
and becomes $ES^a_1$, which induces the shift of the total excess supply $ES^T$ to $ES^T_1$. The new world equilibrium price becomes $WP_1$ which is higher than $WP$. Total world trade increases and both exporters increase their exports to $q_{a1}$ and $q_{b1}$. The rates of the increased market share in the two exporters depend on the elasticities of their excess supplies in the world market.

In Figure 3, one sees the effects of the dollar depreciation against the importer country and appreciation against the export competing country. An expansionary U.S. monetary policy should depreciate the dollar against other currencies and increase domestic price. However, some export competitors are developing countries who may adopt exchange rate intervention to maintain or even depreciate their currencies against the dollar in order to guarantee their foreign exchange earnings. As a result, the real world price faced by the U.S. decreases and the real world price in local currency increases in the export competing country. In the long run, the excess supply of the U.S. shifts backward to $ES^a_1$, and the excess supply of export competitor B shifts to the right as $ES^b$, which may result in a shift of aggregate excess supply to $ES^T$, in the world market. The excess demand shifts outward to $ED_2$. If the diminished U.S. excess supply is equal to the increased excess supply of the export competitor in quantity, then the new world equilibrium is determined at the intersection point between $ED_2$ and $ES^T$. If the total excess supply decreases to $ES^T_2$, the world equilibrium price becomes $WP_2$ which is lower than $WP_1$ in Figure 2 and U.S. exports may still increase a very small amount compared to the increase of foreign exports. The results will depend on the elasticities of excess supply and demand schedules in the world market. One possible extreme case may be that total world trade and foreign exports
Figure 3. Expansionary U.S. Monetary Policy Impacts on Both Importer and Foreign Exporter Exchange Rates
increase but U.S. exports decrease if U.S. exports are extremely less elastic than foreign exports. The way the graph is drawn shows that the world equilibrium price and trade are increased.

The graphical analysis shows only the possible results of an expansionary U.S. monetary policy but not the actual results. Empirical estimations on the above model must be performed in order to achieve the world analysis. Chapter IV will concentrate on the estimations of the model explained in this chapter. Chapter V will draw the conclusion of this research and discuss policy implications.
CHAPTER IV
EMPIRICAL RESULTS

This chapter presents the empirical estimations of the monetary model, the trade-competition model, and the elasticities of world price and trade with respect to the rate of U.S. monetary growth. Hypotheses that are important for the reasoning process of this research will be tested empirically. The first section will apply the trade-weighted exchange rate to test the short-run monetary model and to estimate the general monetary model. A test for a random walk process of the U.S. money supply is also performed. Section two will incorporate the estimated agricultural trade-weighted exchange rates in the trade-competition model for soybeans and soybean meal. A test for the structural change between the periods 1965-1972 and 1972-1985 is performed to validate the model's estimates. The extremely unreliable data for the soybean oil sector limits the research findings and thus only soybeans and soybean meal results will be reported. The third section will use estimated elasticities in monetary

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10 The trade-weighted exchange rates are calculated by weighting the indexed exchange rate (1980=100) of importing countries or exporting countries with their trade shares, i.e. \( \sum w_i X_i \). Subscript \( i \) denotes the \( i \)th country and \( w \) is the import share of country \( i \) from the U.S. or export share between Brazil and Argentina. Other aggregated data used in this study follow the same rule of calculation.

11 The quantities of domestic supply, demand, and exports are shown in Appendix A, by product and by country. The exports of U.S. soybean oil are small in quantity. It is also hard to trace out the destinations of U.S. soybean oil exports. Thus, the export data of soybean oil are not reliable for the analysis of export competition. The export share is also shown in Table 3.

- 56 -
and trade models to calculate the elasticities of nominal world soybean prices and soy­
bean trade with respect to U.S. monetary growth. The monetary effect on domestic level consumer price is also performed, in part, to help the calculations.

4.1 Estimation of The Monetary Equations

To determine a correct monetary model for the agricultural trade-weighted exchange rates one must be concerned about the possible short-run and general economic implications. It is not accurate to say that the annual data series must represent the economic situation in the long run while quarterly data represents that in the short run. Thus, the test of the short-run "overshooting" model is performed prior to the estimation of any monetary equations.

Table 4 shows the regression results of the short-run "overshooting" (fixed-price) monetary model represented by equation (3.2). 12 The assumption that domestic and foreign countries have the same elasticity parameters is relaxed for the empirical estimation. It is assumed that domestic and foreign countries have different income and price elasticities as implied by the functional form of (2.1). This assumption generates different elasticities of exchange rate with respect to money supply and to inflation rate. Thus, only domestic and foreign real income and inflation rates are seperated in terms of the estimation of the monetary model. Estimated coefficients of the real interest differential variables in the soybean and soybean meal equations for both Brazil/Argentina and EC-12/Japan cases are statistically insignificant. The results imply that the adjustment speeds (θ) of these annual exchange rates toward equilibrium are

12 The definition of the exchange rate is explained in equation (3.1). For the convenience of the analysis in this chapter, the exchange rate is defined as foreign currency per U.S. dollar.
Table 4. The test for the short-run "overshooting" monetary model.\(a\)

(The dependent variable is the logarithm of foreign currency/dollar)

<table>
<thead>
<tr>
<th>Products &amp; Countries</th>
<th>Constant (m^* - m)</th>
<th>(y^*)</th>
<th>(y)</th>
<th>(EAP^*)</th>
<th>(EAP)</th>
<th>(1 - EAP^*) (- (1 - EAP))</th>
<th>(R^2)</th>
<th>d.f.</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Soybeans</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. EC-12 &amp; Japan</td>
<td>-24.71</td>
<td>-2.42</td>
<td>3.26</td>
<td>0.05</td>
<td>-0.01</td>
<td>-0.003</td>
<td>0.77</td>
<td>8</td>
<td>1.71</td>
</tr>
<tr>
<td></td>
<td>(-3.32)</td>
<td></td>
<td>(4.07)</td>
<td>(2.34)</td>
<td>(-0.45)</td>
<td>(-0.32)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>14.51</td>
<td>1.20</td>
<td>0.98</td>
<td>-0.94</td>
<td>-0.002</td>
<td>-0.057</td>
<td>0.996</td>
<td>7</td>
<td>1.85</td>
</tr>
<tr>
<td></td>
<td>(0.98)</td>
<td></td>
<td>(0.23)</td>
<td>(-0.44)</td>
<td>(-0.34)</td>
<td>(-1.59)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>II. Soymeal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. EC-12 &amp; Japan</td>
<td>-28.40</td>
<td>-3.13</td>
<td>4.84</td>
<td>0.08</td>
<td>-0.01</td>
<td>-0.004</td>
<td>0.70</td>
<td>8</td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td>(-3.90)</td>
<td></td>
<td>(4.35)</td>
<td>(2.38)</td>
<td>(-0.33)</td>
<td>(-1.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>41.16</td>
<td>1.93</td>
<td>0.08</td>
<td>-1.17</td>
<td>-0.004</td>
<td>-0.07</td>
<td>0.908</td>
<td>7</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>(2.97)</td>
<td></td>
<td>(0.18)</td>
<td>(-2.29)</td>
<td>(-0.62)</td>
<td>(-2.04)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(a\): The variables are in logarithm forms except the interest rates and price changes. The variables are defined as

\(m^*\) : EC-12/Japan or Brazil/Argentina levels of money supply (M1), \(m\) : U.S. level of money supply (M1), \(E^*\) : EC-12/Japan or Brazil/Argentina real gross national income (GNI), \(E\) : U.S. real gross national income, \(y^*\) : EC-12/Japan or Brazil/Argentina real gross national income (GNI), \(y\) : U.S. real gross national income, \(EAP^*\) : lagged rate of change in EC-12/Japan or Brazil/Argentina consumer price index, \(EAP\) : lagged rate of change in U.S. consumer price index, \(i^* - EAP^*\) : real EC-12/Japan or Brazil/Argentina discount rate, \(i - EAP\) : real U.S. 6-month T-Bill rate. The data representing foreign countries are calculated by weighting the index of that variable (1990=100) in each country with its trade share, i.e. \(\sum w_i Y_i\). Subscript \(i\) denotes the \(i\)th country and \(w\) is the import share of country \(i\) from the U.S. or export share between Brazil and Argentina. Variable \(X\) represents any one variable of money supply, real GNP, inflation, and interest rate.

\(b\): Figures in parenthesis are t statistics.

\(---\): Excluded based on multicolinearity considerations.
infinite. Thus, there is no short-run "overshooting" for the annual agricultural trade-weighted exchange rates. As a result, the flexible-price monetary model may be correct for the annual data series. However, a general monetary model will be adopted instead of the flexible-price monetary model, assuming that secular inflation does exist. If secular inflation exists, then price changes may affect domestic consumption behavior and subsequently the money demand function.

The estimated results of the general monetary model in the form of the equation (3.3) are shown in Table 5. Exchange rates are trade-weighted either by trade shares of soybeans or soybean meal in major importing countries, EC-12 and Japan, and major export competing countries, Brazil and Argentina. These equations show that the exchange rate is a function of the relative level of money supply, foreign real income, domestic real income, interest rate differential, the expected foreign inflation, and the expected domestic inflation. These variables, except interest and inflation rates, are in logarithm forms. They are calculated as indices, using the quantity traded as a weighting factor.

Since the key goal of this monetary model is to determine the effects of U.S. monetary policy on agricultural trade-weighted exchange rates, the estimation will focus on the monetary term. Explanatory variables having high correlation coefficients with the relative level of money supply are excluded to correct for possible estimation bias. The relative level of the money supply is negatively related to the exchange rate of EC-12 and Japan while it is positively related to the exchange rate of Brazil and Argentina in the soybean and soybean meal cases. Given the level of foreign money supply, an increase in the level of U.S. money supply will increase the EC-12/Japan exchange rate and decrease the Brazil/Argentina exchange rate. However, the change in
Table 5. The Monetary Equations. (1972-1985) /a

(The dependent variable is log of foreign currency/dollar)

<table>
<thead>
<tr>
<th>Products &amp; Countries</th>
<th>Constant</th>
<th>(m - m)</th>
<th>y</th>
<th>(1 - 1)</th>
<th>E ΔP</th>
<th>E ΔP</th>
<th>R²</th>
<th>d.f.</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Soybeans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. EC-12 &amp; Japan</td>
<td>-19.752</td>
<td>-2.950/c</td>
<td>3.249</td>
<td>0.671</td>
<td>-0.004</td>
<td>0.062</td>
<td>-0.021</td>
<td>0.83</td>
<td>7</td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>6.729</td>
<td>1.182/c</td>
<td>0.051</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>-0.041</td>
<td>0.996</td>
<td>10</td>
</tr>
<tr>
<td>II. Soymeal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. EC-12 &amp; Japan</td>
<td>-38.396</td>
<td>-3.133/c</td>
<td>—</td>
<td>4.839</td>
<td>-0.004</td>
<td>0.085</td>
<td>-0.018</td>
<td>0.80</td>
<td>8</td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>7.402</td>
<td>1.174/c</td>
<td>-0.137</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>-0.039</td>
<td>0.996</td>
<td>10</td>
</tr>
</tbody>
</table>

a: The variable definitions are the same as those in Table 4.
b: Figures in parenthesis are t-statistics.
c: Significant level is 0.99.
—: Excluded based on multicollinearity considerations.
the level of U.S. money supply does not fully reflect U.S. monetary policy. The change of the level of money supply represents the quantity change which does not catch the speed of monetary change. The change in the growth rate of U.S. money supply will reflect U.S. macroeconomic policy and affect the equilibrium exchange rate.

Signs of other other estimated coefficients are correct except some estimates of U.S. and foreign real incomes. The estimated coefficients of the real incomes, \( y^* \) and \( y \), are both positively related to the EC-12/Japan exchange rate and are biased due to some degree of collinearity in the soybean case. The sign of Brazil/Argentina real income, \( y^* \), is incorrect and statistically insignificant in the soybean case. In the soybean meal case, the signs of real incomes are correct but the estimated Brazil/Argentina real income, \( y^* \), is statistically insignificant. The sign of the interest difference is negatively related to the exchange rate and implies that the U.S. dollar appreciates as U.S. interest rate increases relative to foreign interest rate. Moreover, the expected foreign inflation and the expected U.S. deflation will appreciate the U.S. dollar relative to foreign currencies.

In order to determine the elasticity of the exchange rate with respect to U.S. monetary growth instead of the level of money supply one needs to test for the process of U.S. money supply. The converting formula with the hypothesis of first-order autocorrelation process of U.S. money supply is derived in Appendix A. The hypothesis that the annual series of U.S. money supply is a random walk process is tested by regressing the level of U.S. money supply in an autocorrelation model. Results are shown as:

\[
MS_t = 1.077 \times MS_{t-1}, \quad R^2 = 0.996, \quad D-W = 1.54, \quad d.f. = 19. \quad (4.1)
\]

(0.0057)
Where MS is the level of U.S. money supply and t and t-1 are time subscripts. The data used is the annual data from 1965 to 1985. The figure in the parenthesis is the standard error of the coefficient. It turns out that the coefficient of the lagged U.S. money supply is statistically rejected as one implying that the process of U.S. money supply is not a random walk but is serially correlated.

According to the derivation in Appendix B, equation (3.4) can be used to convert the elasticity of the exchange rate with respect to the level of money supply to that with respect to the growth rate of money supply. Using the estimated coefficient, 1.077, and the mean values of current and lagged level of U.S. money supply, equation (3.5) becomes:

\[ E_{EM} = -0.434 E_{MS}^{EX}. \]

Results of calculated elasticities of exchange rates with respect to U.S. monetary growth rate, M, are shown in Table 6. U.S. monetary growth becomes negatively related to the EC-12/Japan exchange rate and positively related to the Brazil/Argentina exchange rate. As the U.S. increases its monetary growth rate, the dollar depreciates and the EC-12/Japan exchange rate declines. However, the Brazil/Argentina exchange rate is different from the EC-12/Japan exchange rate in monetary impacts. Expansionary U.S. monetary policy depreciates the EC-12/Japan exchange rate but not the Brazil/Argentina exchange rate. It is largely due to the small and continuous devaluations in Brazil and the undervalued currency of Argentina.

The estimated trade-weighted exchange rates are compared to calculated exchange rates to find the goodness of fit in the monetary model. In the soybean case, Figure 4 shows the actual and estimated exchange rates of EC-12 and Japan. The period of 1974 to 1978 shows a larger estimated deviation from the actual series but the long-
Table 6. Elasticities of the Exchange Rates with respect to U.S. Monetary Growth. *

<table>
<thead>
<tr>
<th>Products and Countries</th>
<th>Elasticities $e_{EM}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Soybeans</td>
<td></td>
</tr>
<tr>
<td>a. EC-12 &amp; Japan</td>
<td>-1.280</td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>0.513</td>
</tr>
<tr>
<td>II. Soymeal</td>
<td></td>
</tr>
<tr>
<td>a. EC-12 &amp; Japan</td>
<td>-1.360</td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>0.510</td>
</tr>
</tbody>
</table>

* : Data range is from 1972 to 1985.
Figure 4: Actual and Estimated Exchange Rate: (Soybeans - EC-12 and Japan)
run trend is consistent. The period of 1978 to 1985 catches the long-run trend of the EC-12/Japan exchange rate very well with the exception of the 1983-1984 period. Figure 5 shows a very good fit between the actual and the estimated Brazil/Argentina exchange rate in the long run. The 1983-1984 data has a slight deviation.

In the soybean meal case, Figure 6 shows the actual and the estimated EC-12/Japan exchange rates. The estimated series captures the long-run trend of the actual series very well except for the 1977-1978 and 1981-1982 series. Figure 7 shows a very good fit between the actual and the estimated series.

Due to the problem of obtaining out-of-sample data after 1985 and the small degree of freedom, the comparison of the actual and predicted exchange rates are performed for 1984 and 1985 only. The monetary model is first estimated using data from 1972 to 1983 and the estimates are then used to predict the 1984 and 1985 exchange rates. The results are shown in Figures 8 to 11. Predicted values follow the long-run trend. However, there exists slight underestimates for EC-12/Japan exchange rates and overestimates for Brazil/Argentina exchange rates. These deviations have to do with the small degree of freedom. By looking back at Figures 4 to 7, the fitness performed by the monetary model was good.
Figure 5: Actual and Estimated Exchange Rate: (Soybeans - Brazil and Argentina)
Actual and Estimated Exchange Rate: (Soymeal - EC-12 and Japan)

**Figure 6:** Actual and Estimated Exchange Rate: (Soymeal - EC-12 and Japan)
Figure 7: Actual and Estimated Exchange Rate: (Soymeal - Brazil and Argentina)
Figure 8: Predicted Sample Comparison (Soybeans - EC-12 and Japan)
Figure 9: Predicted Sample Comparison (Soymeal - EC-12 and Japan)
Figure 10: Predicted Sample Comparison (Soybeans - Brazil and Argentina)
Figure 11: Predicted Sample Comparison (Soymeal - Brazil and Argentina)
4.2 Estimation of The Soybean Trade Competition Model

The estimated trade-weighted exchange rates are placed into the trade competition model to calculate the real world prices of soybeans and soybean meal in local currency. The trade competition model is developed in Chapter 3. The export capacity variable is created to capture the structural relationships between exports and domestic demand for crushing or consumption and stocks. This specification also captures the component of the competing price in the supply equation. The dependent variable is lagged since it is an annually determined variable for soybeans. It is assumed that there is no serial correlation between the lagged dependent variable and the error term.

Soybean demand is derived from demand for soybean meal and oil. Crushing margin is the difference between the values of soybean products and soybeans. It may be important for import and export decisions for soybeans and soybean products. As the world price of soybeans increases, the crushing input cost increases which may depress soybean crushing and push up the soybean meal price. As the world soybean meal price increases, the demand for soybeans increases which may push up the world price of soybeans. The relationship between the prices of meal and oil is different from that between the prices of meal and beans. Soybean meal and oil are joint products in crushing. As the supply of soybean meal increases caused by an increased crushing margin, the supply of soybean oil increases as well. This may depress the price of oil. It is still uncertain whether the increased crushing margin is induced by an increase of meal price, or a decrease in bean price, or both. However, the available data are only reliable for the study of soybeans and soybean meal. Therefore, the estimation of soybean oil trade competition is excluded from this research.
The linkage between these three product markets is not complete due to policy induced distortions. Brazil and Argentina have the policy of encouraging exports of soybean meal and oil but not raw soybeans. In EC-12 and Japan, a large capacity of mill plants were built for soybean crushings. This huge processing capacity intended to encourage imports of soybeans rather than soybean meal and oil to save foreign exchange earnings. However, the European Community countries may increase meal imports from Brazil and Argentina due to an artificially lowered price rather than a decreased crushing margin. Moreover, Japan has an insulated consumption market which keeps domestic consumption from world competition. Given the above distortions, price linkage between soybeans and soybean meal can not be clearly defined as fixed relationship.

The actual exchange rates from 1965 to 1971 and the estimated exchange rates of the monetary model from 1972 to 1985 will be combined as one variable in the trade-competition model. However, possible inconsistence may exist when merging data together from different time periods and different sectors. This must be carefully examined. The examination will focus on the test of structural change between the two periods of time, 1965-1972 and 1972-1985.

The model is estimated by putting the markets of soybeans and soybean meal together. It is assumed that there is correlation among the disturbance terms of these equations. A seemingly unrelated regression technique is employed to estimate the

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13 Section 301 action of the U.S. and the antidumping complaints of European Community processors in the late 1970s decreased advantage of soybean meal exports from Brazil and Argentina, Williams and Thompson (1984b).

14 Jabara and Schwartz (1987) examined the exchange rate pass-through of agricultural prices from the U.S. to Japan. Soybean price in the U.S. is not fully reflected, through the yen/dollar exchange rate, in Japan. It proves that Japan has an insulated consumption market for soybeans.
trade-competition model. Data are separated into two periods, 1965-1972 and 1972-1985. Chow test is adopted to test possible structural change between the two time periods, prior to and after 1972, for each equation in the trade model. The estimated model gives the sum of square residuals (SSR) which is used to calculate the statistical F value. If the estimated F value is smaller than the standard F value with the degrees of freedom \((n, m)\), there is no structural change across these two time periods in the estimated equation. \(^{15}\)

Results of the above structural change tests show that only the equation of Brazil/Argentina soybean meal exports has structural change across the time periods 1965-1972 and 1972-1985. A dummy variable, \(D_{72}\), is used to examine whether the structural change is the shift of intercept or slope or both. \(^{16}\) Results suggest that there are no shifts of the intercept term and the slope of world price in real local currency. Thus, the possibilities for the existing structure of Brazil/Argentina soybean meal exports are the export capacity term and other non-economic terms.

The Brazil/Argentina soybean export policies may be the reason for the existing structural change of its soybean meal exports. Brazil and Argentina adopt the policies of encouraging exports of soybean products rather than soybeans. It has been in effect since the early 1970s. Furthermore, domestic demand for high-protein meal has been stimulated in Brazil and Argentina since the mid-1970s. The interactions of the policies to protect domestic consumption and to encourage exports of processed products may have created this structural change over time.

\(^{15}\) The data used are annual time series. The degree of freedom \(n\) belongs to the time period from 1965 to 1972. The degree of freedom \(m\) belongs to the time period from 1972 to 1985.

\(^{16}\) \(D_{72}\) is defined as zero prior to 1972 and 1 after 1971.
Due to the shortage of foreign exchange, Brazil and Argentina have strengthened their export oriented policies since the late 1970s. These export oriented policies may have further stimulated the effects of export capacity, not world price, on their soybean meal exports. These must be examined through empirical results. Thus, the trade-competition model is estimated for the time period 1965-1985 and is compared with the estimation of the same model for the time period 1975-1985. 17 Not only the structural change of Brazil/Argentina soybean meal exports but also the structural stability of the world soybean meal trade may be examined.

Table 7 shows the estimated trade-competition model in the time period 1965-1985. In the world soybean market, the real world price is positive in sign for the U.S. at the 95 percent significant level statistically. The U.S. export capacity is positively related to U.S. exports but is statistically insignificant which implies that the export capacity is not a constraining factor for U.S. exports of soybeans. The lagged dependent variable is positively related to U.S. soybean exports which implies that the actual exports of U.S. soybeans face an adjustment from the desired level of exports due much of the time to constraint in production.

In Brazil and Argentina, the world soybean price in real local currency is positively related to their exports of soybeans. As the U.S. dollar appreciates, Brazil and Argentina increase their competitiveness relative to the U.S. exports of soybeans. The Brazil/Argentina export capacity is positively related to its exports of soybeans. As the soybean crushing industry grows at a rate faster than the production growth rate, the export capacity of Brazilian soybeans decreases and the exports of soybeans decline. This

17 The empirical comparison uses the time period 1975-1985 to avoid the possible effects of significant price distortion in 1973-1974 period on this trade model. In 1973 and 1974, world price significantly increased which may create the real effects on structural change.
Table 7. The Soybean Trade-Competition Model, 1965-1985. /a
(Using Seemingly Unrelated Regression)

<table>
<thead>
<tr>
<th>USP, BWP, and EMP</th>
<th>Other Variables</th>
<th>R²</th>
<th>d.f.</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant WP QR D2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Real QR D3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Soybeans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. U.S.</td>
<td>2.67 0.229**</td>
<td>0.129</td>
<td>0.238</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(2.63) (0.63)</td>
<td>(0.65)</td>
<td>(13.62)</td>
<td></td>
</tr>
<tr>
<td>b. Brazil &amp;</td>
<td>4.918 0.463***</td>
<td>1.133</td>
<td>0.237</td>
<td>1.963</td>
</tr>
<tr>
<td>Argentina</td>
<td>(2.63) (2.64)</td>
<td>(1.94)</td>
<td>(2.03)</td>
<td>(6.42)</td>
</tr>
<tr>
<td>c. EU-12 &amp;</td>
<td>20.355 -0.701***</td>
<td>0.411</td>
<td>1.657</td>
<td>—</td>
</tr>
<tr>
<td>Japan</td>
<td>(20.03) (-5.01)</td>
<td>(4.67)</td>
<td>(14.73)</td>
<td></td>
</tr>
<tr>
<td>II. Soymeal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. U.S.</td>
<td>13.055 0.172**</td>
<td>5.745</td>
<td>—</td>
<td>-0.167</td>
</tr>
<tr>
<td></td>
<td>(7.42) (2.31)</td>
<td>(9.45)</td>
<td>(14.48)</td>
<td></td>
</tr>
<tr>
<td>b. Brazil &amp;</td>
<td>13.573 -0.268</td>
<td>0.399</td>
<td>—</td>
<td>2.633</td>
</tr>
<tr>
<td>Argentina</td>
<td>(3.40) (-0.37)</td>
<td>(1.10)</td>
<td>(6.62)</td>
<td></td>
</tr>
<tr>
<td>c. EU-12 &amp;</td>
<td>17.255 -0.173*</td>
<td>-0.163</td>
<td>3.415</td>
<td>-0.177</td>
</tr>
<tr>
<td>Japan</td>
<td>(20.01) (-1.17)</td>
<td>(-0.63)</td>
<td>(11.29)</td>
<td>(1.72)</td>
</tr>
</tbody>
</table>

/a: The variables are in logarithmic form and are defined as USP: quantity of U.S. exports of soybeans or soybean meal to EU-12 and Japan (marketing year); BWP: quantity of Brazil/Argentina exports of soybeans or soybean meal to EU-12 and Japan (marketing year); a proxy data, AY: EMP: quantity of EU-12/Canada imports of soybeans or soybean meal from the U.S., Brazil, Argentina (marketing year); BWP and AY; WP: real world price of soybeans at Bonn or soybean meal at Bonn ports deflated by consumer price index; this world price is multiplied by the exchange rate to become local currency; AY; QR: export capacity in exporting country of soybeans or soybean meal calculated by dividing total domestic supply, including stocks with total domestic use, USP; QR: logged dependent variable; QR: real gross national income of EU-12 and Japan; BWP; QR: dummy variable equals 0 prior to 1972 and 1 after 1972 for the Brazil/Argentina equations; D3: dummy variable equals 1 in 1973 and 0 otherwise for U.S. and EU-12/Canada equations; BWP stands for Foreign Agricultural Trade of the U.S., USD; AY is Agricultural Trade Yearbook; EU: BIS is the International Financial Statistics, IMF.

b: Figures in parentheses are t-statistics.
—: Included based on multicollinearity consideration.
***: Significant level is 0.05.
**: Significant level is 0.05.
*: Significant level is 0.10.
finding is consistent with the research of Williams and Thompson (1984a) on the Brazilian soybean industry. If domestic soybean production grows faster than the growth of crushing demand, soybean exports will increase. The lagged Brazil/Argentina soybean exports is positively related to current soybean exports which also implies that the actual export level of Brazil/Argentina soybeans has been adjusted from the desired export level over time. The dummy variable D72 is statistically significant which captures the structural changes between the periods prior and after 1972 in Brazil/Argentina domestic consumptions.

In EC-12 and Japan, the world price of soybeans in real local currency is negatively related to their imports of soybeans. As the U.S. decreases monetary growth rate and increases the value of the dollar, the EC-12/Japan soybean imports decline, and vice versa. Rapeseed is a primary import substitute for soybeans and its price is positively related to soybean imports. As the price of soybeans increases, EC-12 countries would prefer rapeseed as an import substitute. The real income level has a positively signed coefficient as expected. The increasing real gross national product in EC-12 and Japan increases the imports of soybeans.

In the soybean meal market, U.S. soybean meal exports respond to real world price positively at the 95 percent significant level, statistically. Soybean meal export capacity is positively related to exports in the U.S. and is highly elastic. This suggests that U.S. soybean meal exports are sensitive to domestic crushing capacity and feed demand. The soybean embargo in 1973 decreased U.S. soybean meal exports and is captured by the coefficient of the dummy variable D73.

In Brazil and Argentina, the estimated coefficient of world price in real local currency is statistically insignificant. It implies that Brazil/Argentina soybean meal
exports may not respond to this world price under this equation specification. Even if Brazil/Argentina soybean meal exports respond to this world price statistically, the impacts of this world price on exports are limited by farm policies. It also implies that U.S. monetary policy may not affect Brazil/Argentina soybean meal exports through exchange rate changes. The Brazil/Argentina export capacity is positively related to its exports of soybean meal. If domestic high-protein input demand increases at a faster rate than the increase of crushed output, Brazil/Argentina government will limit its soybean meal exports. The dummy variable D72 also captures the changing government policy between the periods prior and after 1972, especially in Brazil.  

In EC-12 and Japan, soybean meal imports increase as the trade value of the dollar decreases. This finding is similar to the imports of soybeans. The major substitutable meals are rapeseed meal and cottonseed meal, especially in EC-12. The imports of cottonseed meal are larger in portion than rapeseed meal but both imports make up a relatively small percentage as compared to soybean meal imports. Prices of rapeseed meal and cottonseed meal are highly correlated. Due to the incomplete data for price of rapeseed meal in European ports, the price of the cottonseed meal is adopted here. The sign of the substitute price is negative and statistically insignificant. Income level is positively related to soybean meal imports which implies that increasing income level increases the demand for meat consumption as well as high-protein inputs. The U.S. soybean embargo in 1973 decreased the imports of soybean meal as is reflected by the coefficient for D73 in this equation.

---

18 In the early 1970s, Brazilian soybean meal exports dominate the aggregate Brazil/Argentina soybean meal exports. Argentina became a major exporter of soybean meal after 1975.
Table 8 shows the estimated trade-competition model in the time period 1975-1985 to compare this most recent structural relationship with that in Table 7. In the world soybean market, there are two major differences between the results of the two time periods 1965-1985 and 1975-1985. First, U.S. export capacity becomes statistically significant in the equation of U.S. soybean exports. Export capacity becomes a constraint factor for U.S. soybean exports. It implies that U.S. domestic demand for soybean crushings increases at a rate greater than the increase of its soybean production during 1975-1985. Thus, U.S. soybean exports are constrained by its export capacity and the response of exports to the real world price decreases. Second, Brazil and Argentina have a greater rate of increase than the U.S. in the expansion of soybean production during 1975-1985. Thus, the coefficient of the lagged soybean exports in the U.S. decreases and that in Brazil and Argentina increases.

In the world soybean meal market, U.S. exports respond to the real world price increases its magnitude in comparison with that in Table 7. It implies that U.S. soybean meal exports respond to price fluctuations more sensitively in 1975-1985 than the average price response in 1965-1985. The monetary effects on the world price may change the competitiveness of U.S. soybean meal exports.

In Brazil/Argentina soybean meal export equation, the coefficient estimate maintains statistically insignificant on the real world price. It suggests that the structural change of Brazil/Argentina soybean meal exports may have little to do with the real world price but other variables. Export capacity has greater impact on soybean meal exports in 1975-1985 than that in 1965-1985. It implies that government policies do affect the structure of Brazil/Argentina export capacity significantly over time. In fact, policy interactions limit soybean meal exports to respond to the real world price and the
Table 8. The Sylven Trade-Competition Model, 1975-1985. /a  
(Using Seemingly Unrelated Regression)

<table>
<thead>
<tr>
<th>USP, BWP, and EMP</th>
<th>Other Variables</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant</td>
<td>WP</td>
<td>GDP</td>
<td>DP</td>
<td>SP</td>
<td>GDP</td>
</tr>
<tr>
<td>I. Sylven</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. U.S.</td>
<td>9.599</td>
<td>0.199*</td>
<td>1.888</td>
<td>0.331</td>
<td>0.723</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(3.14)*</td>
<td>(0.98)</td>
<td>(2.52)</td>
<td>(1.65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Brazil &amp;</td>
<td>-2.954</td>
<td>0.570***</td>
<td>0.971</td>
<td>0.651</td>
<td>0.552</td>
<td>7</td>
</tr>
<tr>
<td>Argentina</td>
<td>(-0.65)</td>
<td>(2.61)</td>
<td>(2.63)</td>
<td>(4.99)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. E3-12 &amp;</td>
<td>20.801</td>
<td>-0.739**</td>
<td>0.336</td>
<td>1.740</td>
<td>0.841</td>
<td>7</td>
</tr>
<tr>
<td>Japan</td>
<td>(29.81)</td>
<td>(-5.71)</td>
<td></td>
<td>(1.82)</td>
<td>(5.99)</td>
<td></td>
</tr>
<tr>
<td>II. Sylven</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. U.S.</td>
<td>12.975</td>
<td>0.179**</td>
<td>6.035</td>
<td>0.784</td>
<td>8</td>
<td>2.04</td>
</tr>
<tr>
<td></td>
<td>(38.74)</td>
<td>(1.45)</td>
<td>(5.25)</td>
<td>(5.11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Brazil &amp;</td>
<td>12.634</td>
<td>0.230</td>
<td>1.334</td>
<td>0.380</td>
<td>8</td>
<td>0.24</td>
</tr>
<tr>
<td>Argentina</td>
<td>(6.41)</td>
<td>(0.95)</td>
<td>(3.01)</td>
<td>(3.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. E3-12 &amp;</td>
<td>17.151</td>
<td>-0.182</td>
<td>-0.230</td>
<td>1.956</td>
<td>0.670</td>
<td>7</td>
</tr>
<tr>
<td>Japan</td>
<td>(17.46)</td>
<td>(-0.76)</td>
<td>(-1.65)</td>
<td>(3.26)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

/a: Definitions of the above variables are the same as those in Table 7.  
b: Figures in parentheses are t statistics.  
---: Included based on multicolinearity consideration.  
***: Significant level is 0.05.  
**: Significant level is 0.01.  
*: Significant level is 0.05.
export capacity. Thus, the magnitude of the export capacity impacts on soybean meal exports in the U.S. is significantly greater than that in Brazil and Argentina. The low value of R**2 further suggests that there may be non-economic factors affecting the structure of Brazil/Argentina soybean meal exports over time. However, the specification of the non-economic factors presents a difficulty in this model. As Brazil/Argentina soybean meal exports become mature, it is expected that some of the independent variables may be more sensitive to exports of soybean meal. Under this situation, the export competition may be more sensible to U.S. monetary policies.

In EC-12 and Japan, soybean meal imports respond to the real world price negatively. Cottonseed meal imports become a supplement of soybean meal imports and this relationship is captured by the coefficient estimate of SWP in Table 8. The real income maintain its dominant impacts on soybean meal imports.

Elasticities of exports and imports of soybeans and soybean meal with respect to world price in real local currency in 1965-1985 are presented in Table 9. The world price in real local currency is the nominal world price in the dollar terms converted into local currency by the exchange rate and deflated by the price level of local country. Thus, the elasticity of Brazil/Argentina exports or EC-12/Japan imports with respect to nominal world price in the dollar is the same as that with respect to exchange rate.

The elasticities of exports and imports with respect to world prices in real local currency have supported the relationship between trade and the exchange rate. As the exchange rates shift to benefit export competing and importing countries, Brazil/Argentina soybean exports and EC-12/Japan soybean and soybean meal imports are stimulated. The magnitudes of the increased imports is greater than the magnitude of
Table 9. Elasticities of Exports and Imports with respect to World Prices in Real Local Currencies. /*

<table>
<thead>
<tr>
<th>Products and Countries</th>
<th>Elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Soybeans</strong></td>
<td></td>
</tr>
<tr>
<td>a. U.S.</td>
<td>0.229</td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>0.686</td>
</tr>
<tr>
<td>c. EC-12 &amp; Japan</td>
<td>-0.701</td>
</tr>
<tr>
<td><strong>II. Soymeal</strong></td>
<td></td>
</tr>
<tr>
<td>a. U.S.</td>
<td>0.172</td>
</tr>
<tr>
<td>b. Brazil &amp; Argentina</td>
<td>0.000</td>
</tr>
<tr>
<td>c. EC-12 &amp; Japan</td>
<td>-0.173</td>
</tr>
</tbody>
</table>

*: Data range is from 1965 to 1985.
Brazil/Argentina exports (Table 9). Thus, U.S. exports may be stimulated by the exchange rate shifts to fit into the difference. Moreover, the increasing crushing capacity in EC-12 and Japan may be reasons of the low price elasticities in the world soybean meal market.

Brazil/Argentina soybean meal exports are policy oriented instead of market price oriented in the world market. The exchange rate shifts may stimulate soybean exports but not soybean meal exports. It implies that Brazil/Argentina exports of soybeans compete with U.S. soybean exports through market framework while Brazil/Argentina soybean meal exports compete with U.S. soybean meal exports through other means but not price incentives. This non-price oriented soybean meal exports may have greater impact on the export competition than the soybean export competition in the world market. However, this is not shown in the estimated results.

Before the calculation of the elasticities of world soybean and soybean meal trade with respect to U.S. monetary growth rate, U.S. monetary effects on domestic price level must be estimated. U.S. monetary policy affects not only the world trade but the domestic price level in the long run. An expansionary monetary policy may have inflationary effects on the domestic economy. The price level determines the level of the real world price received by U.S. exporters. Thus, U.S. monetary policy may affect the domestic price level and have a real effect on U.S. exports. The effects of U.S. monetary growth on domestic price level can be estimated by regressing U.S. monetary growth on the reciprocal of the consumer price index:

\[
1/CPI_a = -3.18 - 0.57 M, \quad R^2 = 0.29, \quad D-W = 0.65.
\] (4.2)

(-8.34) (-2.76)
Equation (4.2) is in the log-linear form and the figures in the parentheses are t-statistics. The elasticity of the reciprocal of the U.S. domestic price level with respect to U.S. monetary growth is -0.57.

In summary, the world price in real local currency of soybeans and soybean meal has the expected effects on exports and imports except that the Brazil/Argentina soybean meal exports respond to world price negatively. The model also captures the structural difference among the U.S., the export competing countries, and the importing countries. Only Brazil/Argentina soybean meal exports exhibit structural change over time periods. The statistically significant estimates of the world price in real local currency in the trade competition model associated with the estimates of the monetary equations lead to the conclusion that there is a strong linkage between the U.S. monetary policy, the competitive position on U.S. soybean trade, and the world price. The impacts of U.S. monetary policy on trade and price can be calculated in elasticity forms by inserting the estimated elasticities of the monetary model and the trade competition model into equations (3.33) to (3.36).

4.3 Elasticities of Monetary Effects on Soybean Trade

The elasticities of U.S. and Brazil/Argentina exports, EC-12/Japan imports, and the world price with respect to U.S. monetary growth are calculated in this section. Combining the elasticities in Tables 6 and 9 and equation (4.2), U.S. monetary impacts on world trade in elasticity forms are presented in Table 10. The examples of elasticity calculations are shown in Appendix C.
Table 10. The Elasticities of Exports, Imports, and World Price with respect to U.S. Monetary Growth. (1965-85) /*

<table>
<thead>
<tr>
<th>Products</th>
<th>World Price (WP)</th>
<th>United States (Export)</th>
<th>Brazil &amp; Argentina (Export)</th>
<th>EC-12 &amp; Japan (Import)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Soybeans</td>
<td>0.939</td>
<td>0.084</td>
<td>0.995</td>
<td>0.239</td>
</tr>
<tr>
<td></td>
<td>(0.83)</td>
<td>(0.17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. Soymeal</td>
<td>1.135</td>
<td>0.097</td>
<td>0.000</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.60)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: Figures in the parenthesis are average export market shares.
4.3.1 Elasticities in World Soybean Trade (1965-1985)

In Table 10, elasticities of trade and price with respect to U.S. monetary growth rate are all positive in the world soybean market. As the U.S. increases monetary growth rate, domestic price level increases and the trade value of the dollar relative to the EC-12/Japan currency decreases. At the same time, the trade value of the dollar relative to Brazil/Argentina currency increases. This is the situation discussed graphically in Figure 3. Results of world soybean trade from an expansionary U.S. monetary policy are increases in nominal world soybean price, exports, and imports.

Signs of the elasticities in the world soybean market depend on the relative magnitude among terms in the numerator of any of equations (3.33), (3.34), and (3.35). The relative magnitude between the two terms in (3.36) determines the magnitude and sign of EC-12/Japan import elasticity. For the world soybean price, the last term in equation (3.33) becomes critical for the determination of the sign. It is because of small price elasticity of U.S. exports and small Brazil/Argentina market share. The numerator and the denominator of equation (3.33) are all negative. Thus, the world soybean price increases as U.S. monetary growth rate increases. This result is used to calculate the remaining trade elasticities in the world soybean market.

The net impact of the decreased exchange rate and increased world price is the increase in EC-12/Japan imports. Both decreased exchange rate and increased world price encourage Brazil/Argentina soybean exports. The magnitude of EC-12/Japan import response is greater than the magnitude of Brazil/Argentina export response. Thus, the numerator of equation (3.34) is positive in sign. U.S. soybean exports are increased by an expansionary U.S. monetary policy. However, the sign of this elasticity may turn
into negative if the Brazil/Argentina market share is greater than 0.24. 19

An expansionary U.S. monetary policy also increases Brazil/Argentina soybean exports. The increased world price encourages U.S. exports but the increased domestic price level depresses U.S. exports. The net effect is an increase in U.S. exports. However, the low price elasticity of U.S. exports decreases the competitiveness of U.S. exports in the importing market. The EC-12/Japan import response dominates the numerator of equation (3.35). Thus, Brazil/Argentina soybean exports are increased by an expansionary U.S. monetary policy.

The net effect of a U.S. monetary expansion on imports is the increase in EC-12/Japan soybean imports. The elasticity of EC-12/Japan imports with respect to U.S. monetary policy is simply the share-weighted sum of the above two export elasticities. Since the two export elasticities are positive, the import elasticity is positive as well.

The magnitudes of the elasticities of world soybean price and trade in Table 10 depend on the relative magnitude between the numerator and the denominator in any of equations (3.33), (3.34), and (3.35). The numerator of equation (3.33) represents the monetary impacts on world soybean price through the changes in U.S. domestic price and in exchange rates. The relative magnitude of these monetary impacts on U.S. and Brazil/Argentina soybean exports is smaller than the monetary impacts on EC-12/Japan imports. The effects of U.S. monetary policy on U.S. and Brazil/Argentina soybean exports are offset by each other in the numerator. The denominator of equation (3.33) represents the elasticities of exports and imports with respect to nominal world soybean

19 If Brazil/Argentina market share is greater than 0.24, then U.S. market share must fall to less than 0.76. Applying this new combination of market shares into equation (3.36), the elasticity of EC-12/Japan soybean imports with respect to U.S. monetary growth rate becomes negative.
price. The price elasticity of EC-12/Japan imports maintains the dominance in the denominator. However, the magnitude of the aggregate response of exports and imports to the level of world price in the denominator is greater than the magnitude of the numerator. Thus, the elasticity of world soybean price with respect to U.S. monetary growth rate is less than unity.

The magnitude of the elasticity of U.S. soybean exports with respect to U.S. monetary growth rate is determined by the relative magnitude of the numerator and the denominator in equation (3.34). The relative magnitude of the elasticities of EC-12/Japan imports and Brazil/Argentina exports with respect to U.S. monetary growth rate through exchange rate changes are similar. The difference between the two terms in the numerator generates a small figure which is also small as compared to the denominator. Thus, the elasticity of U.S. soybean exports with respect to U.S. monetary growth rate is very inelastic.

The magnitude of the elasticity of Brazil/Argentina soybean exports with respect to U.S. monetary growth rate is determined by the relative magnitude of the numerator and the denominator in equation (3.25). U.S. monetary expansion will lower the real price faced by exporters and exports are decreased. Effects of the increased world soybean price on U.S. exports is, in part, depressed. The low price elasticity of U.S. exports further generates a low value of the second term in the numerator of equation (3.35). The magnitude of the numerator becomes slightly greater than the magnitude of the denominator. Thus, Brazil/Argentina soybean exports have elastic response to U.S. monetary policy. However, this elasticity may turn into inelastic if Brazil/Argentina market share increases.
The magnitude of the elasticity of EC-12/Japan imports with respect to U.S. monetary growth rate is determined by the sum of the two share-weighted export elasticities. The share-weighted elasticity of Brazil/Argentina soybean exports with respect to U.S. monetary growth rate dominates this import elasticity. Thus, the elasticity of EC-12/Japan soybean imports with respect to U.S. monetary growth rate is inelastic. However, this import elasticity is greater than the elasticity of U.S. export elasticity.

In conclusion, U.S. monetary expansion does not serve to increase the competitiveness of U.S. over Brazil/Argentina soybean exports. An expansion of U.S. monetary growth rate increases world price, imports, and exports. The rate of the increased U.S. soybean exports is less than the rate of the increased Brazil/Argentina soybean exports. Thus, U.S. monetary expansion may serve for the purpose of increasing U.S. exports but not increasing the competitiveness of U.S. soybean exports in EC-12/Japan market.

4.3.2 Elasticities in World Soybean Meal Market (1965-1985)

In the world soybean meal market, all elasticities except Brazil/Argentina export elasticity are positive in Table 10. The signs are determined by the relative magnitude among terms in the numerator of equations (3.33), (3.34), and (3.35). The magnitudes of these elasticities depend upon the relative magnitude of the numerator and the denominator in each of these equations.

U.S. monetary policy has a positive impact on the world soybean meal price. The mean value of the price elasticity of Brazil/Argentina soybean meal exports is higher than the price elasticities of U.S. exports and EC-12/Japan imports. Low price elasticity of U.S. exports makes the first term in the numerator of equation (3.33) negligible. The sign of the numerator is determined by the relative magnitude of the last two
terms, the Brazil/Argentina export and the EC-12/Japan import responses. The import response is greater than the export response to U.S. monetary policy. The signs of the numerator and the denominator are all negative. Thus, the elasticity of world soybean meal price with respect to U.S. monetary growth rate has a positive sign. This elasticity is used to calculate other elasticities in the world soybean meal market.

U.S. monetary policy has a positive impact on U.S. soybean meal exports but the impact is very inelastic. An expansion of U.S. monetary growth rate does not change the Brazil/Argentina exchange rate but decreases the EC-12/Japan exchange rate. The EC-12/Japan imports of soybean meal are stimulated. Moreover, the increased world soybean meal price decreases EC-12/Japan imports. The monetary impact on the increase of imports is positive but minimal. The numerator of equation (3.34) is positive in sign. Thus, the elasticity of U.S. soybean meal exports with respect to U.S. monetary growth rate is positive.

However, the sign of the elasticity of U.S. soybean meal exports with respect to U.S. monetary growth rate may turn into negative. If U.S. monetary effects on EC-12/Japan exchange rate is smaller in magnitude than U.S. monetary effects on the world equilibrium price, U.S. soybean meal export elasticity will become negative in sign.

U.S. monetary policy has a positive impact on Brazil/Argentina soybean meal exports. An expansion of U.S. monetary growth rate increases EC-12/Japan imports. The increased imports plus the loss of U.S. exports generate a positive sign on the numerator of equation (3.35) but the magnitude is close to zero. Thus, Brazil/Argentina export elasticity in Table 10 is zero.
The net effect of U.S. monetary policy on imports of soybean meal exhibits positive sign. Since Brazil/Argentina exports are not affected by U.S. monetary policy, the EC-12/Japan import elasticity is equal to the U.S. export elasticity in Table 10. Thus, EC-12/Japan imports of soybean meal with respect to U.S. monetary growth rate has a positive sign. However, this calculation ignores the growing Brazil/Argentina exports during this time period. If Brazil and Argentina increase their soybean meal exports by ignoring the market price movements, the world price may be lowered which may stimulate EC-12/Japan imports but depress U.S. exports. As U.S. monetary policy is imposed, EC-12/Japan imports may be further stimulated at the same time. The net effects of U.S. monetary policy with the increase of Brazil/Argentina exports may be the increase of EC-12/Japan imports and decrease of U.S. exports and world price. The elasticities shown in Table 10 do not consider the impacts of factors other than U.S. monetary growth rate on the exchange rates and world prices.

The magnitude of the elasticities of soybean meal price and exports with respect to U.S. monetary growth rate depend upon the relative magnitude between the numerator and the denominator of each of equations (3.33), (3.34), and (3.35). The magnitude of the elasticity of imports with respect to U.S. monetary growth rate depend on the relative magnitude of the first and the second term in equation (3.36). The magnitudes of these equations will be discussed in the order.

In equation (3.33), the low price elasticity of U.S. exports and low U.S. market share make the first term negligible in magnitude. Brazil/Argentina export response to U.S. monetary policy is zero. The EC-12/Japan import response to U.S. monetary policy through exchange rate changes dominates the numerator of equation (3.33). Comparing the numerator to the denominator where the price elasticity of EC-12/Japan imports
dominates, the elasticity of world soybean meal price with respect to U.S. monetary growth rate becomes elastic.

The magnitude of the elasticity of U.S. exports with respect to U.S. monetary growth rate depends upon the relative magnitude of U.S. monetary impacts on imports through changes in world price and U.S. market share. The increased world price decreases imports while the decreased exchange rate increases imports. These two terms offset each other in magnitude. The low price elasticity of EC-12/Japan imports also contributes to the low value of the elasticity of U.S. soybean meal exports with respect to U.S. monetary growth rate. Thus, the elasticity of U.S. soybean meal exports with respect to U.S. monetary growth rate is inelastic.

The numerator of equation (3.35) is the sum of U.S. monetary impacts on imports and U.S. exports. Since Brazil/Argentina exports do not respond to real world price, the sum of the two terms in the numerator of equation (3.35) becomes zero. Thus, the elasticity of Brazil/Argentina soybean meal exports with respect to U.S. monetary growth rate is inelastic.

The magnitude of the soybean meal import elasticity is the sum of the share-weighted monetary impacts on U.S. and Brazil/Argentina exports. Since the elasticity of Brazil/Argentina exports with respect to U.S. monetary growth rate is zero, the elasticity of EJ-12/Japan imports with respect to U.S. monetary growth rate is equal to the calculated U.S. export elasticity in Table 10 multiplied by U.S. share. Thus, the elasticity of EC-12/Japan soybean meal imports with respect to U.S. monetary growth rate is very inelastic.

The elasticities shown in Table 10 are based on the assumption that the relative market share between U.S. and Brazil/Argentina exports is the averages of market
shares during the time period 1965-1985. The change of this market share combination may alter the calculated elasticities in Table 10. However, using the average market shares of either time period, 1975-1985 or 1980-1985, only changes the magnitudes but not the signs of the elasticities. Moreover, the changing sensitivity of exports and imports to the real world prices may also affect the calculated results. Table 10 shows the average competitive situations of world soybean and soybean meal trade during the period 1965-1985. This exhibition of the competitive situations may be used for the analysis policy implications.
CHAPTER V
CONCLUSIONS

This study investigates macroeconomic linkages of soybean trade competition between the U.S., Brazil and Argentina in the EC-12 and Japan importing market. It is argued that U.S. monetary growth may impact the competitive position of U.S. soybean exports through exchange rate changes. However, export competing countries such as Brazil and Argentina follow a trade policy of devaluing their currencies against the U.S. dollar in response to their domestic rates of inflation. The importing countries of EC-12 and Japan have less restrictive exchange rate policies.

The annual data series from 1972 to 1985 are used to estimate the monetary equations of the exchange rate determination. All variables are obtained by using the traded quantity to weight every data series. The test on the "overshooting" monetary equation using the annual data results in the rejection of the possible short-run deviation from the equilibrium exchange rate. A general monetary equation of the exchange rate determination is then applied to find the effects of U.S. monetary policy on the volatility of the agricultural trade-weighted exchange rates. The hypothesis that the level of U.S. money supply follows a random walk process is rejected. The estimated first-order autocorrelation coefficient is used to convert the elasticity of the trade-weighted exchange rate with respect to the level of U.S. money supply into that with respect to the rate of U.S. monetary growth. An expansionary U.S. monetary growth
increases the trade value of the dollar against the EC-12/Japan currency but decreases the trade value of the dollar against the Brazil/Argentina currency.

The specification of the trade competition model provides a reasonable explanation of the structural and policy differences among the trading countries. The elasticity of U.S. soybean exports with respect to the world price in real local currency is less than unity for soybeans and soybean meal. U.S. excess supply of soybeans to the world market is not constrained by domestic crushing demand because of the large production capacity. U.S. export of soybean meal is constrained by domestic crushing capacity and domestic need.

The elasticity of Brazil/Argentina exports with respect to the world price in real local currency is also less than unity for soybeans. Brazil/Argentina soybean meal exports exhibit structural change over time. The Brazil/Argentina soybean meal exports do not respond to the world soybean meal price in real local currency. Thus, U.S. monetary impacts on Brazil/Argentina soybean meal exports are none. Moreover, Brazil/Argentina excess supplies of soybeans and soybean meal are constrained by domestic policies which encourage soybean crushing and the export of meal and oil while at the same time support domestic need.

The elasticity of EC-12/Japan imports with respect to the world price in real local currency is less than unity for soybeans and soybean meal. The magnitude of import price elasticity is greater for soybean imports than that for soybean meal imports. The real income exhibits as a dominating factor in imports of soybeans and soybean meal.

Empirical results presented in this research further suggest that the soybean export competing country and importing country responses to the exchange rates are statistically significant. The estimation thus provides evidence of a strong link between U.S.
monetary growth and the value of trade-weighted exchange rates and a strong link between trade and the exchange rates. As a result, the link between U.S. monetary growth and soybean prices and trade quantities is apparent.

The effects of U.S. monetary growth on soybean trade and price are calculated in elasticity forms. An expansionary U.S. monetary policy weakens the dollar against the EC-12/Japan currency but not the Brazil/Argentina currency. The import elasticity has a magnitude greater than the export elasticities and serves to increase the world soybean price. The increasing world price increases world soybean trade in the long run. U.S. soybean exports are increased by a small percentage in response to a one percent increase of U.S. monetary growth. Brazil/Argentina soybean exports increase nearly one percent in response to a one percent increase of U.S. monetary growth. It proves that U.S. monetary expansion may serve to increase U.S. soybean exports but not to increase the competitiveness of U.S. soybean exports.

In the world soybean meal market, an expansionary U.S. monetary policy increases U.S. exports and EC-12/Japan imports of soybean meal but no effects on Brazil/Argentina soybean meal exports. These results imply that U.S. monetary policy does serve to increase the quantity and the competitiveness of U.S. soybean meal exports.

A number of limitations emerge from this study. The linkage between U.S. monetary policy and the exchange rate may be extended to include price expectation variables. If the price expectation is introduced, the purchasing power parity may be tested and the monetary model may have to be revised. The aggregation of data among countries can not show the response of specific country of interest. To expand the trade competition model into a large model containing all major trading countries may be time consuming and inefficient. The unreliable data limit the trade competition
**Appendix A**

Table 11. Domestic Supply, Demand, and Exports of Soybeans, by country, marketing year. (Thousand Metric Tons)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>U.S.</th>
<th>Brazil</th>
<th>Argentina</th>
</tr>
</thead>
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<tr>
<td></td>
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<td>Domestic Total Supply</td>
<td>Demand</td>
</tr>
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<tr>
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<td>1968</td>
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<td>7255</td>
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<tr>
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<tr>
<td>1970</td>
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<td>11773</td>
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<td>1971</td>
<td>36930</td>
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<td>11806</td>
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<tr>
<td>1985</td>
<td>55426</td>
<td>30545</td>
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</table>

Source: USDA

* : Total supply is the production plus beginning stocks.
Table 12. Domestic Supply, Demand, and Exports of Soybean, by country, marketing year. (Thousand Metric Tons)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>U.S. Total Domestic Total</th>
<th>Brazil Total Domestic Total</th>
<th>Argentina Total Domestic Total</th>
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Source: USDA

*: Total supply is the production plus beginning stocks.

**: na means not available.
Table 13. Domestic Supply, Demand, and Exports of Soyoil, by country, marketing year. (Thousand Metric Tons)

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<th>U.S.</th>
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Source: USDA

* : Total supply is the production plus beginning stocks.
** : na means not available.
Appendix B

THE DERIVATION OF ELASTICITY COVERSION

By definition, the elasticity of the nominal exchange rate (EX) with respect to U.S. monetary growth rate can be represented in the form of:

\[ E_M^{EX} = \frac{\partial EX}{\partial M} \frac{M}{EX} \]

where M represents U.S. monetary growth and E is the sign of the elasticity. The derivative sign is \(\partial\) in front of EX and M. The above equation may be expanded by substituting M by the level of U.S. money supply (MS) with the time symbol at the subscript. It turns to be:

\[ E_M^{EX} = \frac{\partial EX}{\frac{MS_t - MS_{t-1}}{MS_{t-1}}} \frac{MS_t - MS_{t-1}}{EX} \]

Taking total differentiation on the denominator of the first term in the above equation, the above equation becomes:

\[ E_M^{EX} = \frac{\partial EX}{\frac{MS_t - MS_{t-1}}{MS_{t-1}} \frac{\partial MS_t - MS_{t-1}}{MS_{t-1}}} \frac{MS_t - MS_{t-1}}{EX} \]

- 102 -
Assuming that the process of U.S. money supply follows a first-order autocorrelation model, the relationship between current and lagged level of money supply can be presented as:

\[ MS_t = \delta MS_{t-1} + u, \]

where \( \delta \) is the autocorrelation coefficient and the disturbance is \( u \). Mussa (1976) suggested that the coefficient is close to unity which implies a random walk money supply process. On the discussion of the postsample predictions, Meese and Rogoff (1983) submitted detailed discussion on the process of U.S. money supply. Let the money supply process be as the one like the above equation. The relationship of the relative change in the current and lagged money supply can be expressed as:

\[ \partial MS_t = \delta \partial MS_{t-1}. \]

Substituting this relationship into the elasticity equation will generate the following equation:

\[ E_{MS}^{EX} = \frac{QEX}{\partial MS_t} \frac{MS_{t-1}(MS_t - MS_{t-1})}{EX}. \]

Rearranging the above equation and multiplying one on to the right hand side, the elasticity of the exchange rate with respect to U.S. monetary growth rate becomes:

\[ E_{MS}^{EX} = \frac{\partial EX}{\partial MS_t} \frac{MS_t}{EX} \frac{MS_{t-1}}{MS_t} \frac{(MS_t - MS_{t-1})}{(MS_{t-1} - \frac{1}{\delta} MS_t)}. \]

Converting the right hand side of the above equation to elasticity form, conversion formula comprising the elasticity of the exchange rate with respect to U.S. money supply and that with respect to U.S. monetary growth is obtained as:

\[ E_{MS}^{EX} = E_{MS}^{EX} MS_{t-1} \frac{(MS_t - MS_{t-1})}{(MS_{t-1} - \frac{1}{\delta} MS_t)}. \]
Where the elasticity of the exchange rate with respect to the level of money supply can be obtained from the estimation of the equation (3.3). The ratio of lagged money supply to current money supply can be calculated using the mean values.
Appendix C

THE CALCULATION OF ELASTICITIES

The elasticities of the world price and U.S. soybean exports are obtained as follows. For the elasticity from equation (3.33):

\[ [X] = 0.83(0.229)(-0.57) + 0.17(0.686)(0.513) - (-0.701)(-1.280) \]

\[ = -0.10834 + 0.05982 - 0.89749 = -0.94601. \]

The related denominator is:

\[ -0.723 - 0.83(0.174) - 0.17(0.815) = -0.98897, \]

and the elasticity of world soybean price with respect to U.S. monetary growth rate becomes 0.939.

For the elasticity from equation (3.34):

\[ [Y] = -0.701((-1.280) + 0.939) \]

\[ -0.17(0.686)((0.513) + 0.939) = 0.0699. \]

The related denominator is 0.83. The number -0.434 is calculated from the formula derived in Appendix A and is used to convert the elasticity of the exchange rate with respect to U.S. money supply into that with respect to U.S. monetary growth rate. As a result, the elasticity of U.S. soybean exports with respect to U.S. monetary growth rate becomes 0.084. The elasticities of Brazil/Argentina exports and EC-12/Japan imports with respect to U.S. monetary growth rate can be calculated by using the same technique.
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