1982

Feed grains imports and pricing in the European Economic Community

Shida Rastegari

Iowa State University

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FEED GRAINS IMPORTS AND PRICING IN THE EUROPEAN ECONOMIC COMMUNITY

Iowa State University  PH.D.  1982

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Feed grains imports and pricing in
the European Economic Community

by

Shida Rastegari

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of

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Approved:

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In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1982
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DEDICATION

To my parents
CHAPTER I. INTRODUCTION

World Trade in Feed Grains

World trade in feed grains\(^1\) has been rising for quite some time. From 1965/66\(^2\) to 1979/80, world trade in feed grains grew from 4.5 million metric tons to 104.9 million metric tons, a 130.5% increase in fifteen years. Corn is the major commodity being traded, while barley and sorghum take second and third places. Very little rye and oats are traded internationally. During the 1965/66-1979/80 period, corn accounted for 66.4%, barley for 17.2%, and sorghum for 12.9% of the world trade in feed grains. Oats and rye accounted for only 2.2% and 1.4%, respectively, of the world feed grains' trade during this period. Table 1-1 presents data on world trade in feed grains by year and commodity component.

Major exporters of feed grains

The United States, Argentina, West Europe, Canada, South Africa, Australia, Thailand, and Brazil are the world's major feed grains' exporting regions. Including EC-9\(^3\) intra-trade, their exports accounted for 93.9% of total world exports during the period 1965/66

\(^1\) Corn, barley, grain sorghum, oats, and rye are feed grains.

\(^2\) 1965/66 stands for the crop year beginning on July 1, 1965, and ending June 30, 1966. This notation will be used throughout the study.

\(^3\) The nine member countries of the European Economic Community: France, West Germany, Italy, Belgium, Luxembourg, the Netherlands, Denmark, Ireland, and the United Kingdom. Greece became the tenth member of the E.E.C. on January 1, 1981. However, because the research for this study started prior to January 1, 1981, Greece is excluded whenever reference is made to present members of the Community.
Table 1-1. World exports of feed grains (in thousands of metric tons)\(^a\)

<table>
<thead>
<tr>
<th>Year beginning July 1</th>
<th>Corn</th>
<th>Barley</th>
<th>Grain Sorghum</th>
<th>Oats</th>
<th>Rye</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965/66</td>
<td>27,426</td>
<td>8,557</td>
<td>7,279</td>
<td>1,636</td>
<td>587</td>
<td>45,485</td>
</tr>
<tr>
<td>1966/67</td>
<td>25,881</td>
<td>6,725</td>
<td>8,913</td>
<td>1,270</td>
<td>941</td>
<td>43,730</td>
</tr>
<tr>
<td>1967/68</td>
<td>27,948</td>
<td>6,988</td>
<td>5,599</td>
<td>1,148</td>
<td>834</td>
<td>42,517</td>
</tr>
<tr>
<td>1968/69</td>
<td>28,011</td>
<td>7,103</td>
<td>4,792</td>
<td>1,130</td>
<td>666</td>
<td>41,702</td>
</tr>
<tr>
<td>1969/70</td>
<td>28,497</td>
<td>8,935</td>
<td>5,084</td>
<td>936</td>
<td>713</td>
<td>44,165</td>
</tr>
<tr>
<td>1970/71</td>
<td>29,707</td>
<td>11,547</td>
<td>7,396</td>
<td>1,908</td>
<td>873</td>
<td>51,431</td>
</tr>
<tr>
<td>1971/72</td>
<td>33,441</td>
<td>13,882</td>
<td>5,467</td>
<td>1,969</td>
<td>809</td>
<td>55,568</td>
</tr>
<tr>
<td>1972/73</td>
<td>42,353</td>
<td>12,086</td>
<td>7,185</td>
<td>1,654</td>
<td>1,473</td>
<td>54,751</td>
</tr>
<tr>
<td>1973/74</td>
<td>51,981</td>
<td>12,972</td>
<td>10,617</td>
<td>1,871</td>
<td>1,887</td>
<td>79,328</td>
</tr>
<tr>
<td>1974/75</td>
<td>48,327</td>
<td>11,449</td>
<td>9,230</td>
<td>1,109</td>
<td>743</td>
<td>70,858</td>
</tr>
<tr>
<td>1975/76</td>
<td>58,292</td>
<td>13,144</td>
<td>11,083</td>
<td>1,291</td>
<td>730</td>
<td>84,540</td>
</tr>
<tr>
<td>1976/77</td>
<td>58,455</td>
<td>14,232</td>
<td>12,916</td>
<td>1,578</td>
<td>630</td>
<td>87,811</td>
</tr>
<tr>
<td>1977/78</td>
<td>62,361</td>
<td>15,379</td>
<td>11,286</td>
<td>1,302</td>
<td>945</td>
<td>91,273</td>
</tr>
<tr>
<td>1978/79</td>
<td>68,807</td>
<td>15,007</td>
<td>10,783</td>
<td>1,699</td>
<td>872</td>
<td>97,168</td>
</tr>
<tr>
<td>1979/80</td>
<td>75,871</td>
<td>14,462</td>
<td>11,801</td>
<td>1,820</td>
<td>923</td>
<td>104,877</td>
</tr>
</tbody>
</table>

| Total 1965/66-1979/80 | 667,358 | 172,468 | 129,431 | 22,321 | 13,626 | 1,005,204 |

\(^a\)Source: [U.S.D.A., Grains Supply-Distribution, World total].
to 1978/79. Table 1-2 presents data on the exports of major feed grains'exporting regions for the years 1965/66 to 1979/80.

For many years, the United States has been the leading exporter of feed grains. From 1965/66 to 1978/79, its exports accounted for 51.2% of total world feed grains' exports. The U.S. has consistently been the leading exporter of corn and sorghum. From 1973/74 to 1976/77, its corn exports accounted for 71.3% of total world corn exports, and its sorghum exports accounted for 54.3% of total world sorghum exports.

The percentage of U.S. feed grains' production that is exported has been increasing rapidly. In 1960/61, only about 8% of the feed grains produced in the U.S. was exported; by 1978/79 this figure reached 26%. In other words, U.S. feed grains' producers have been relying more and more on international markets for the sale of their products. Since the price of U.S. feed grains is almost always competitive with the prices offered by other exporters, the U.S. has many markets. Western Europe is the largest importer of U.S. feed grains, but, as a single country, Japan is the largest market. 3

1 This percentage is calculated based on the data from table 1-2.
2 All the percentages throughout this chapter are calculated based on the data from U.S.D.A., Grains, unless the source is stated otherwise.
3 During the period 1973/74 to 1976/77, Western European countries imported about 44% (the EC-9 imported about 33%), and Japan imported about 20% of total U.S. exports of feed grains.
Table 1-2. *Feed grains' exports of major feed grains' exporting countries (in million metric tons)*

<table>
<thead>
<tr>
<th>Year beginning July 1</th>
<th>U.S.</th>
<th>Argentina</th>
<th>West Europe Intra EC-9 trade included</th>
<th>West Europe Intra EC-9 trade excluded</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965-66</td>
<td>25.4</td>
<td>3.8</td>
<td>5.9</td>
<td>2.2</td>
<td>1.2</td>
</tr>
<tr>
<td>1966-67</td>
<td>20.9</td>
<td>6.5</td>
<td>6.6</td>
<td>2.6</td>
<td>1.3</td>
</tr>
<tr>
<td>1967-68</td>
<td>19.7</td>
<td>4.0</td>
<td>6.7</td>
<td>2.7</td>
<td>1.2</td>
</tr>
<tr>
<td>1968-69</td>
<td>16.0</td>
<td>5.6</td>
<td>8.3</td>
<td>3.2</td>
<td>0.6</td>
</tr>
<tr>
<td>1969-70</td>
<td>19.2</td>
<td>6.0</td>
<td>8.9</td>
<td>4.1</td>
<td>1.4</td>
</tr>
<tr>
<td>1970-71</td>
<td>19.4</td>
<td>7.6</td>
<td>9.2</td>
<td>4.1</td>
<td>4.2</td>
</tr>
<tr>
<td>1971-72</td>
<td>20.8</td>
<td>6.2</td>
<td>12.0</td>
<td>5.2</td>
<td>4.6</td>
</tr>
<tr>
<td>1972-73</td>
<td>35.6</td>
<td>4.2</td>
<td>11.1</td>
<td>5.1</td>
<td>4.2</td>
</tr>
<tr>
<td>1973-74</td>
<td>44.5</td>
<td>8.4</td>
<td>13.9</td>
<td>5.5</td>
<td>2.9</td>
</tr>
<tr>
<td>1974-75</td>
<td>34.4</td>
<td>8.5</td>
<td>11.3</td>
<td>4.5</td>
<td>2.8</td>
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<tr>
<td>1975-76</td>
<td>46.3</td>
<td>5.4</td>
<td>13.3</td>
<td>5.0</td>
<td>4.9</td>
</tr>
<tr>
<td>1976-77</td>
<td>50.6</td>
<td>9.5</td>
<td>10.1</td>
<td>4.6</td>
<td>4.6</td>
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<tr>
<td>1977-78</td>
<td>52.1</td>
<td>11.0</td>
<td>14.0</td>
<td>6.0</td>
<td>3.7</td>
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<td>1978-79</td>
<td>56.5</td>
<td>11.5</td>
<td>15.5</td>
<td>6.4</td>
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<tr>
<td>1979-80</td>
<td>69.7</td>
<td>9.9</td>
<td>11.4</td>
<td>5.4</td>
<td>4.4</td>
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<tr>
<td>Grand Total</td>
<td>461.4</td>
<td>98.2</td>
<td>145.7</td>
<td>61.2</td>
<td>41.0</td>
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*a Source: [U.S.D.A., Grains].

b Preliminary estimates.
<table>
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<th>South Africa</th>
<th>Australia</th>
<th>Thailand</th>
<th>Brazil</th>
<th>World Total Intra EC-9 Trade Included</th>
<th>World Total Intra EC-9 Trade Excluded</th>
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<td>0.6</td>
<td>0.5</td>
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<td>0.9</td>
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<td>0.6</td>
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<td>39.8</td>
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<td>1.3</td>
<td>0.7</td>
<td>42.6</td>
<td>38.7</td>
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<td>2.4</td>
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<td>1.3</td>
<td>1.2</td>
<td>41.7</td>
<td>36.6</td>
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<tr>
<td>1.1</td>
<td>0.9</td>
<td>1.6</td>
<td>0.6</td>
<td>44.0</td>
<td>39.2</td>
</tr>
<tr>
<td>1.1</td>
<td>2.2</td>
<td>1.8</td>
<td>2.0</td>
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<td>46.3</td>
</tr>
<tr>
<td>3.1</td>
<td>3.2</td>
<td>2.3</td>
<td>0.6</td>
<td>55.5</td>
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<td>3.3</td>
<td>1.6</td>
<td>1.1</td>
<td>0.5</td>
<td>65.3</td>
<td>59.4</td>
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<tr>
<td>0.5</td>
<td>1.9</td>
<td>2.3</td>
<td>0.0</td>
<td>79.2</td>
<td>70.8</td>
</tr>
<tr>
<td>3.5</td>
<td>3.2</td>
<td>2.2</td>
<td>1.5</td>
<td>70.7</td>
<td>63.9</td>
</tr>
<tr>
<td>3.4</td>
<td>3.2</td>
<td>2.6</td>
<td>1.4</td>
<td>84.7</td>
<td>76.4</td>
</tr>
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<td>1.4</td>
<td>3.3</td>
<td>2.3</td>
<td>1.3</td>
<td>88.1</td>
<td>82.6</td>
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<tr>
<td>2.8</td>
<td>1.9</td>
<td>1.3</td>
<td>1.0</td>
<td>91.4</td>
<td>83.4</td>
</tr>
<tr>
<td>3.2</td>
<td>3.1</td>
<td>2.1</td>
<td>0.0</td>
<td>97.2</td>
<td>89.2</td>
</tr>
<tr>
<td>2.0</td>
<td>3.4</td>
<td>2.4</td>
<td>0.3</td>
<td>106.6</td>
<td>99.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30.6</td>
<td>27.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24.7</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>901.1</td>
<td>816.8</td>
</tr>
</tbody>
</table>
Argentina, the second leading exporting country, accounted for 10.9% \(^1\) of total world feed grains' exports during the period 1965/66 to 1978/79. Argentine coarse grain producers, too, have been relying more and more on international markets. The percentage of Argentine feed grains' production that is exported has increased from 32.1% in 1965/66 to 58.9% in 1978/79. Most of those exports have been corn and sorghum. From 1973/74 to 1976/77, corn constituted 56.4% and sorghum 40.5% of total Argentine feed grains' exports. During this period, Argentina exported very little barley and oats. Italy is the largest importer of Argentine corn. \(^2\) One reason Italy is such a good market for Argentine corn is the trade agreement, made prior to 1962, by which Italy granted import licensing preferences for some Italian manufactured goods. Another reason for Italy's large imports is the type of corn that Argentina grows. Argentine flint type corn is preferred by Italians for poultry feed purposes because it has a relatively high concentration of carotene which produces dark-yolked eggs and yellow-skinned meat when fed to poultry [Reed, 1979, p. 4]. Spain is another major market for Argentine corn. \(^3\) This is because of a "combination of normal freight and pricing factors and certain Spanish regulations affecting freight and levies on corn" [Reed, 1979, 

---

\(^1\) This percentage is calculated based on the data from table 1-2.

\(^2\) During the years from 1973/74 to 1976/77, Italy imported 46% of Argentina's total corn exports.

\(^3\) During the period from 1973/74 to 1976/77, Spain imported 14% of Argentina's total corn exports.
Japan is the major market for Argentine sorghum exports.\(^1\)

The third leading exporter of feed grains is Western Europe. From 1965/66 to 1978/79, its feed grains' exports constituted 16.2\(^\%\)^2 of total world trade in feed grains, including EC-9 intra-trade. (Excluding EC-9 intra-trade the figure is 7.5\%.) Among the Western European countries, France is the major feed grains' exporter. France's feed grains' exports have grown rapidly: from 1,774,000\(^3\) metric tons in 1960/61 to 6,646,000\(^3\) metric tons in 1978/79. This 274.6\%\(^3\) increase can be attributed to France's membership in the European Economic Community (E.E.C.). As will be explained in detail in the next chapter, the E.E.C. Common Agricultural Policy (C.A.P.), which was adopted in 1962 and became fully operative in 1967, meant higher internal prices for France, resulting in larger supplies and larger exports. From 1965/66 to 1978/79, France accounted for 55.9\% of total Western Europe feed grains' exports, including the EC-9 intra-trade. From 1967/68 to 1976/77, 66.7\% of France's total feed grains' exports went to other member countries.

Canada is the fourth leading exporter of feed grains with exports accounting for 4.5\%\(^4\) of world exports from 1965/66 to 1978/79. Most of Canada's feed grains' exports are barley: 87.4\% from 1973/74 to

---

\(^1\)During the period 1973/74 to 1976/77, Japan imported 32.6\% of Argentina's total sorghum exports.

\(^2\)This percentage is calculated based on data from table 1-2.

\(^3\)Source: [USDA, Grains Supply-Distribution, France].

\(^4\)This percentage is calculated based on the data from table 1-2.
1977/78. During this period, 30.5% of Canada's total barley exports went to the EC-9 countries, primarily to Italy, West Germany, the Netherlands, and the United Kingdom. Because of its commonwealth status, Canada was given preferential tariff rates in the United Kingdom before the United Kingdom joined the E.E.C. in 1973 [Reed, 1979, p. 5]. Access to Japanese markets by West Coast sea ports makes Japan another major importer of Canadian barley.¹

South Africa is the fifth leading exporter of feed grains with exports constituting 3.4%² of world exports during the 1965/66 - 1978/79 period. Almost all South Africa's feed grains' exports are corn, 92.2% from 1971/72 to 1976/77, sent mainly to Japan, the United Kingdom, and the Netherlands. South Africa's exports vary significantly from one year to the next because of significant fluctuations in feed grains' production, fluctuations caused by variations in precipitation coupled with the use of marginal land [Reed, 1979, p. 6].

Thailand, the sixth leading exporter, accounted for 3%³ of total world feed grains' exports from 1965/66 to 1978/79. Corn exports accounted for 93% of its total feed grains' exports from 1971/72 to 1976/77. Because of low consumption of corn in Thailand, a high proportion of corn produced in the country is exported to Japan, Taiwan, Singapore, and Hong Kong.

¹During the period from 1973/74 to 1976/77, Japan imported 26.3% of Canada's total barley exports.
²This percentage is calculated based on the data from table 1-2.
³This is calculated based on the data from table 1-2.
Major importers of feed grains

West Europe has been the largest importer of feed grains. During the period from 1965/66 to 1978/79, its imports accounted for 42% of world total feed grains' imports, excluding the EC-9 intra-trade. Including the EC-9 intra-trade, West Europe accounted for 47.2% of total world imports in feed grains. Among Western European countries, Italy, West Germany, the United Kingdom, and the Netherlands are major feed grains importers. Data on feed grains' imports of these countries are presented in table 1-3. From 1965/66 to 1979/80, Italy accounted for 8.8%, West Germany for 7.5%, the United Kingdom for 6.4%, and the Netherlands for 6% of world total feed grains' imports, including the EC-9 intra-trade. These countries are all currently members of the E.E.C., a customs union whose importance in world feed grains' trade will be discussed in the following section.

Japan, another leading importer of feed grains, accounted for 18% of the world total feed grains' imports from 1965/66 to 1979/80, as the data in table 1-3 show. Eighty percent of mixed feed consumption in Japan is used in swine and poultry operations. Barley imports and prices in Japan are directly controlled by the government. Corn and sorghum are imported by private firms. However, to stabilize the market, intervention purchases of the grain are made by the Japanese government [Reed, 1979, pp. 7-8].

1The percentage is calculated based on the data from table 1-3.
Table 1-3. Feed grains' imports of major feed grains' importing countries (in thousands of metric tons)\(^a\)

<table>
<thead>
<tr>
<th>Year beginning July 1</th>
<th>West Germany</th>
<th>United Kingdom</th>
<th>The Netherlands</th>
<th>Italy</th>
<th>Japan</th>
<th>World Total Including EC-9 intra-trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965-66</td>
<td>5,352</td>
<td>4,316</td>
<td>3,171</td>
<td>6,712</td>
<td>5,192</td>
<td>45,500</td>
</tr>
<tr>
<td>1966-67</td>
<td>4,717</td>
<td>4,133</td>
<td>2,974</td>
<td>6,254</td>
<td>7,163</td>
<td>43,825</td>
</tr>
<tr>
<td>1967-68</td>
<td>4,943</td>
<td>4,052</td>
<td>3,134</td>
<td>6,065</td>
<td>7,747</td>
<td>42,564</td>
</tr>
<tr>
<td>1968-69</td>
<td>4,251</td>
<td>4,085</td>
<td>2,327</td>
<td>6,215</td>
<td>8,517</td>
<td>41,521</td>
</tr>
<tr>
<td>1969-70</td>
<td>3,948</td>
<td>4,188</td>
<td>2,677</td>
<td>5,472</td>
<td>10,050</td>
<td>44,015</td>
</tr>
<tr>
<td>1970-71</td>
<td>6,075</td>
<td>4,076</td>
<td>3,492</td>
<td>5,984</td>
<td>10,476</td>
<td>51,487</td>
</tr>
<tr>
<td>1971-72</td>
<td>5,577</td>
<td>4,377</td>
<td>2,648</td>
<td>5,732</td>
<td>10,274</td>
<td>55,504</td>
</tr>
<tr>
<td>1972-73</td>
<td>4,828</td>
<td>4,155</td>
<td>3,289</td>
<td>6,006</td>
<td>12,048</td>
<td>64,813</td>
</tr>
<tr>
<td>1973-74</td>
<td>5,487</td>
<td>4,484</td>
<td>5,361</td>
<td>6,723</td>
<td>14,111</td>
<td>79,640</td>
</tr>
<tr>
<td>1974-75</td>
<td>5,077</td>
<td>3,891</td>
<td>6,284</td>
<td>5,450</td>
<td>13,116</td>
<td>70,893</td>
</tr>
<tr>
<td>1975-76</td>
<td>4,733</td>
<td>4,485</td>
<td>5,756</td>
<td>5,341</td>
<td>13,535</td>
<td>82,990</td>
</tr>
<tr>
<td>1976-77</td>
<td>6,710</td>
<td>5,570</td>
<td>6,439</td>
<td>5,987</td>
<td>15,894</td>
<td>86,331</td>
</tr>
<tr>
<td>1977-78</td>
<td>4,536</td>
<td>4,089</td>
<td>4,409</td>
<td>4,372</td>
<td>16,954</td>
<td>87,667</td>
</tr>
<tr>
<td>1978-79</td>
<td>4,288</td>
<td>3,711</td>
<td>3,660</td>
<td>5,536</td>
<td>17,871</td>
<td>95,034</td>
</tr>
<tr>
<td>1979-80</td>
<td>4,260</td>
<td>3,950</td>
<td>3,784</td>
<td>5,555</td>
<td>18,470</td>
<td>102,129</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>74,782</strong></td>
<td><strong>63,535</strong></td>
<td><strong>59,405</strong></td>
<td><strong>87,404</strong></td>
<td><strong>181,418</strong></td>
<td><strong>993,913</strong></td>
</tr>
</tbody>
</table>

\(^a\)Source: [U.S.D.A., Grains Supply-Distribution].
Japan, Italy, West Germany, the United Kingdom, and the Netherlands accounted for about 47% of total world feed grains' imports from 1965/66 to 1979/80. These major feed grains' importers are among the developed countries whose relatively high level of per capita income has produced a relatively high level of demand for meat and thus for feed grains to be fed to the livestock.

The importance of the E.E.C. in world feed grains' trade

The E.E.C. has played an important role in the world feed grains' trade over the past decade and a half. From 1965/66 to 1978/79, EC-9 total imports including their intra-trade accounted for 35.5%\(^1\) of world total feed grains' trade. The Community has consistently been the largest market for U.S. feed grains' exports. As the data in table 1-4 show, the E.E.C. imported 30.9% of U.S. total feed grains' exports from 1965/66 to 1979/80. However, this percentage has been decreasing. In 1965/66, U.S. exports to the E.E.C. constituted 49.1% of U.S. total feed grains' exports; the figure dropped to about 16.3% in 1979/80. Meanwhile, EC-9 intra-trade has increased from 3.7 million metric tons in 1965/66 to 7.0 million metric tons in 1978/79, 89.2% in thirteen years.

Some argue that without the E.E.C. Common Agricultural Policy (C.A.P.), the volume of E.E.C. feed grains' imports from non-member

\(^{1}\)This percentage is calculated based on the data given in tables 1-3 and 1-4.
Table 1-4. The E.E.C. (includes the nine member countries) and the U.S. feed grains trade (in thousands of metric tons)

<table>
<thead>
<tr>
<th>Year beginning July 1</th>
<th>EEC total Imports(^a)</th>
<th>EEC Imports from U.S.(^a)</th>
<th>U.S. Total Exports(^a)</th>
<th>Percentage of U.S. Exports to EEC</th>
<th>EEC Intrac-trade (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965/66</td>
<td>23,402</td>
<td>12,479</td>
<td>25,406</td>
<td>49.10</td>
<td>3,700</td>
</tr>
<tr>
<td>1966/67</td>
<td>22,233</td>
<td>9,417</td>
<td>20,945</td>
<td>44.96</td>
<td>4,000</td>
</tr>
<tr>
<td>1967/68</td>
<td>21,724</td>
<td>9,259</td>
<td>19,718</td>
<td>46.96</td>
<td>3,900</td>
</tr>
<tr>
<td>1968/69</td>
<td>20,014</td>
<td>7,172</td>
<td>16,006</td>
<td>44.81</td>
<td>5,100</td>
</tr>
<tr>
<td>1969/70</td>
<td>19,666</td>
<td>7,497</td>
<td>19,226</td>
<td>39.00</td>
<td>4,800</td>
</tr>
<tr>
<td>1970/71</td>
<td>24,260</td>
<td>8,837</td>
<td>19,414</td>
<td>44.52</td>
<td>5,100</td>
</tr>
<tr>
<td>1971/72</td>
<td>22,202</td>
<td>7,212</td>
<td>20,757</td>
<td>34.75</td>
<td>6,800</td>
</tr>
<tr>
<td>1972/73</td>
<td>21,927</td>
<td>9,581</td>
<td>35,603</td>
<td>26.91</td>
<td>5,900</td>
</tr>
<tr>
<td>1973/74</td>
<td>26,693</td>
<td>11,248</td>
<td>44,472</td>
<td>25.29</td>
<td>8,400</td>
</tr>
<tr>
<td>1974/75</td>
<td>25,092</td>
<td>12,767</td>
<td>34,357</td>
<td>37.16</td>
<td>6,800</td>
</tr>
<tr>
<td>1975/76</td>
<td>25,393</td>
<td>13,061</td>
<td>46,334</td>
<td>28.19</td>
<td>8,300</td>
</tr>
<tr>
<td>1976/77</td>
<td>32,398</td>
<td>20,664</td>
<td>50,593</td>
<td>40.8</td>
<td>5,500</td>
</tr>
<tr>
<td>1977/78</td>
<td>23,140</td>
<td>11,576</td>
<td>52,116</td>
<td>22.2</td>
<td>8,000</td>
</tr>
<tr>
<td>1978/79</td>
<td>22,579</td>
<td>11,922</td>
<td>57,113</td>
<td>20.9</td>
<td>7,000</td>
</tr>
<tr>
<td>1979/80</td>
<td>22,087</td>
<td>10,902</td>
<td>66,766</td>
<td>16.3</td>
<td>N.A.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>352,810</strong></td>
<td><strong>163,594</strong></td>
<td><strong>528,826</strong></td>
<td><strong>30.9</strong></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\text{Source: [USDA, Grains Supply-Distribution].}\)

\(^{b}\text{Source: [USDA, grains].}\)
countries would have been larger. The main features of the C.A.P. have been the removal of all restrictions on member countries' trade, the establishment of uniform support prices (target prices) for agricultural products among members, and the imposition of a common system of tariffs (variable levy) with respect to third countries. Adoption of the C.A.P. has protected the E.E.C. domestic markets from non-member country exports and has led to an increase in EC-9 intra-trade and domestic production. A detailed description of the C.A.P., support prices and the variable levy system, the E.E.C.'s agrimoney system, the institutions of the Community, and the agricultural decision making process of the Community will be given in the next chapter (Chapter II).

Objectives of this Study

The main objective of this study is to develop an economic rationale for past E.E.C. policy decisions on feed grains' target prices. Also examined are the effects of these decisions on E.E.C. livestock inventory, feed grains' trade, and world prices. This involves:

1) Investigating the factors affecting the level of feed grains' target prices in the Community and quantifying their effects.
2) Obtaining the E.E.C. import demand equation for feed grains.
3) Determining the factors that influence the E.E.C. livestock inventory.
4) Developing an equation for feed grains' world prices.
Only the six original member countries are studied in this project, and they are treated as one large country.

The Following Chapters

Chapter II explains the European Economic Community's Common Agricultural Policy with respect to grains. This chapter also contains a discussion on the E.E.C. Agrimoney System, and a brief description of the Institutions of the Community and the decision making process in the Community.

The review of literature is presented in Chapter III. In the first part of this chapter the theory of tariffs will be explained. This theory is used to develop the econometric model in this study. In the second part, the previous work in agricultural economics which is related to this study is discussed.

Chapter IV sets forth the analytical model which is composed of four simultaneous equations. The purpose of this model is to explain the determination of the E.E.C.'s feed grains' target prices.

Chapter V discusses the sources and construction of data that are used to estimate the model developed in Chapter IV.

Chapter VI describes the statistical procedures used to estimate the Chapter IV model.

Chapter VII presents the estimation results of the study.

Chapter VIII offers some concluding remarks for this study.
CHAPTER II. THE WORKING OF THE COMMON AGRICULTURAL POLICY (C.A.P.)

This chapter discusses the working of the Common Agricultural Policy in the E.E.C.

The first section presents a description of the objectives and principles underlying the C.A.P., gives a brief review of the agreements among member countries which led to the establishment of the common support prices, and describes the market organization for grains. The second section discusses the E.E.C. agrimonetary system and the problems involved with the various currency units that were used in the Community for statistical purposes. The third section presents a brief discussion of the Community institutions and the agricultural decision making process.

The C.A.P.

An introductory note

The primary function of the E.E.C. has been to create a customs union which involves removal of all restrictions among member countries' trade and imposition of a common system of restrictions for trade with non-member countries. This complies with Article 9 of the Treaty of Rome (March 1957) which set up the E.E.C.:

The Community shall be based upon a customs union covering the exchange of all goods and comprising both the prohibition, as between Member States, of customs duties on importation and exportation and all charges with equivalent effect and the adoption of a common customs tariff in their relations with third countries [Marsh, 1971, p. 9].
Considering the importance of the agricultural sector in their economies as a major source of employment,\footnote{In 1960, one-fifth and in 1977, one-twelfth of the working population in the E.E.C. were farmers or farm workers [Commission of the European Communities, The Common Agricultural Policy, 1977].} a major source of food for the population and raw materials for industry, and a major source of revenue from external trade, member countries had to stress the need for a Common Agricultural Policy when forming the E.E.C. Such emphasis is reflected in Article 38 of the Treaty of Rome. "The Common Market shall extend to agriculture and trade in agricultural products" [Marsh, 1971, p. 9].

Prior to joining the E.E.C., each member country had its own agricultural policies which were aimed at protecting its own farm sector and raising the farm population's income and standard of living. These policies often led to restrictions on imports from other countries, including future partners of the E.E.C. The Common Agricultural Policy had to bring six, and then nine, national policies into a single system.

The basic objectives of the C.A.P. which were set out in the Treaty of Rome, signed by the six original member states\footnote{The six original member states were: West Germany, France, Italy, the Netherlands, Belgium, and Luxembourg.} in 1957, are these:

1) To increase agricultural productivity.
2) To ensure a fair standard of living for the farm population.
3) To stabilize the markets.

4) To guarantee regular supplies.

5) To ensure reasonable consumer prices.

But the Treaty of Rome did not spell out the details of the C.A.P. Instead, these details have been worked out in a series of long, difficult negotiations between member countries.

**A review of the 1958 to 1968 agreements between member countries**

In July 1958, representatives of governments and farmers' organizations met at Stresa and established a number of objectives, summarized by Butterwick and Neville-Rolfe (1968) as follows:

1) To increase trade in agricultural produce between member countries and with third countries, and eliminate all quantitative restrictions.

2) To maintain a close correlation between structural and market policies.

3) To achieve a balance between supply and demand, avoiding encouragement of surpluses and giving scope to the comparative advantage of each region.

4) To eliminate all subsidies tending to distort competition between one country or region and another.

5) To improve the rate of return on capital and labor.

6) To preserve the family structure of farming.
7) To encourage rural industrialization so as to draw away surplus labor and eliminate marginal farms, and to give special aid to geographically disadvantaged regions.

By the end of 1960, the Council of Ministers had accepted the system of the variable levy and the common target and threshold prices\(^1\) as the means for establishing a unified market for agricultural commodities.

In January 1, 1962, after a marathon session ending at 5 a.m., the Council of Ministers agreed on the basic features of the C.A.P. and on regulations for grains, pork, eggs, poultry, fruit and vegetables. The agreement was the E.E.C.'s first major step toward a Common Agricultural Policy. The second major step, which was the installment of regulations covering other major products such as beef, veal, dairy products, rice, vegetable oil and oilseeds, took place in December 1963 in the session known as the Christmas eve marathon.

However, these two agreements did not result in the establishment of common support prices for agricultural products in the Community. The agreement on uniform prices for grains was made in December 1964, and the regulations established by the agreement became effective on July 1, 1967. German and Italian farmers were allowed to receive temporary subsidies to compensate them for the

\(^{1}\)The system of variable levy, and the common support prices will be explained in detail in the next section of this chapter.
rapid introduction of the common grain prices.\footnote{The introduced common prices were lower than the West German prices, and higher than, but closer to, French prices.}

After adopting a common price for grains, it was possible to start negotiations on other common agricultural prices. By the end of June 1968, E.E.C. member countries achieved a full customs union in farm products by removing the remaining restrictions on their mutual trade in agricultural products.

The United Kingdom, Denmark, and Ireland adopted the C.A.P. in 1973 with a transitional period lasting till December 31, 1977.

**Principles underlying the C.A.P.**

The three principles underlying the C.A.P. are: a single market, Community preference, and guidance and guarantee financing.

1) The single market involves the removal of all customs duties or equivalent charges or subsidies on imports from or exports to other member countries along with the imposition of common prices. The creation of a single market causes products to circulate freely between member countries.

2) The Community preference principle is expressed by the E.E.C.'s system of import tariff and export subsidy that the Community uses to protect the internal market from low world market prices. That is, when world market prices are lower than those in the Community, an import tax known as the "variable levy" brings
the imported product prices up to the level of the E.E.C. common prices. Also, an export subsidy known as the "export restitution" is granted to exporters to cover the difference between the world market prices and the higher E.E.C. common prices. When the world market prices are higher than the E.E.C. common prices an export tax is charged on exports while an import subsidy is granted on imports to the Community.

From these two principles, one can conclude that the E.E.C. functions in such a way that import needs for agricultural products in any one member country will first be satisfied by imports from other member countries. Only if sources within the E.E.C. cannot completely satisfy the import demand of that member country will imports from non-member countries take place.

3) The European Agricultural Guidance and Guarantee Fund (E.A.G.G.F.) finances the Common Agricultural Policy, support buying, export restitution, and technology improvements. This fund has two components: Guidance and Guarantee.

The Guarantee section finances intervention buyings, export restitution, and other measures in an effort to keep the prices at the targeted levels and to apply the C.A.P. to the markets of member countries.

The Guidance section of the E.A.G.G.F. finances the programs on structural reform to help the member states modernize farming and increase farm productivity.
The E.A.G.G.F. is financed by receipts from agricultural import levies and other custom duties and also by contributions from member countries. The following figures give an estimate of the total cost of financing the system of C.A.P. to the Community. In 1968/69, total E.A.G.G.F. budget expenditures were 1,945 million Units of Account (U.A.)\(^1\). One should also consider that individual member countries spend considerable amounts on agricultural policy. These expenditures, which are independent of community control, were estimated to have been about 3,000 million U.A. in 1967. In 1975, the expenditure for the Guarantee section came to about 4,700 million Units of Account. About 13% of this expenditure, 621 million U.A., was devoted to cereals. In the same year (1975), 325 million U.A. was devoted to the Guidance section. About 65% of this expenditure financed 692 projects for improving marketing structures and agricultural production.

Since 1975, the budget of the European Communities has financed the E.A.G.G.F. Sixty-six percent of the budget is financed by the agricultural levies, customs duties, and a charge on sugar. Contributions from member countries finance the remaining 33%.

**Market organization for grains**

Grains are of major importance to the E.E.C., as they constitute a large proportion of total farm production and account for half the

\(^1\)One Unit of Account was equal to one U.S. dollar at that time. A detailed explanation of the U.A. will be given later in this chapter in the section on the E.E.C. agrimonetary system.
E.E.C. total cropland. The E.E.C. has had a gross deficit of about 24.7 million tons per year in feed grains, but it is usually a surplus producer of soft wheat. The surplus can either be exported or be fed to livestock as a feed component.

Table 2-1 gives the Community self-sufficiency levels for cereals.

Table 2-1. Self-sufficiency figures in the Community of six(1) and nine(2)\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>1968/69(1)</th>
<th>1973/74(2)</th>
<th>1974/75(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals TOTAL</td>
<td>94</td>
<td>91</td>
<td>95</td>
</tr>
<tr>
<td>Soft wheat</td>
<td>120</td>
<td>103</td>
<td>112</td>
</tr>
<tr>
<td>Hard wheat</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>107</td>
<td>103</td>
<td>107</td>
</tr>
<tr>
<td>Oats</td>
<td>96</td>
<td>96</td>
<td>99</td>
</tr>
<tr>
<td>Maize</td>
<td>55</td>
<td>59</td>
<td>55</td>
</tr>
</tbody>
</table>

\(^a\)Source: [Commission of the European Communities, The Common Agricultural Policy, 1977, p. 18].

Grain prices influence the production cost and the required level of protection in other sectors where grain is used as a major input. Therefore, decisions on grain prices are fundamental to the working of the Common Agricultural Policy. In the next section, the Community system for grain pricing will be investigated. Understanding
the E.E.C. grain pricing system is the key to understanding the C.A.P. since the basic principles of the C.A.P. with respect to internal support and external protection have evolved out of the 1962 marketing regulations for grains.

The Community system for grain prices Grains, considered the cornerstone of the policy, were the first product to come under the C.A.P. Under the Community system, the following types of prices are set each year for each type of grain. These prices are set prior to the crop year that they apply to.¹

1) The "target price" is the price toward which the common market price should tend, which should provide a fair return to the efficient family farm producer, and which should serve as a guide for farmers in planning their production. Target prices for common wheat, durum wheat, barley, maize, and rye are established in advance for the coming crop year. These prices are "fixed at the level which is hoped producers will achieve on the open market in that area of the Community where grain is in shortest supply – Duisburg² in the Ruhr Valley" [Commission of the European Communities, the Common Agricultural Policy, 1977, p. 18]. This price is for grain that is delivered to a store or merchant

¹For example, prices that are set in May 1980 apply to the crop year that starts in August 1980.

²Duisburg, West Germany is an intervention center with the highest deficit for almost all grains.
and is not an on-farm price. Target prices for other areas in the
Community are derived from those calculated for Duisburg after
deducting costs of transporting grains from other areas to Duisburg.
All other official prices for grains, i.e., intervention and
threshold prices, are linked to the target prices.

2) The "intervention price," set at 12-20 percent below the target
price, is a guaranteed minimum price for producers. The inter­
vention agencies and marketing centers throughout the E.E.C. stand
ready to purchase the grain offered at this price, if it meets
specified quality standards. The intervention price for each type
of grain no longer varies regionally, but is the same throughout the
E.E.C. Maize, barley, and common wheat have a single intervention
price which is established for the main surplus area, Ormes in France.

3) The "threshold price" is the minimum price at which grain imports
from non-E.E.C. countries enter the E.E.C. ports. Its purpose is
to assure that grain imported at Rotterdam and transported to
Duisburg, West Germany sells at or above the target price. The
threshold price is the same for all E.E.C. entry points and applies
to a standard quality of grain. Calculated by subtracting from
the target price the cost of handling and transporting grain from
Rotterdam to Duisburg, the threshold price insulates domestic
E.E.C. prices from world price fluctuations. Increasing the cost
of imported grain from non-E.E.C. sources during times of low world
prices and setting the intervention price below the threshold price

---

1 This is a common characteristic that applies to all official cereal
prices in the Community.
facilitates the E.E.C. intra-trade and minimizes the need for
government intervention agencies to buy the surplus product.

4) "Import levies" (variable levies) are calculated as the difference
between the prevailing E.E.C. threshold price and the lowest quoted
C.I.F.\(^1\) price at Rotterdam after adjusting for quality coefficients.\(^2\)
C.I.F. prices are reviewed by the EC\(^3\) commission every day, and
the variable levies are revised if the price of any kind of grain
has changed more than 0.60 U.A. per ton.

The following equations state the relationships between various
EC prices:

\[
\begin{align*}
PT &= PH + T \\
PH &= PT - T \\
PT - 0.20 PT &\leq PI \leq PT - 0.12 PT \\
Li &= PH - PW = PT - T - PW = PT - (PW + T)
\end{align*}
\]

where:

\[
\begin{align*}
PT &= \text{Target price} \\
PI &= \text{Intervention price} \\
PH &= \text{Threshold price}
\end{align*}
\]

\(^1\)C.I.F. stands for cost, insurance, and freight.
\(^2\)Since EC prices are set for grains of a standard quality,
C.I.F. offer prices are adjusted for quality differences. For this
purpose "coefficients of equivalence" are added to or subtracted from
the C.I.F. offer prices.
\(^3\)EC is an abbreviation for the European Community.
Li = Variable levy

\[ T = \text{Marketing and transportation cost for transporting and marketing grain from Rotterdam to Duisburg.} \]

\[ PW = \text{The lowest C.I.F. offer price (world price).} \]

Figure 2-1 shows the relationship between target price, threshold price, and intervention price. When the EC threshold price is above the world C.I.F. price, an import levy is charged on imports to and an export subsidy (restitution) is granted on exports from the Community. The level of the export restitution, which is determined by commission officials, depends on, among other factors, the amount of surplus at home and on future trends. Export levies are imposed on grain exports from the E.E.C. to third countries when world prices are higher than those in the E.E.C.

The threshold, intervention, and target prices are stepped up monthly in predetermined amounts to take into account handling, storage, and financing costs, thereby creating an incentive for orderly marketing. At the end of a marketing year, intervention prices fall back to the levels which are set for the beginning of the coming crop year. To prevent substantial sales into intervention centers at the end of each marketing year, subsidies are given to the holders of end-of-year stocks of grain.
Figure 2-1. Levy and refund system for grains

\[\text{Source: [Commission of the European Communities, The Agricultural Policy of the European Community, 1976, p. 10].}\]
The Variable Levy

Unloading & Transport Costs

The Import Price (c.i.f.) (variable)

Threshold Price (All EC entry points)

Import

Intervention Price (Ormes)

Export

Target Price (Duisburg)

Market Price (f.o.b. * Community Port)

Restitution (variable)

The World Price (variable)

Agricultural Expenditure: E.A.G.G.F.
Portion of E.E.C. Budget
Agricultural Revenue: general system of E.E.C. budget receipts

*f.o.b. Free on Board: A term applied to the valuation of goods up to the point of embarkation.
The E.E.C. Agrimonetary System

The currency unit

Because the introduction of the common agricultural prices created a need for a common denominator for currencies of the member countries, the Unit of Account (U.A.) was introduced in 1962. Since then, the common support prices, import levies, and subsidies have been fixed on a Community-wide basis in U.A. ¹ However, the actual transactions, such as the payment of minimum prices to producers, take place in national currencies. The U.A. is a fictitious (physically non-existent) but legal currency used as an accounting device. Its value was fixed in 1962 by the Council of Ministers at 0.88867088 grams of fine gold. In 1962, that gold value was identical to the parity of the American dollar as declared to the International Monetary Fund (IMF). Convenience and expediency were the reasons that the U.A. was made equal in value to the U.S. dollar.

In the international exchange system of the day, most of the major trading nations, including the E.E.C. member countries, declared parities to the IMF. Parities were defined in terms of gold content of each currency and also, because of its world-wide importance and convertibility, were expressed in terms of the U.S. dollar.² As a result, the exchange rate between the U.S. dollar and other currencies

¹With the birth of the European Monetary System (EMS) in March 1979, the common denominator for agricultural prices was changed from the U.A. to the European Currency Unit (ECU). The European Monetary System will be discussed later in this chapter.

²The U.S. dollar was fixed in terms of gold.
and among other currencies themselves were fixed. In addition, E.E.C. member countries' currencies, via the gold/$US link, were fixed in terms of the U.A. Therefore, the original exchange rates used for the operation of C.A.P.\(^1\) were nothing more than re-statements of exchange rates declared to the IMF at that time and applied in the day-to-day foreign exchange operations in the member states' currencies.

During the first few years of its adoption the 1962 system of exchange rates worked fairly smoothly, a result of the relative stability between the U.S. dollar and gold, between the exchange rates of member states' currencies, and between these currencies and the U.S. dollar. However, signs of stress on this monetary system began to appear with the monetary instability of late 1968 and early 1969.

**Currency crisis**

On August 11, 1969, France devalued its currency (French franc) by 11.1% by lowering the gold content declared to the IMF. The gold content of the French franc (F.F.) was decreased from 0.18 to 0.16 grams of fine gold. Since the gold content of the U.A. remained the same, the French franc became worth fewer units of account. The parity for the franc in terms of U.A. fell from 1 U.A. = F.F. 4.93706 to 1 U.A. = F.F. 5.55419. Because the common support prices which

\(^1\) The exchange rates used for C.A.P. purposes are referred to as green rates.
were expressed in U.A. were to be maintained, the devaluation would have meant an overnight rise in the franc price of farm products. Considering that the devaluation had been made in a situation of rapid inflation in France, at least by 1969 standards, the French government was unwilling to accept such a sharp rise in the cost of food. Therefore, for agricultural transactions, France requested permission to use the exchange rate which prevailed in the market before devaluation.\footnote{The conversion rates which were different from market exchange rates and were used in converting the official agricultural prices from the U.A. to national currencies were called "representative rates." The term "green rate" was used later for the same purpose. "Green Currency" refers to individual currencies which are converted at green rates like "Green Mark," "Green Lira," etc.} Permission to do so was granted, allowing France, under the arrangements agreed to by the Council of Agricultural Ministers, to set intervention prices at the levels in existence before the devaluation of the franc.

This action, however, created difficulties for the Community's intervention system. Using the old exchange rate in converting the intervention prices from U.S. dollar to F.F. led to a French intervention price below the intervention prices used in other member countries, giving France a trading advantage. In other words, in the absence of any compensatory measure, the C.A.P. prices in France would have undermined those in other member countries, and, in turn, would have caused trade distortions.

In order to offset the strong incentive for French traders to export products to other member states as well as to non-member countries, it was necessary to impose a levy on France's exports.
Also, in order to preserve other member countries' competitive positions and to keep French farm prices down, it was necessary to pay a subsidy on imports into France from members as well as from non-member countries. The export levy and import subsidy was 11.1% of the common price expressed in devalued francs, the amount by which common prices in terms of the franc would have increased as a result of devaluation.

These border taxes and subsidies are called Monetary Compensatory Amounts (MCAs). In trading with non-member countries, the MCAs are subtracted from the variable levies and export restitutions for member countries with depreciating currencies.

In October 1969, two months after the French franc devaluation, the German mark was revalued upwards by 9.29%. The gold content of the Deutsche mark (D.M.) was increased from 0.222168 grams to 0.242806 grams of fine gold, and the parity in terms of U.A. was changed from 1 U.A. = D.M. 4.00 to 1 U.A. = D.M. 3.66. This revaluation meant an 8.2% reduction in the C.A.P. prices in terms of D.M., and, therefore, a decrease in prices paid to German farmers. Such a reduction in farm product prices, which would have led to a reduction in farmers' incomes, was unacceptable to the West German government. So, like France, West Germany requested and received permission to use the exchange rate which prevailed before the revaluation of the D.M., while reducing the farm prices gradually. Similar to France's case, but operating in the opposite direction, the MCAs bridged the gap between the common prices expressed in revalued D.M.s and the prices
actually effective in West Germany. The MCAs were applied to levies on imports and subsidies on exports.¹

The establishment of MCAs, which included border taxes and subsidies applied to trade among member countries, was a threat to the C.A.P. and incompatible with the concept of a single market. However, both France and West Germany at that time agreed to return to free intra-Community trade by abolishing the MCAs and equating their green rates of exchange to their market rates of exchange. But before long the system fell into another state of disorder.

In May 1971, as a consequence of pressures on the Deutsche mark, this currency was floated. In August 1971, the U.S. dollar's convertibility into gold was suspended, and later that month the Benelux (Belgium, the Netherlands, and Luxembourg) and Italian currencies were floated. Once again, the E.E.C. countries decided to maintain farm support prices at the same level that prevailed before their currencies fluctuated. They used green exchange rates and MCAs for this purpose but reached no decision on when to abolish the MCAs.

In March 1972, the E.E.C. Council of Ministers agreed that the margin of fluctuation between the member states' currencies be limited to a 2.25% (+ 1.25%) band. However, they decided to maintain a 4½% band for the margin of fluctuation between their currencies.

¹In trade with non-member countries, the MCAs are added to the variable levies and export restitutions for member countries with appreciating currencies.
and the U.S. dollar. This system of exchange rates was referred to as "the snake in the tunnel," the "snake" being the 2.25% band within which the E.E.C. currencies could fluctuate and the "tunnel" being the 4% band within which the E.E.C. currencies could fluctuate against the U.S. dollar [Irving and Fearn, 1975, p. 13]. But this system of exchange rates did not last long. In June 1972, the speculative attack against the pound forced the British to let the pound float. After that, as funds moved from one currency to another, other currencies came under heavy pressure also. In January 1973, the lira was allowed to float. Eventually, most other European currencies had to be permitted to float upwards as they rose in value because of increased speculation. The six European Common Market countries (Belgium, Luxembourg, the Netherlands, Denmark, France, and West Germany) announced that from March 1973, while allowing their currencies to float in value against other currencies outside the group, they would maintain the maximum margin of 2.25% between their own currencies, an arrangement known as the "joint float" or the "snake." The currencies of the United Kingdom, Ireland, and Italy were to remain floating independently.

With all the changes taking place in the E.E.C. member countries' monetary systems, it was necessary to continue the use of MCAs. Since 1969, there have been some "devaluations" and "revaluations" of green rates, but because these have not matched the changes of the

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1 On March 15, 1976, France dropped out of the E.E.C. snake.
market exchange rates, the system of subsidies and levies among member countries in the form of MCAs has been continued. The exceptions are the Benelux countries that have no MCAs in trade between themselves.

Because of the use of MCAs, while the price expressed in units of account is "common" throughout the E.E.C., the absolute level of prices expressed in national currencies differs from one member country to another. There are now seven price zones for farm products within the E.E.C., with the German price level at the top and the British price level at the bottom of the price hierarchy [Swinbank, 1980]. This price disparity among member countries not only violates the principle of the C.A.P. and the goal of having a single market with free trade among partners, but may also lead to a distortion in competition and inefficient resource allocation.

Moreover, MCAs are costly, and they generate red tape. In 1975, the E.E.C. spent about 406 million U.A. to finance the MCAs, a cost incurred not as a result of agricultural problems, but because of monetary instability.

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1 The MCAs have been imposed on trade in most commodities covered by C.A.P. including cereals, pork, beef and veal, eggs and poultry, milk and milk products, etc. Prior to the introduction of EMS in 1979, MCAs were set once a year for countries whose currencies were in the snake: West Germany, Denmark, and the Benelux countries. However, they had to be adjusted often, sometimes weekly, for countries whose currencies floated independently: France, Italy, Ireland, and the United Kingdom.

2 Note that the comparison is done by converting common prices in different member countries to one currency using the market exchange rates.
In response to these difficulties, the EC Commission had made proposals for the readjustments of MCAs, so that the green rates would take into account the average market rate in the preceding eighteen months. Then, its 1978/79 proposals suggested the elimination of all the MCAs over a period not to exceed seven years. However, the decision to abolish MCAs can have lasting effect only in a stable foreign exchange market.

The Commission has been more successful in convincing member countries with devalued currencies than those with revalued currencies to remove MCAs. For example, Ireland and Italy\(^1\) have requested the removal of their MCAs to increase their farmers' incomes and to reduce the levies charged on their agricultural exports. But countries with revalued currencies resist such a change because it will lead to lower agricultural prices and a decrease in farmers' incomes.\(^2\)

The green rates, MCAs, and the Unit of Account constitute the EC agrimonetary system.

Developments in the E.E.C. agrimonetary system

The changes taking place in the monetary system during the 1970s proved that the definition of the Unit of Account was too inflexible

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\(^1\)These countries' currencies have been devalued.

\(^2\)However, one should not ignore the fact that farmers in countries with revalued currencies can purchase imported raw materials and other imported farm inputs with their revalued currencies at a lower price than in the past (before revaluation). Therefore, it can be concluded that MCAs are a form of over-compensation for countries with revalued currencies since they make no allowance for the cost advantage that producers in these countries have. In countries with devalued currencies, MCAs make no allowance for the cost disadvantage faced by producers in purchasing imported inputs of production.
Therefore, in December 1974, a new unit, the European Unit of Account (EUA), was introduced to provide a currency unit that would reflect the changing values of member states' currencies. The EUA was literally a basket of member states' currencies. Each currency was weighted based on the member country's intra-Community trade and GNP over the five-year period from 1969 to 1973.

The quantity of each member country's currency in the basket was determined so that 1 U.A. = 1.20635 U.S. dollar. The quantity of each currency in the basket was valued in terms of Belgian francs on a daily basis, and therefore, the value of the EUA itself in terms of Belgian francs was determined. The rate of the EUA in terms of any other world currency, such as the U.S. dollar, could then be determined from the rate of exchange of that world currency and the Belgian franc on the Brussels market, and the EUA value in Belgian francs.

The Statistical Office of the European Communities started using this new unit, EUA, in its publications beginning in January 1977. For the two preceding years (1975-1976), the unit used in the statistical series was the Eur. Derived from the unit of account still used by the member states in the framework of operations of the European Monetary Cooperation Fund (EMCF), the Eur was defined in terms of currencies which, in the past, had tended to appreciate. Since the Eur took its value from the appreciating currencies, it produced a considerable rise in real farm prices. By shifting from
Eur to EUA, which included weaker as well as stronger currencies in its basket, a gradual decrease in the E.E.C. farm product prices in relation to the rest of the world prices was expected.

One can see how confusing this array of units of accounts can be. However, since all the prices used in this study are expressed originally or translated into the units of account, an understanding of the various currency units used for statistical purposes in the Community is essential.

The introduction of the European Monetary System (EMS)

The new European Monetary System (EMS) went into effect on March 12, 1979. The principal motivations for its creation were dissatisfaction with floating exchange rates and the belief that the monetary system was having adverse effects on the growth, employment, and economic integration in Europe. This system was intended, as was the joint float, its predecessor, to reduce exchange rate fluctuations among E.E.C. member countries and thereby to promote trade, to promote other commercial relations, and to help generate closer political ties among these countries. The EMS is a coordination of the exchange rates of all member countries except Britain. All the currencies of the participants in the EMS have a declared central rate related to the ECU. Except for Italy, all the participants have agreed to keep

1Britain is not an EMS member; however, the British pound is included in the basket of currencies that determine the value of the European Currency Unit (ECU).

2ECU is the Community unit of account which will be discussed later in this section.
the values of their currencies within a 2.25% band around their declared rates. For Italy, the band is 6% around its declared central rate.

To support the EMS and to provide financial support for the currency stabilization efforts, members are required to commit 20% of their gold and dollar reserves to the European Monetary Cooperation Fund. The value of any participant country's currency inside the band is maintained by intervention of monetary authorities of the countries involved. That is, if the fluctuations of the value of one participant country's currency against another's threaten to exceed the agreed-upon band, the monetary authorities of both countries intervene to correct the situation.

Under the EMS, the ECU (European Currency Unit) replaces the European Unit of Account for statistical purposes. In time the ECU will be used in reporting and policy-setting functions. The value and composition of the ECU are identical with the definition of the European Unit of Account (EUA), and those given in table 2-1.

Although the ECU cannot be used for commercial transactions and reserve purposes, the long range goal is to use it as a common European currency. Currently, the common agricultural prices are expressed in terms of ECU and these prices are translated into each member country's currency by the use of ECU green rates.

A brief description of the institutions of the Community and the decision making process in the E.E.C. follows. The objective of this section is to give an understanding of the role and the power of each
member country versus the Community in setting and implementing policy decisions such as determining the level of agricultural support prices.

Table 2-1. The composition of the European Unit of Account (EUA) and subsequently, the European Currency Unit (ECU)\(^a\)

<table>
<thead>
<tr>
<th>Currency</th>
<th>Number of Currency Units Making Up the Unit of Account</th>
</tr>
</thead>
<tbody>
<tr>
<td>West German mark</td>
<td>0.828</td>
</tr>
<tr>
<td>French franc</td>
<td>1.15</td>
</tr>
<tr>
<td>British pound</td>
<td>0.0885</td>
</tr>
<tr>
<td>Italian lira</td>
<td>109.0</td>
</tr>
<tr>
<td>Dutch florin</td>
<td>0.286</td>
</tr>
<tr>
<td>Danish krone</td>
<td>0.217</td>
</tr>
<tr>
<td>Belgian franc</td>
<td>3.66</td>
</tr>
<tr>
<td>Luxembourg franc</td>
<td>0.14</td>
</tr>
<tr>
<td>Irish punt [sic]</td>
<td>0.00759</td>
</tr>
</tbody>
</table>

\(^a\)Source: [Swinbank, 1980].

The Institutions of the Community

The Council of Ministers: Each member country has a seat on the Council which meets in Brussels and Luxembourg.

Although the Rome Treaty allows for majority voting on most issues in the Council, unanimity has been the practice. That is, one member government can in effect veto a proposal that it finds contrary to its interest.

The European Commission: It consists of thirteen commissioners and their personal staffs. Each commissioner is appointed by the Council for a period of four years on the recommendation of the nine member-governments, and each specializes in a particular field. Each of the larger member countries, France, West Germany, Italy, and the United Kingdom, has two commissioners, while the rest each have one. Although they are drawn from member countries and most have a political, diplomatic, or academic background, they are all committed to acting independently of national governments and of the Council. And while they take an oath to accept no instructions from their national governments or any other outside body, they are expected to keep in contact with their home countries in order to be informed. The Commission also includes twenty administrative departments, each

1The Commission, then, emphasizes the E.E.C.'s common interests whereas the Council emphasizes the sense of independent nations working cooperatively.
headed by a director-general of which Agriculture and Fisheries is by far the largest.\footnote{The Agriculture and Fisheries department spends over 80% of the Community's budget. The reason for its size is that all the policy decisions that it controls are taken at the Community rather than at the national level, for instance managing the E.A.G.G.F. (the European Agricultural Guidance and Guarantee Fund) and operating the complex system of interventions, levies and refunds [Kerr, 1977, pp. 46-47].}

The Commission plays a dual role. One is to prepare policy decisions for the Council and to draw up proposals for the Community policy. The other is to implement these decisions in cooperation with the member states, in other words to act as an executive and secretariat. The detailed functioning of the C.A.P. takes up much of the commission's work. For example, Commission officials have to calculate levies on a daily basis for cereals and on a weekly basis for beef, and determine the level of export rebates daily.

The European Parliament (The Assembly): The Parliament, or the Assembly as it is called in the Treaty of Rome, consists of 198 members who are appointed from the parliaments of the Community member countries. France, West Germany, Italy, and the United Kingdom have 36 members each, Belgium and the Netherlands have 14 members each, Denmark and Ireland have 10 members each, and Luxembourg has six members.

The Assembly's main role is to provide opinions on all the proposals which are submitted by the Commission to the Council. The commissioners appear before the Assembly to answer questions, and to explain and defend their policies. The Assembly has the
power to address questions and criticism to the Commission. It also has the power to dismiss the Commission by a two-thirds majority vote.

The Economic and Social Committee (ESC): This is a Community institution consisting of 143 members who are appointed by the governments of their respective countries. One-third of them represent trade unions, and one-third represent employers. The remaining members represent various groups including consumers, farmers, doctors, and shopkeepers.

The ESC's functions are similar to those of the Parliament, but without its powers. Its permanent staff is very small compared with other E.E.C. institutions and its meetings are not reported in the press.

The European Court of Justice: The Court consists of nine judges, one from each member-state, appointed for six-year terms, and two advocates general.

Legal arguments related to the Community's legislation are resolved here. In some cases, the complaint may be raised from the Commission or from a member-state against another member-state or a firm. In other cases, the court may deal with disputes between E.E.C. institutions.

The Agricultural Decision Making Process of the Community

The core of the Community's decision making process is a two-way dialogue between the Council of Ministers and the European Commission
[Commission of the European Communities, the Common Agricultural Policy, 1977, p. 14]. The Commission formulates and draws up policy proposals, but only the Council of Ministers can make those proposals legally binding. That is, neither the Commission nor the Council has unlimited power to make important decisions.

The decision making process can be initiated by requests for action from various parties. Normally, requests come from: the Council, at the request of one of the member states; the thirteen commissioners in a meeting; or the Parliament in a general debate. A small group of officials within the Commission write a first draft. The draft, depending on the subject matter and complexity of the proposal, is sent for discussion to one or more study groups chaired by a Commission official and including mainly civil servants and experts. In consultation with one or two other Commission officials who present, explain, and defend the draft proposal, the study groups help the Commission shape a final draft more or less acceptable to all nine member countries. This initial work typically requires from three months to a year or more.

On agricultural matters, experts from national governments and concerned organizations are invited by the Commission's Directorate General for Agriculture to advise on preparation of draft proposals for submission to the Commission member in charge. This draft proposal then becomes the basis for public discussion. The farmers' and cooperatives' committees of the Community are asked for their views on the proposal by the Commission.
The final draft of a routine or non-controversial proposal is acted on independently by each commissioner and accepted when all thirteen have approved it; a matter of considerable importance is acted on by the Commission as a body. After the Commission has given its formal approval, the proposal is received by the Council Secretariat and distributed to the nine member countries through their permanent representatives. At the same time, it is sent to the Assembly and possibly to the Economic and Social Committee (ESC).

The nine governments examine the draft and return their comments to the Council working groups. At the same time, the Parliament (Assembly) and the ESC prepare their advisory opinions which although not binding, are taken very seriously because the Assembly's opinion represents the opinion of the national parliaments and the ESC opinion reflects the opinion of national employers' organizations and trade unions.

A final decision is reached in a meeting of the nine permanent representatives of the member countries to the Council who act on instructions from their home countries. If a proposal is rejected at this meeting, the Commission withdraws it. If it is accepted unanimously by these permanent representatives, the Council of

These permanent representatives form the Council's supporting body, COREPER. They have diplomatic or senior Civil Service backgrounds and are the "ambassadors" of the member countries to the Community. The Commission proposals, except in rare emergencies, must be considered by COREPER or CSA (Committee of Specialists in Agriculture which consists of the agricultural specialists attached to each Permanent Delegation), before going to the Council.
Ministers usually gives formal approval. If it is accepted by only a majority, then amendments are probably required before the Council gives formal approval. The final product generally comes in the form of a directive, a regulation, or a decision.

A directive sets out an objective to be achieved, leaving the means of implementation to member country governments. A directive usually calls for changes in national legislation within a time limit.

A regulation is applicable in all member states as a law as soon as it has been published in the Official Journal. However, it has to be applied through member states' officials.

A decision settles a particular issue and may be addressed to a government, to an organization, or to an individual.
CHAPTER III. REVIEW OF THE LITERATURE

Previous Work in General Economics: The Theory of Tariffs and Customs Unions

The primary function of the E.E.C., as discussed in Chapter II, has been to create a customs union among its member countries. This involves removing all restrictions on trade among member countries and freeing the flow of commodities among them, while protecting the domestic markets against imports from non-member countries. In this chapter, the effects of and reasons for protection and theory of customs unions will be discussed.

Partial equilibrium effects of a tariff imposition

Partial equilibrium analysis is used in this study mainly because of the complexity involved in a general equilibrium analysis. This complexity can be explained partly by the lack of relevant econometric models and partly by the lack of data required for a general equilibrium analysis. The analysis of the welfare impacts of a tariff imposition will begin with a small country case and then be extended to the large country case.

The small country case

Suppose country A is a small country in the sense that it cannot affect world prices no matter how much it imports, i.e., this country is a price taker in world markets for the good it imports (good x). The welfare impacts of a tariff imposed by this small country in the imported good can be demonstrated by figure 3-1.
In figure 3-1, OW is the world price converted into country A's national currency. This price also represents country A's domestic equilibrium price, assuming zero handling and transportation costs from the exporting country to this country. Country A's domestic export supply curve to country A.

1 Under the small country assumption, WW' represents the world export supply curve to country A.
equilibrium price cannot stay below OW, because any price below the world price will create excess demand in its markets. No foreign suppliers will export to this country because they can sell in other markets at the world price. Therefore, the excess demand in country A will increase the domestic price. Nor can the price go above OW because country A will then become an export target for outside exporters, and excess supply will depress its domestic price. So country A's domestic equilibrium price must be at OW or at the world price level. At this price, the quantity demanded domestically is \( WL = OB \), the quantity supplied domestically is \( WK = OA \), and the excess demand imported from the rest of the world is \( KL = AB \).

Now assume that the government of country A imposes a tariff on imports of good \( x \) by requiring that a payment be made to the customs agent whenever good \( x \) enters its borders. The payment may be in terms of either a fixed amount per unit of imports or a percentage of its foreign price. If the government of country A applies the latter and imposes a tariff of rate \( t \) on imports of commodity \( x \), the domestic price of \( x \) will be increased by \( T = OW \cdot t \). The domestic price will increase by the same amount if the per unit import tariff of \( T \) is applied. In both cases the equilibrium domestic price will be at \( OZ = OW + T = OW(1 + t) \). At the new higher domestic price, quantity demanded has decreased to \( OB' \), quantity supplied has increased to \( OA' \), and thus quantity imported has dropped from \( AB \) to \( A'B' \), i.e. this country has become more nearly self-sufficient in good \( x \). Here, because it is assumed that country A is a relatively
small purchaser of commodity x in world markets, the drop in its imports does not affect the world price. In order to analyze the impacts of a tariff imposition on the welfare of the tariff-imposing country's society, three groups are considered: consumers, producers, and the government.

1) Consumers: Because of the tariff imposition, consumers are going to lose; they will have to pay a higher price (OZ in figure 3-1) for good x than before (OW). As a result, consumers will cut back on their consumption from OB to OB'. The loss in their welfare can be measured by the reduction in consumers' surplus or the area "a + b + e + d."

2) Producers: Producers are going to gain, because after the tariff imposition they will receive a higher price (OZ) than before (OW). Because of the upward sloped supply curve, they will increase the quantity supplied from OA to OA'. The gain in the producers' welfare can be measured by the increase in producers' surplus or the area "a." This area represents a redistribution of income from consumers to producers.

3) The government: As a result of a tariff imposition, the government collects a tariff of \(ZW = CM\) on each unit of good x being imported, and since total imports are \(A'B' = MN\), country A's government collects total revenues of \(CM \cdot MN\), area e in figure 3-1.

Considering the above effects, one could conclude that there is a net loss in social welfare associated with the imposition of a tariff
in a small country case. This is because the rise in domestic price as a result of the tariff imposition reduces consumers' surplus by the area $a + b + e + d$, while it increases producers' surplus by the area $a$, and government revenue by the area $e$. The area $b + d$, then, represents the net social loss from tariffs. This "deadweight loss" is the loss in consumers' surplus that is gained neither by producers nor by the government. However, one should note that in this kind of welfare analysis consumers, producers, and the government are given equal weight in social welfare.

The large country case This is the case in which the country, say country B, is a relatively large importer of good x in international markets so that the reduction in its quantity of imports as a result of a tariff imposition will cause the world price to decrease.¹ The welfare effects of the tariff imposed by a large country are shown in figure 3-2.

In this figure, DD' and SS' represent domestic demand and supply curves for good x in country B. In the absence of trade, equilibrium price and quantity will be at point E. In the case of free trade, assuming that the equilibrium world price is at OW, country B's quantity demanded of good x is WL, quantity supplied is WK, and quantity of import demand is KL. Similar to the small country case, the world price OW will also represent country B's domestic equilibrium price.

¹In this case, country B faces an upward sloping world export supply curve.
assuming zero handling and transportation costs from the exporting
country to country B.

Figure 3-2. The welfare impacts of a tariff imposition for a large
country case

Now suppose that the government of country B imposes a tariff
equal to T on each unit of good x being imported. Again as in the
small country case this tariff imposition will increase country B's
domestic price, increase its quantity supplied, and reduce its quantity
demanded, and, thus, its imports. But unlike the small country case,
since country B is a relatively large importer of commodity x in international markets, the decrease in its import demand will depress the world price. In equilibrium, as is shown in figure 3-2, the world price drops to $OW'$ and the domestic price increases to $OZ = OW' + T$. The quantity supplied increases from $WK$ to $ZC$ and the quantity demanded decreases from $WL$ to $ZU$, and, as a result, the quantity of imports decreases from $KL$ to $CU$.

In order to analyze the effect of the tariff imposition on the welfare of country B's society, the impact of the tariff on consumers, producers, and the government must be considered. As in the small country case, consumers lose in welfare while producers and the government gain. The loss in consumers' welfare can be measured by the reduction in consumers' surplus which is measured, in figure 3-2, by the area $a + b + e + d$. The gain in producers' welfare can be measured by the increase in producers' surplus, measured by the area $a$. The government gains a total revenue equal to the area $e + f$ on CU imports of good x.

Here, unlike the small country case, there might not always be a net social loss because of the tariff imposition. If the area $f$ is greater than the sum of the two triangular areas $b$ and $d$, there will be a net gain for country B as a result of tariff imposition on commodity x. This is the reasoning behind the optimum tariff argument. According to this argument, in some countries tariffs or other trade barriers are used as an instrument to reduce the quantity of imports, thus changing the terms of trade in favor of the tariff-imposing
nation. In this example, the optimum tariff level for country B is that which maximizes the difference between the areas $f$ and $b + d$.

Again, as was noted in the small country case, in this type of welfare analysis we are assuming that consumers, producers, and the government have equal weights in the social welfare function. This assumption makes it possible to compare the loss in consumers' surplus with the gain in producers' surplus and government revenue.

**Arguments advanced for tariff protection**

As was discussed in the previous section (in the large country case), the optimum tariff argument is one explanation of why countries impose tariffs. However, other arguments are advanced for imposing tariffs.

One is the use of tariffs to correct domestic market distortions. As long as there are gaps between private and social benefits and/or costs, private actions may not lead to a socially optimum allocation of resources [Kindleberger, 1978, p. 135]. For example, when externalities involved in production of a good are not reflected in its price, tariffs can be used to affect the relative prices so that the socially optimum level of production is achieved. Some argue that distortions should be corrected rather by those policy tools such as taxes or subsidies that are aimed directly at the cause of distortion. They reason that tariffs may force the country into giving up some of the benefits of free trade and cause it to impose higher prices on consumers [Grubel, 1977, p. 165].
The protection of infant industries has been another argument for imposing tariffs. It is based on the fact that some industries enjoy economies of scale and learn how to produce at lower costs if they are allowed to develop. In some of these industries, however, foreign competition is so keen that the industry does not get a chance to develop unless the government protects the domestic market. A temporary tariff raises domestic prices and reduces imports while the infant industry grows. Note that tariffs based on the infant industry argument should be removed as the industry reaches its optimal size and as firms learn how to produce at low enough costs to compete with foreign production without the help of tariffs.

In many developing countries tariffs are the main source of government revenue. For these countries, revenue can be raised more cheaply through tariffs than through the more elaborate tax systems. Also, government revenues from trade barriers are more indirect and, thus, liable to draw less opposition than taxes [Reed, 1979].

Some also argue that by imposing tariffs and protecting the labor intensive industries from foreign competition, they are protecting the wage rate of workers in these industries. "Recall that the Stolper-Samuelson theorem states that a tariff raises the relative income of the factor of production that is used intensively by the protected good" [Grubel, 1977, p. 166].

Self-sufficiency, independence, and a higher level of employment are other arguments for trade barriers. Trade barriers allow domestic production to increase, leading to a lower level of imports and, as a
result, to more self-sufficiency and less dependence on foreign sources of supply, and to a higher employment level in the protected industry or sector. The self-sufficiency argument becomes especially important for commodities essential to national security and defense. Historically, particularly during the great depression of the 1930's, temporary tariffs have been used to complement or replace monetary or fiscal policies aimed at maintaining full employment. However, this policy has not been very successful since export sales were lost because of partner retaliation to the trade barriers imposed by the country [Grubel, 1977, p. 171]. Also, for countries that have over-crowded cities, employment in rural areas can be increased by raising farm incomes, thus attracting more people into agricultural areas. Farm incomes can be raised by imposing trade barriers on foreign imports of farm products [Reed, 1979, p. 35].

Trade barriers can also be used to improve a country's balance of payments situation. As was explained in the previous section, in the small country case tariffs cause a reduction in imports, and in the large country case tariffs result in a reduction in imports and world prices. In both cases, the decrease in the flow of currency out of the importing country will lead to an improvement in the balance of payments [Reed, 1979, p. 36].

The effective rate of protection

The concept of the effective rate of protection is based on the fact that imposing a tariff on intermediate products along with a
A tariff on final goods will increase the cost of producing the final product and, in turn, will reduce the production-increasing effect of a tariff on final goods [Grubel, 1977, p. 142]. Imposing a tariff on the intermediate product will shift the supply curve to the left by increasing the cost of production. This is shown in figure 3-3, where $S_0'S_0'$ is the original supply curve and $S_1'S_1'$ is the supply curve after imposition of a tariff on inputs.

![Figure 3-3. The effect of a tariff imposed on intermediate and final product when production is increased](image-url)
Without a tariff on either the input or the final product, at the equilibrium world price $OW$ the quantity supplied domestically will be $OA$. Now if a tariff of rate "$T" is imposed on the final product and a tariff of rate "$x" is imposed on the intermediate product, at the equilibrium domestic price $OW'$, the quantity produced domestically will be $OA''$, whereas without any tariffs on inputs the quantity produced domestically would have been $OA'$.

Figure 3-4 demonstrates the case in which tariffs on imported inputs are so high relative to the nominal level of tariffs on the final good that the output has fallen below its original level, a level attained when there were tariffs neither on inputs nor on the final product.

Figure 3-4. The effect of tariff imposed on the intermediate and final product when production is decreased.
By definition, the rate of effective protection\(^1\) for good x is:

\[
g = \frac{v'}{v} - 1
\]

where: \( v \) is the value added\(^2\) under free trade.

\( v' \) is the value added under protection.

Considering that feed grains are intermediate products in livestock production, imposing a tariff on feed grains will cause the effective rate of protection on the livestock to be below the nominal rate.

The theory of customs union

As explained previously, the foundation of a customs union involves eliminating all trade barriers between member countries while establishing a common tariff and other regulations or trade restrictions on trade with non-member countries. The effects of a customs union on member and non-member countries can be divided into static and dynamic effects.

The static effects

Static effects are the effects of formation of a customs union on income and output as a result of the reallocation of a fixed amount of productive resources [Kreinin, 1974, p. 19].

Removing trade barriers between member countries would eliminate discrimination against home-produced products and products produced

\(^1\)For more information on the effective protection refer to Grubel [1977, p. 143] and Kindleberger [1978, p. 114].

\(^2\)Value added is the market price minus the expenditure on primary factors of production.
in partner countries [Balassa, 1961, p. 23]. Such action would stimulate trade among member countries by shifting production from a high-cost home producer to a lower-cost member country producer. This positive effect on trade which does not replace third world imports is called the "trade creation effect." At the same time, because of lower prices of commodities produced in a member country, an expansion in consumption of these products may occur at the expense of less desirable substitute products. This is referred to as the "favorable consumption effect" [Kreinin, 1974, p. 20].

However, establishing trade barriers against non-member countries will give rise to discrimination between commodities produced in a member country and those produced in non-member countries, i.e., it may make it more expensive to import from a third country than from a partner country [Balassa, 1961, p. 23]. Consequently, it may lead to a shift of imports from more efficient non-member producers to less efficient member producers, a negative trade effect known as the "trade diversion effect" [Kreinin, 1974, p. 20]. Trade creation and trade diversion are static effects of a customs union. Positive effects add to the world welfare while negative effects reduce it.\(^1\) Static effects, trade creation and trade diversion, can be illustrated by figure 3-5.\(^2\)

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1 Note that trade creation is a movement towards free trade while trade diversion is a movement away from a free trade position.

2 The following analysis is from Kindleberger [1978, Chapter 9].
In this figure, DD' and SS' represent the domestic demand and supply of a member country. The world price is OW. Begin by assuming that the country under consideration has already imposed a tariff of rate "T" on each unit of the imported good. The domestic equilibrium price is then O\(O_H = OW + T\) and the quantity of imports is MN. Assume further that this is the small country case, that is, this country faces an infinitely elastic world export supply curve at OW. The world price is fixed no matter how much this country's import demand fluctuates.
Now assume that this country joins a customs union. Its partners' supply curve is assumed to be infinitely elastic at OP. Since, before joining the customs union, the future members faced the same tariff level as did non-members, it would have been cheaper for the country under consideration to import from other countries at OW than from the future partners at OP. After forming the union, all the imports come from the partner countries and none from non-members, the reason being that non-member exporters still have to pay the tariff of WH while imports from member countries are free of tariffs. As a result, imports from non-member countries enter the country at the price of OH per unit while imports from other member countries enter at the price of OP per unit. Since it is cheaper to import from members than from non-members and assuming that the partners' export supply curve is also infinitely elastic at the price OP, all the import requirements are satisfied by imports from the partner countries and none from the rest of the world. At OP, the quantity of imports from other member countries is equal to M'N'. The rise in imports from MN to M'N' is the trade creation effect. The welfare gains associated with this trade creation can be measured by the two triangles a and b. Trade diversion is measured by the quantity of MN imports that is shifted from a non-member, low-cost supplier to a high-cost partner. The loss associated with this trade-diversion is measured by area c, which is the increase in the cost of purchasing MN from the partner country. In this example, the net static welfare
effect is the welfare gain (or loss, if negative) equal to the area
"a" plus "b" minus "c."\(^1\)

Note that the above argument is relevant only if the member
country's price (OP) is lower than the world price plus the tariff
(OH). If OP were greater than OH, even after creation of the customs
union, all the import requirements would still be satisfied by imports
from non-member countries and nothing would be imported from partner
countries.

In the E.E.C., trade diversion is more significant than trade
creation in agriculture, and was significantly increased as Britain
became a full member. Before joining the E.E.C., West Germany and
Britain subsidized their agriculture and imported the excess demand
needs from the least expensive sources abroad. But now they have to
divert imports from low cost foreign sources to higher cost supplies
from other members. The United States, the commonwealth countries,
and the producers of tropical products were adversely affected by
this trade diversion effect.

**Dynamic effects of a customs union** Not all welfare gains or
losses are static. Dynamic effects of a customs union may occur
because of enlarged markets. The dynamic impacts on world welfare
may more than offset the negative static effects.

\(^1\)For more discussion of the static welfare effect of customs
union refer to: Kindleberger [1978, Chapter 9].
Upon joining a customs union, member countries enjoy free access to the markets of other partners. Free trade among members and access to a larger market induces specialization and expansion in production which lead in turn to economies of scale. A broader market and lower level of tariffs also make it possible for several sizable firms to function in each industry; thus competition is increased. The combination of increased competition, access to larger markets, and less uncertainty in the investment climate stimulates investment which directly creates new employment and increases income. Moreover, a larger market induces investment in transportation, power, communication, and other elements of the infrastructure which leads in turn to more economic efficiency and growth [Root, 1978, p. 213]. In addition to domestic investment, there may also be foreign investment expansion. Investment from abroad may take place as a result of a rearrangement of the existing foreign investment to take advantage of the broader market. Another kind of foreign investment may be made by the previous exporters to the customs union who now face trade barriers. This is the substitution of "tariff factories for trade" [Kindleberger, 1978, pp. 177-178]. As the growth rate and income in member countries rise as a result of market expansion, then imports from non-member countries will also rise, which should at least partly offset the negative effects of trade-diversion.

With regard to the E.E.C. there have been arguments as to whether its rapid growth rate is caused by the creation of the customs union

The increase in member countries' imports depends on their marginal propensity to import.
or whether it would have happened anyway because of post-war reconstruc-
tion. It has also been argued that trade diversion has unfavorable
dynamic effects for non-member countries of the E.E.C. These un-
favorable effects may offset the positive effects of increased imports
from these non-member countries which would result from the E.E.C.'s
internal growth rate.  

Other forms of economic integration

A customs union is just one form of economic integration.

According to Bela Balassa [1961, p. 2], other forms of economic
integration are the free-trade area, the common market, the economic
union, and total economic integration.

In a free-trade area, all the quantitative restrictions, including
tariffs, are removed on trade among member countries while each country
retains its own tariffs or trade barriers against non-member countries.
The European Free Trade Association represents an industrial free
trade area. However, in a customs union, as was discussed previously,
not only are tariffs between participating countries removed but the
same level of tariffs or other trade restrictions is imposed on trade
with non-members. A customs union becomes a common market when
restrictions on the mobility of factors of production (labor, capital,

\[1\] It is possible that the growth rate of some relatively small
non-member countries depends on the E.E.C. imports of their products.
These countries' growth rates will be adversely affected by the trade
diversion effect. For some non-member countries, the dynamic trade
diversion effect may be more important than the static trade diversion
effects [Kreinin, 1974, p. 23].
etc.) are also abolished. In the E.E.C., language and cultural differences among member countries are the main obstacles to labor mobilities. An economic union involves not only removal of restrictions on factor and product movement but also "... some degree of harmonization of national economic policies, in order to remove discrimination that was due to disparities in these policies" [Balassa, 1961, p. 2]. Total economic integration is the final stage; it requires a single monetary system and unification of all monetary, fiscal, social and foreign policies. That unification requires a supra-national authority responsible for economic policy making. According to Root [1978, p. 198], the E.E.C. is now at the stage of a common market and is moving toward total economic integration (economic union in his definition).

Previous Work in Agricultural Economics

There has not been much work done in rationalizing policy variables such as domestic support prices set by national governments. Instead, most previous work has concentrated on explaining import patterns for individual commodities, with the assumption that the world and domestic prices are exogenous to the system. Moreover, most of these studies have not considered the possibility of domestic prices being different from world prices and, therefore, have ignored the effect of trade barriers.

The GOL (Grains, Oilseeds, Livestock) model [U.S.D.A., Alternative Futures for World Food in 1985, April and June, 1978] is one of the
more general studies in agricultural economics. It was developed by the U.S.D.A. for projections of world feed production, consumption, and trade to 1985. The GOL model covers eleven basic farm products and divides the world into 27 regions: eight developed, three centrally planned, and sixteen developing areas.

In the feed demand-livestock production sector, meat production is a function of meat prices, feed prices, and productivity. Feed demand is specified as a function of appropriate grain prices (to allow competition between feeds), meat prices, and livestock production. The marginal feeding rates\(^1\) constitute the coefficients for livestock products in the feed demand functions. In this model, the six original members of the E.E.C., the EC-6, are considered as one region; and the three new members, the EC-3, as another.

A study by London and Schmidt [1979] attempted to identify the major factors affecting the E.F.C. consumption and imports of major coarse grains: corn, barley, and sorghum. Their work involved:

(1) Examining the trends and patterns of production, utilization, and trade for the principal coarse grains (corn, barley, and sorghum); (2) estimating the Community's future import requirements of coarse grains; (3) quantifying the effects of factors affecting the importation and consumption of coarse grains; and (4) evaluating the effects of the community's current grain policies on trade [1979, p. 2].

This study was conducted for each of the E.E.C. member countries, the EC-6, and the EC-9. From the estimated results, they concluded that the most important factor affecting the Community's imports and

\(^1\) Tons of grain used to produce a ton of livestock product.
consumption of barley and corn had been livestock production. However, in their study neither sorghum imports nor consumption responded to livestock production.

Their work showed that except for the United Kingdom, the import prices of corn and barley had no major impact on imports of these products by the E.E.C. This was to be expected because of the Community's protective system of variable levies which insulates domestic markets from world price fluctuations. They also obtained a competitive relationship between imports of barley and corn on the one hand, and imports of soybean meal on the other. This was attributed to the high level of feed grains' support prices which has accelerated the substitution of lower-cost energy sources for grains in livestock rations.

But despite the C.A.P.'s achievement, they criticized its adverse effect on the economies of member countries:

First, the system failed to bring about any significant improvement in farm income for the smaller farmer. Second, overproduction has caused the consumer not only to pay more for food but also to pay higher taxes in order to remove the surpluses from the markets. Moreover, the CAP distorted international trade in grains and dairy products [London and Schmidt, 1979, p. 28].

They pointed out in addition problems with the use of MCAs such as the financial burdens they have imposed and the gap they have created between agricultural prices among member countries.

The study by Elsheikh [1976] aimed at constructing an economic model for the oilseed sector in the E.E.C. Using annual data from 1952 to 1973, he estimated the structural parameters of this model.
The model was used to make projections for the 1980-85 import demand and to explain the policy implications for Sudan's production and exports of oilseed crops. His study included two models: one for imports of oilseeds and oilseed meal and the other for imports of vegetable oils. In the first model, the import demand for oilseeds and oilseed meal was specified as a linear function of the E.E.C. livestock population, the E.E.C. prices of feed grains, net supply of fishmeal (as a high-protein source of feed, competitive with soybean meal), and the production of oilseeds in the E.E.C. The model was estimated using two stage least squares and ordinary least squares. The general results, which were satisfactory, showed a complementary relationship between oilseeds and oilseed meal on the one hand and feed grains on the other. The prices used in this study are the C.I.F. prices at the European ports.

Many studies in agricultural economics are concerned with U.S. exports to foreign markets with the objective of deriving import demand functions for U.S. products. The research done by Houck and Mann [1968] is a good example. The objective of their study as stated in Houck and Mann [1968, p. 39] was "... to develop theoretical and statistical models of the domestic and foreign markets for U.S. soybeans and soybean products." Their analysis is based mainly on a thirteen-equation simultaneous model of the soybean sector and includes both domestic and foreign markets with the emphasis on the demand side of the market. Total demand for U.S. soybeans is assumed to be the summation of the U.S. crushing industry's demand for beans,
the demand for carry over stocks, and the export demand for beans. The U.S. crushing industry's demand arises because of the demand for soybean meal and soybean oil. Crushing demand for U.S. soybean meal consists of U.S. meal demand and export meal demand. Meal exports are expressed as a function of meal produced in the U.S., the number of soybean meal consuming units in 28 importing nations, and the production of feed grains in soybean importing nations. Their study showed that an acceptable empirical relationship between meal exports and meal prices was difficult to obtain. The soybean export demand is expressed as a function of the U.S. price of soybeans, the U.S. wholesale price of soybean meal, index of personal income in fat and oil importing nations other than the U.S., and production of feed grains in the soybean importing nations.

Both two stage least squares and ordinary least squares were used to estimate the coefficients of this model using crop year (October-September) data from 1946 to 1964. To study the export markets more closely, demand relationships were found for six regions outside the United States: the E.E.C., the non-E.E.C. Europe, Canada, Latin America, Africa, Japan, and the balance of Asia and Oceania. They obtained a significant relationship between E.E.C. soybean meal imports and feed grains' production.

Some research has been done in the past to study the effect of the adoption of the C.A.P. by European member countries on world trade and on U.S. exports in particular. One of these studies is the research project carried on by the U.S.D.A. and Michigan State
University [Ferris et al., 1971]. It examines the effects of the accession of the United Kingdom, Ireland, Denmark, and Norway to the E.E.C. on the United States' agricultural trade. For this purpose, demand analysis and projections, supply analysis, and trade matrices were used for the grain-livestock sector of the countries under consideration. Per capita consumption is estimated as a function of income level, prices of products (including competing products), non-food prices, and trend factors. The estimates for these coefficients were obtained from time-series, cross-sectional, and budget studies. Supply is estimated as a function of prices or gross margins (net returns over input costs) as the key variables. In this study, supply analysis for some countries consisted of acreage and yield equations.

Pagoulatos, Debertin, and Pagoulatos [1978] attempt to evaluate the impact of the C.A.P. on world trade in feed grains through an econometric model. Their model includes a domestic supply, a market demand, and a change in stocks equation for the E.E.C. It also includes an equation for exports to non-E.E.C. countries, one for intra-E.E.C. imports, an equation for imports from the United States, and an equation for imports from the rest of the world. In their study, E.E.C. prices are treated as exogenous to the model. The reason, as they explain, is that prices are fixed each year by the E.E.C. Commission. The grain sector is disaggregated into five commodity groups: wheat, rice, barley, corn, and other grains.
The E.E.C. export supply to the rest of the world is specified as a function of the current E.E.C. product price, product output, and per capita GNP in the rest of the world. Imports from E.E.C. sources are specified as a function of the E.E.C. real per capita GNP, E.E.C. production, and output price. Import demand from the United States is specified as a function of product output in the United States, change in stocks, E.E.C. real per capita GNP, current E.E.C. product prices (consumer, producer, or wholesale price depending on the commodity), and the price of related products. Imports from other non-E.E.C. sources are defined by the following identity:

\[ M_t = PCC_t \cdot POP_t - Q_t + DST_t + X_t - ECM_t - USM_t \]

where:
- \( M_t \) is imports from other non-E.E.C. sources.
- \( PCC_t \) is the E.E.C. per capita market demand.
- \( POP_t \) is total E.E.C. population.
- \( Q_t \) is the E.E.C. production.
- \( DST_t \) is changes in stocks.
- \( X_t \) is the E.E.C. exports to the rest of the world.
- \( ECM_t \) is imports from E.E.C. sources.
- \( USM_t \) is import demand from the U.S.

This model was estimated by three stage least squares using annual data from 1953 to 1972. The estimated equations were then used to obtain the value of E.E.C. intra-trade, imports from the United States, and imports from other non-E.E.C. sources under free trade conditions. The free trade situation was represented by equating
domestic E.E.C. prices to the world prices and estimating the import values. Then, by comparing the import values under free trade with the actual figures from 1968 to 1972\(^1\), they concluded that because of the adoption of C.A.P., domestic production had been stimulated while consumption was discouraged and consequently trade diversion effects were observed.

E. Pagoulatos [1973] investigated the static effects of the C.A.P. on production, consumption, and trade of temperate zone products. The import demand functions were estimated for the E.E.C. for fourteen agricultural commodity groups, for all temperate zone products lumped together, for animals and animal products, and for all cereals and preparations. Pagoulatos' model includes three equations for the E.E.C. import demand: one equation for total E.E.C. import demand, another for the E.E.C. import demand from extra-E.E.C. sources, and a third for E.E.C. import demand from member countries.

The general form of the import demand equation is written as a function of the E.E.C. income level, the previous year's changes in stocks, and the ratio of the E.E.C. producer (or wholesale) price to the world price. This ratio is supposed to capture the C.A.P. margin of protection which can be approximated by the difference between the prices that domestic producers actually receive and those which they would have received if they had been competing with non-E.E.C. producers. The import demand equations were estimated for

\(^1\)This is the period that C.A.P. was in operation.
two time periods. The first is the pre-E.E.C. period (1953-1961) and the second is the post-E.E.C. period (1961-1969). By comparing the income elasticities for pre- and post-C.A.P. periods, Pagoulatos concluded that the evidence of trade creation was shown for all cereals (particularly for wheat, rice, and maize), for dairy products, and food stuffs. He also found trade diversion effects of C.A.P. for all commodities except dairy products, maize, and feed stuffs. From these results he concludes that:

...the formation of the Common Agricultural Policy has considerably affected the pattern of international trade flows by shifting from foreign products to partner-country sources of supply for eleven out of fourteen individual commodity groups studied. This conclusion is in accordance with the theoretical effects of the CAP and the existing empirical evidence [Pagoulatos, 1973, p. 111 & p. 120].

The study by Mike Reed [1979] has taken into account the fact that tariffs cause domestic prices to vary from world prices. Reed estimated the import demand equations for feed grains for six feed grains' importing countries: Greece, Israel, Japan, Portugal, Spain, and the United Kingdom. The analysis was extended to study determinants of foreign sales of U.S. feed grains to these six countries.

The import demand function in his study is specified as an excess demand function, i.e., the difference between domestic demand and supply equations. The domestic feed grains' supply is written as a linear function of current and lagged domestic feed grains' prices and the price of inputs used in feed grains production. The domestic demand for feed grains is specified as a linear function of current domestic
price of feed grains, domestic per capita income, and the size of livestock inventory.

However, unlike many previous studies, prices are not exogenous in his model. Reed also estimates the equation for the domestic price of feed grains. The basis of his analysis for determining the functional form for the domestic prices is the assumption that the governments of the countries can control the domestic price of feed grains by imposing trade barriers on feed grains' imports if the government policies are the only restriction in the feed grains' market [Reed, 1979, pp. 38-39]. To explain government decisions on the level of feed grains' prices, he assumes that the governments simply maximize their utility functions. He further assumes that a government's utility is a function of the value of domestic feed grains' sales, the quantity and the value of feed grains' imports, the government revenue from trade barriers on feed grains, and the amount of consumer surplus. By differentiating this utility function with respect to the domestic price of feed grains and setting it equal to zero, he obtains the functional form for the domestic price of feed grains for the countries under consideration.

Philip Abbott [1979] attempts to capture the effects of government regulations on trade behavior. The model that he develops as he states [1979, p. 23] "will be used to interpret parameters of a net import demand model." In his model he considers the possibility of domestic prices being different from the world prices by tariffs, quotas, or other devices, the levels of which are determined endogenously.
He considers the "release of stock," "consumer prices," and the "producer prices" as instruments that governments can use in controlling domestic markets. After the decisions are made with respect to the level of any of these instruments, a specific trade policy is required to maintain these variables at the desired levels. Abbott explains that foreign exchange flows, the level of domestic production, stocks on hand, and aid in kind received may be factors that determine the levels of these instruments. He reasons that in bad years when production is low or foreign exchange receipts are low, it is very likely that the government of the country would be unwilling to choose and maintain a low domestic price level. Similar reasoning is used for the determination of consumer prices and the net stocks released.

The effects of world prices on domestic markets in his model are shown through their effect on domestic prices. He specifies domestic demand as a linear function of consumer prices, population, national income at constant prices, time trend, and stock of animals. The domestic supply is expressed as a fraction of production. This fraction depends on the urban/rural terms of trade. Variations in the level of production are generally assumed to be predetermined by exogenous factors such as weather. The import demand function is derived as the difference between domestic demand and supply functions. This model was estimated for wheat and feed grains, for thirty-three countries or regions using annual data from 1951 to 1973. But the econometric estimates, as is mentioned in Abbott [1979, p. 28] were
weak "...due to the nature of the available data and the simplifying assumptions involved."
CHAPTER IV. A MODEL FOR THE E.E.C. FEED GRAINS' PRICING

The objective of this chapter is to develop an econometric model that explains the determination of the E.E.C. target prices of feed grains.

The size of the E.E.C. livestock inventory, feed grains' imports,\(^1\) and world prices are among the variables that influence the level of target prices.\(^2\) However, these variables not only affect feed grains' target prices but are themselves affected by the target prices. This happens because the level of target prices affects the level of domestic prices and, thus, quantity demanded, supplied, and imports of feed grains by the E.E.C. And since the E.E.C. is a relatively large importer of feed grains in international markets, any change in its feed grains' import demand also influences the world prices for feed grains by affecting total import demand.\(^3\) Additionally, because feed grains are inputs in livestock production, their target prices influence the size of livestock inventory. Therefore, it is not only a matter of these variables (world prices, livestock inventory, and E.E.C. feed grains' imports) influencing the policy variable (target prices), but also a matter of the policy variable influencing them.

So in order to avoid simultaneous equation bias, the equations for

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\(^1\)As it is used in the rest of this study, feed grains' imports is a measure of quantity and not value.

\(^2\)The effect of these variables on target prices will be discussed later in this chapter.

\(^3\)World feed grains' prices are determined by total world import demand and total world export supply of feed grains.
the E.E.C. feed grains' imports, livestock inventory, and feed grains' world prices are derived and included in the model and are estimated along with the target price equation.

As was mentioned in Chapter I, only the six original member countries are studied in this project and they are treated as one large country.

The E.E.C. Import Demand Function

The quantity of imports at any given time is the difference between the quantities demanded and supplied domestically.

The supply function

The E.E.C. supply function for feed grains is derived by assuming profit maximization by producers. The E.E.C. supply of feed grains \( (SF_t) \)\(^1\) is specified as a function of the current feed grains' target price \( (PT_t) \)\(^2\), the lagged feed grains' market price \( (PM_{t-1}) \), the lagged index of input prices \( (P0_{t-1}) \), the current target price of soft wheat \( (PTW_t) \), and the time trend \( (T) \).

Assuming a linear form for the E.E.C. supply equation, we have:

\[
SF_t = a_0 + a_1 PT_t + a_2 PM_{t-1} + a_3 P0_{t-1} + a_4 PTW_t + a_5 T + e_t \quad (4-1)
\]

From equation 4-1, the current target price level (the target price effective during the harvest time) affects the current level of production and, therefore, the supply of feed grains. This is because,

\(^1\)The subscript "t" denotes time.

\(^2\)All the prices used in this study are nominal prices.
as was explained in Chapter II, target prices are set each year prior to the coming crop year to serve as a guide for farmers who are planning their next year's production. As a result, prices prevailing during harvest time are, to some degree, anticipated by farmers when making planting decisions.

The preceding year's market prices may also affect farmers' planting decisions and, hence, current supplies because the actual market prices may have been below the target prices. Because last year's market prices may be indicative of the current year's market prices, farmers may consider them when making decisions during the planting season.

The lagged index of input prices is included because planting decisions are made six to twelve months before the crop is harvested.

The target price of soft wheat is also included in the E.E.C. supply function because soft wheat is assumed to be a substitute for feed grains when farmers make their planting decisions.

The time trend factor is supposed to capture the effect of technical developments on yield.

As described in Chapter II, E.E.C. policy makers can control the feed grains' domestic prices by using the system of variable levy and support prices: target, threshold, and intervention prices. In other words, because of the C.A.P. regulations on grains, domestic market prices of feed grains follow the target prices. Assuming that the domestic market prices are a linear function of target
prices, one can write:\(^1\)

\[ PM_t = n_o + n_1 PT_t \]  \hspace{1cm} (4-2)

\[ n_1 > 0 \]

By lagging equation 4-2 one period, we have:

\[ PM_{t-1} = n_o + n_1 PT_{t-1} \]  \hspace{1cm} (4-3)

Substituting equation 4-3 for \( PM_{t-1} \) in equation 4-1 we have:

\[ SF_t = a_0' + a_1 PT_t + a_2' PT_{t-1} + a_3 PT_{t-1} + a_4 PTW_t + a_5 T + e_1 \]  \hspace{1cm} (4-4)

where:

\[ a_0' = a_0 + a_2 n_0 \]

\[ a_2' = a_2 n_1 \]

From the nature of the supply curve (upward sloped), one expects \( a_1 \) and \( a_2' \) to be positive. As the current and past levels of prices increase, the quantity supplied is expected to increase. The coefficient \( a_3 \) is expected to be negative because as the cost of

\(^1\)As was explained before feed grains' market prices vary between target price and intervention price (which is set 12-20% below the target price), depending on the demand and supply conditions. So the relationship between market and target price can be more properly presented by a random stochastic model than by a fixed relationship. However, a random stochastic model would make this study very complicated; for simplicity equation 4-2 is used to explain the relationship between market and target prices.
production at the time of planting \((P_{0, t-1})\) increases, the quantity produced should decrease. As the price of soft wheat increases, farmers transfer lands from feed grains to soft wheat, thereby decreasing the quantity of feed grains produced, i.e., \(a_4\) is negative. The coefficient for the time trend \((T)\) is expected to be positive to indicate the technological developments that result in yield increases and, therefore, in production and supply increases.

**The demand function**

The assumptions underlying the E.E.C. demand function for feed grains are profit maximization by producers who use feed grains as an input (producers of livestock products), and utility maximization by consumers who are direct users of feed grains.\(^1\) The E.E.C. demand for feed grains \((DF_t)\) is a function of the domestic market price of feed grains in the Community, the total Community's GDP at constant prices \((Y_t)\), the size of livestock inventory in the EC-6 \((L_t)\), the price of silosed meal in the Community \((POIL_t)\) and the quantity of manioc (Cassava) consumed in the Community \((MA_t)\).

Assuming that the E.E.C. demand function for feed grains is linear, we have:

\[
DF_t = b_0 + b_1 P_{M,t} + b_2 Y_t + b_3 L_t + b_4 POIL_t + b_5 MA_t + e_t
\]  

\(^1\)However, the total grain used in the Community is more greatly influenced by the requirements for animal feed than by those for food. According to London and Schmidt [1979, p. 12] about three-fourths of the coarse grains in the Community are consumed by livestock.
Substituting equation 4-2 for PM\textsubscript{t} in equation 4-5, we have:

\[ DF_t = b'_0 + b'_1PT_t + b'_2Y_t + b'_3L_t + b'_4POIL_t + b'_5MA_t + e_2 \]

(4-6)

where:

\[ b'_0 = b'_0 + b'_1n_0 \]

\[ b'_1 = b'_1n_1 \]

Based on economic theory, as the price of feed grains increases, the quantity demanded should decrease, i.e., \( b'_1 \) is expected to be negative. As the income level increases, in countries with relatively low levels of per capita income the quantity of feed grains demanded for food purposes is expected to increase. However, in countries with higher levels of per capita income, as the income increases there may be a substitution of higher priced commodities for feed grains in the diet [Reed, 1979, p. 32]. Additionally, in all these countries, as the income level increases, the quantity of livestock products demanded will increase, which will lead to an increase in feed grains demanded for feeding purposes. Considering that some E.E.C. countries such as West Germany and the United Kingdom have relatively high levels of income and some countries such as Italy and Ireland have relatively low levels of income, the sign of \( b_2 \) is ambiguous. The sign of \( b_3 \) is expected to be positive since feed grains are used mainly as a source of energy in feed rations.

Imports of oilseed meal, a source of protein in feed rations which can complement feed grains, enter the Community without any tariff or restriction. This has caused the domestic price of oilseed
meal to be equal to the world prices and has encouraged the use of oilseed meal in feed rations in the Community. Also, in recent years, the E.E.C. countries have imported, especially from Thailand, an increasing amount of manioc which bears no trade restriction on its imports.\footnote{The use of manioc in the Community increased eight fold from 1967 to 1978 [London and Schmidt, 1979, p. 3].} Since manioc is a source of energy low in protein, oilseed meals with their relatively high protein content are used by feed compounders along with manioc to assure a nutritionally balanced ration. The mixture of manioc and oilseed meal is then used as a substitute for feed grains.\footnote{According to London and Schmidt [1979, p. 3]: "Normally 1 kilogram of manioc-soybean meal mix (80 percent manioc plus 20 percent soybean meal) can be substituted for 1 kilogram of grain. Since manioc is subject to a duty of only 6 percent ad valorem, the equivalent manioc-soybean meal mix price is lower than that for EC grains."} The sign of $b_4$ is ambiguous because, as mentioned, oilseed meal can complement or substitute for feed grains. The sign of $b_5$ is negative because as the quantity of manioc consumed in the Community increases the demand for feed grains will decrease.

The excess demand function

Now that the E.E.C. supply and demand functions have been specified, the E.E.C. import demand function can be specified as follows:\footnote{Equation 4-7 does not allow for inventory changes. That is, if the governments of member countries or intervention agencies sell or buy any amount of grains, the quantity of imports is equal to the quantity demanded domestically minus the quantity supplied plus changes in inventory. However, since data on the supply of feed grains by the governments of the E.E.C. countries or intervention agencies to the Community's markets were not available, equation 4-7 is used as the import demand equation for feed grains.}
\[ IF_t = DF_t - SF_t \]  

(4-7)

where \( IF_t \) is the quantity of feed grains imported by the E.E.C.

Substituting equations 4-6 and 4-4 into equation 4-7 and manipulating the results, we have:

\[ IF_t = C_0 + C_1 PT_t + C_2 PT_{t-1} + C_3 Y_t + C_4 L_t + C_5 POIL_t + C_6 PO_{t-1} \]
\[ + C_7 PTW_t + C_8 T + C_9 MA_t + e_3 \]  

(4-8)

where: \( c_0 = b_0' - a_0', c_1 = b_1' - a_1, c_2 = -a_2', c_3 = b_2, c_4 = b_3, c_5 = b_4, c_6 = -a_3, c_7 = -a_4, c_8 = -a_5, c_9 = b_5 \)

To capture the effect of the C.A.P. adoption by member states in 1967, a dummy variable (Dl) was added to the import demand equation 4-8. The data used in this study cover the years 1962/63 through 1978/79. From 1962/63 to 1966/67, each member country had its own agricultural policy and support prices. However, from 1967/68 onward, the six original members adopted the same level of support prices (threshold, target, and intervention prices). Therefore, the value of Dl was set equal to zero for the years 1962/63 through 1966/67 and equal to one for the years 1967/68 through 1978/79.

Equation 4-9 is the import demand equation including Dl.

\[ IF_t = c_0 + c_1 PT_t + c_2 PT_{t-1} + c_3 Y_t + c_4 L_t + c_5 POIL_t + c_6 PO_{t-1} \]
\[ + c_7 PTW_t + c_8 T + c_9 MA_t + c_10 Dl + e_3 \]  

(4-9)
The Livestock Inventory

The C.A.P. with respect to livestock products

As in the case for grains, the C.A.P. for livestock products is based on removing the quotas, subsidies, and other trade barriers among member countries while imposing a set of price regulations for these products. This involves applying import levies and export subsidies on imports or exports of these commodities from or to non-member countries. Thus, each type of livestock product has some sort of support system and is governed by market regulations. As a result, prices for livestock products are not determined by supply and demand conditions but are more or less set by the E.E.C. policy makers' decisions.

Because of the time and data limitations, this study does not develop an economic rationale for the E.E.C. decisions on livestock products' support prices. This study does, however, provide a partial policy analysis, treating the feed grains' support prices as endogenous while assuming livestock products' support prices to be exogenous.

The livestock inventory equation

The E.E.C. livestock inventory equation is obtained from "current" and "expected" profit maximization by producers. The word "expected" is used because of the time lag between a change in livestock inventory and a change in the production of livestock products. In other words, there is a lag between the time that the animal is born and the time that it is mature enough to produce livestock products. Therefore,
at the time that the additional unit is added to the inventory of livestock, the producers do not know what the value of the production from that unit will be when the animal is mature enough to produce livestock products. The length of the time lag depends on the type of livestock. Cattle inventory changes affect the production of beef or milk after about nine months whereas poultry inventory changes can affect production of broilers and eggs in less than three months [Reed, 1979, p. 53].

By the time the animal is mature enough to produce livestock products, "current" profits or revenues influence the decision on whether or not the animal should be kept in inventory. In cases in which livestock production can occur without inventory depletion, such as in milk and egg production, the animal is kept in inventory if current revenues exceed current costs. Meat production, however, necessarily implies inventory depletion. After the animal reaches a weight at which it can be slaughtered, current as well as expected profits influence the decision as to whether or not the animal should be kept. If profits from slaughtering the animal in the future when it has gained additional weight exceed profits from slaughtering it immediately, the animal may be kept in inventory [Reed, 1979].

Thus, "expected" as well as "current" profits influence the decision on the size of the livestock inventory. With this in mind, the E.E.C. livestock inventory equation is specified as:

\[ L_t = g_0 + g_1 P_{1t} + g_2 P_{1t} + g_3 P_{2t} + g_4 P_{3t-1} + g_5 P_{4t-1} + g_6 P_{5t-1} + e_4 \]  

(4-10)
where: $L_t$ is the size of livestock inventory at time $t$ (current).

$PT_t$ and $PT_{t-1}$ are current and lagged feed grains' target prices.

$PL_t$ and $PL_{t-1}$ are current and lagged prices received by producers for livestock and livestock products.

$PLO_t$ and $PLO_{t-1}$ are current and lagged prices of other inputs (other than feed grains) used for livestock production.

One period lagged input and output prices are included because they helped determine last period's "expected" and "current" profits and, therefore, the size of livestock inventory at that time. Since the size of the livestock inventory during the previous period influences the current size of the livestock inventory, these variables (lagged input and output prices) are included in the equation for $L_t$.

Present values of these variables (input and output prices for livestock production) are included because they help determine "expected" and "current" profits of this period's inventory change.

The signs of the coefficients on all the variables in equation 4-10 depend on the structure of expectations. If it is assumed that the future pattern of change in prices follows the present pattern (that is, prices would be expected to increase in the future if they are increasing in the present), then $g_1$, $g_3$, $g_4$, and $g_6$ are negative while $g_2$ and $g_5$ are positive. This is so because as the cost of holding a given livestock inventory ($PT_t$, $PT_{t-1}$, $PLO_t$, $PLO_{t-1}$)
increases and it is expected to increase in the future, everything else being constant, the size of the livestock inventory should decrease. As the price of livestock products \( (PL_t \text{ and } PL_{t-1}) \) increases, everything else being constant, the size of the livestock inventory should increase. This is because current and expected future profits from livestock production are expected to increase.

World Prices for Feed Grains

It is assumed that the world price of feed grains is determined by the E.E.C. feed grains' import demand and the rest of the world's\(^1\) feed grains' export supply.

The export supply of the rest of the world depends on the supply by the rest of the world and the demand by the rest of the world for feed grains. World production depends to a large extent on weather and technology factors which are very difficult to measure, and also on factors which affect production decisions during the planting season. Thus, each period's supply is predetermined by the decisions made during the previous period; hence, in this study it will be assumed that the rest of the world's production of feed grains is exogenous to the system. The quantity of feed grains supplied by the rest of the world \( (SFROW_t) \) is specified as a linear function of production in the rest of the world \( (PROW_t) \):

\(^1\) The rest of the world includes all the countries in the world except the six original E.E.C. member countries.
\[ SFROW_t = b_0'' + b_1''PROW_t \]  
(4-11)

where:

\[ b_1'' > 0 \]

The quantity demanded of feed grains in the rest of the world (DFROW\(_t\)) depends upon the world price of feed grains (PI\(_t\))\(^1\) and real income\(^2\) of the rest of the world (YROW\(_t\)). Assuming a linear form for the demand function we have:

\[ DFROW_t = a_0'' + a_1''PI_t + a_2''YROW_t \]  
(4-12)

The export supply by the rest of the world to the E.E.C. (EROW\(_t\)) is specified as the difference between the supply and demand functions of the rest of the world.

\[ EROW_t = SFROW_t - DFROW_t \]  
(4-13)

The quantity of E.E.C. imports from the rest of the world (IEC\(_t\)) is the difference between the E.E.C. demand (DEC\(_t\)) and supply (SEC\(_t\)) of feed grains. Assuming a linear form for the E.E.C. demand, supply, and, therefore, import demand of feed grains, we have:\(^3\)

\[ DEC_t = c_0 + c_1PT_t + e \]  
(4-14)
\[ SEC_t = d_0 + d_1PT_t + e \]  
(4-15)
\[ IEC_t = DEC_t - SEC_t \]  
(4-16)

Based on economic theory, \(c_1\) has a negative sign while \(d_1\) has a positive sign.

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\(^1\)Note that for consistency all the prices in this study including the world price are expressed in terms of units of account.

\(^2\)Gross Domestic Product (GDP) at constant prices.

\(^3\)Here, for simplicity, a simpler form than equation 4-4 and 4-6 will be used to present the E.E.C. feed grains' demand and supply functions.
The equilibrium world price of feed grains is determined by equating (4-13) and (4-16), the rest of the world's export supply and the E.E.C.'s import demand for feed grains.

\[ E_{ROW_t} = IEC_t \]  \hspace{1cm} (4-17)

Substituting equations 4-13 and 4-16 for equation 4-17 we have:

\[ SF_{ROW_t} - D{FROW_t} = DEC_t - SEC_t \]  \hspace{1cm} (4-18)

Substituting equations 4-11, 4-12, 4-14, and 4-15 into equation 4-18 and manipulating the results yields:

\[ P_{t} = J_o + J_1 P_{ROW_t} + J_2 Y_{ROW_t} + J_3 P_{T_t} + e \]  \hspace{1cm} (4-19)

where:

\[ J_o = \frac{b'' - c_o}{a_1''}, \quad J_1 = \frac{b''}{a_1''}, \quad J_2 = \frac{-a_2''}{a_1''}, \quad J_3 = \frac{d_1 - c_1}{a_1''} \]

Based on economic theory, \( J_1 \) is expected to be negative. As production of feed grains in the rest of the world increases, other things remaining the same, the world supply will increase, depressing the world price of feed grains.

The increase in the world's income may have a depressing or elevating effect on feed grains' world price. This increase in income may be due either to an increase in population, which will increase the total demand and, thus, the world price of feed grains, or to an increase in per capita income. In the latter case, in countries with a higher level of per capita income, there may be a

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Because of data problems, when estimating equation 4-19, instead of using the data on real GDP for the rest of the world, the data on real GDP for the whole world (including EC-6) were used. This is justified because the GDP for the whole world can capture the effect of the E.E.C.'s GDP as well as the rest of the world's GDP on total world demand for feed grains.
substitution of higher priced commodities for feed grains in the diet, reducing the quantity demanded by that country and depressing world prices. But in developing countries, with a lower level of per capita income, an increase in per capita income will raise the demand for feed grains and feed grains' world price. Increased per capita income will create higher demand for livestock products, increasing the demand for feed grains to be fed to livestock and, in turn, increasing the feed grains' prices. As a result the sign of $J_2$ is ambiguous.

The sign of $J_3$ is expected to be negative. As the E.E.C. target prices increase, the quantity demanded domestically in the E.E.C. will decrease, the quantity supplied will increase, and, everything else remaining the same, the quantity of import demand by the E.E.C. will decrease. Since the E.E.C. is a relatively large importer of feed grains, this decrease in its quantity demanded from the rest of the world, everything else being constant, will have a depressing effect on world prices.

A Model for E.E.C. Feed Grains' Pricing

In order to identify the factors affecting target prices of feed grains, it is assumed that the E.E.C. policy makers set the target prices each year so that their utility function is maximized.

In this study, the countries included in the E.E.C. are the six original members, some of which are net producers and some of which are net consumers of feed grains. Although their interests in target prices may be competitive or complementary, since the target prices
are "common" throughout the E.E.C. one utility function is assumed for the whole. The assumption of the existence of the E.E.C. utility function and the assumption that the feed grains' target prices are set each year by the Commission so that this utility function is maximized are used for the derivation of an equation for feed grains' target prices. The explanation of the E.E.C. policy makers' behavior is assumed to be the same as it would be if they were maximizing a utility function.1

The variables included in the utility function stem from the objectives of the Common Agricultural Policy2 and the welfare impacts of tariffs on consumers, producers, and the government of the tariff imposing country.3 These variables are as follows:

(a) Producers' income from feed grains' production \((PT_t \cdot SF_t)\).4 This variable has a positive effect on the utility function.

1 Friedman in "The Methodology of Positive Economics" (1953) discusses the use of "as if" assumptions. He "examines the question of the relevance of the falsity of assumptions for the various uses of theories. That is, what if one could show that an assumption is false? Does it matter? He says that as long as the observed phenomenon can be considered to be a logical conclusion from the argument containing the false assumption in question, the use of that assumption should be acceptable." [Boland, 1979, pp. 512-513]. Note that it is not a purpose of my study to examine whether one utility function exists for the whole E.E.C. or to estimate the E.E.C. policy makers' utility function, but rather to derive and estimate the feed grains' target price function.

2 These objectives were listed in Chapter II, pp. 16-17.

3 The welfare impacts of tariffs are explained in Chapter III, Section 1, pp. 47-54.

4 The product of \(PT_t\) and \(SF_t\) represents producers' income assuming the prices that producers receive are equal to target prices.
(b) The quantity of feed grains' imports from non-member countries \((IF_t)\). This term represents the E.E.C.'s level of self-sufficiency in feed grains, and it has a negative effect on the utility function. The larger the quantity of feed grains' imports, the greater the dependence of the E.E.C. on foreign sources, and, therefore, the lower the value of the utility function, everything else remaining constant.

(c) The value of imports \((PI_t \cdot IF_t)\) that is the amount of foreign exchange that the E.E.C. has to pay for feed grains' imports. This variable also has a negative effect on the utility function because larger values of imports result in higher deficits in the E.E.C.'s balance of payments, which, in turn, lower the value of the utility function, everything else remaining the same.

(d) The government revenue from the variable levy \((TT_t)\). This term has a positive effect on the utility function. The amount of revenue that the government receives from the variable levy is the difference between the threshold and the world price multiplied by the quantity of feed grains' imports.

\[
TT_t = (PTh_t - PI_t) \cdot IF_t \quad (4-20)
\]

where:

- \(PTh_t\) is the feed grains' threshold price at time \(t\).
- \(PI_t\) is the world price of feed grains at time \(t\).
- \(IF_t\) is the quantity of feed grains being imported at time \(t\).
- \((PTh_t - PI_t)\) is the variable levy charged on each unit of imports into the Community at time \(t\).
The threshold price can be written in terms of the target price by subtracting from the target price the cost of handling and transporting grain from Rotterdam to Duisburg that is:

\[ P_{Th_t} = P_{T_t} - Tr \]  \hspace{1cm} (4-21)

where \( Tr \) is the cost of handling and transporting grain from Rotterdam to Duisburg.

Substituting equation 4-21 for \( P_{Th_t} \) in equation 4-20, we have:

\[ TT_t = (P_{T_t} - Tr - P_{I_t}) \cdot IF_t \]  \hspace{1cm} (4-22)

(e) Consumers' surplus (\( CS_t \)), which has a positive affect on the utility function. The higher the level of consumers' surplus, the higher the value of the utility function, everything else remaining constant.

By definition, consumers' surplus is the difference between what individuals are willing to pay and what they actually pay for each unit of the commodity consumed. It is measured by the area under the demand curve and above the price line. Figure 4-1 shows the consumers' surplus.

At the price \( P_{T_t} \), consumers' surplus is the triangular area \( PN_{tPT_t}A \). Assuming a linear demand function, consumers' surplus is half the area \( PN_{tPT_t}AB \) or:

\[ CS_t = \frac{1}{2} (PN_{t} - P_{T_t}) \cdot DF_t \]  \hspace{1cm} (4-23)

where: \( PN_{t} \) is the price at which quantity demanded is zero.

\( P_{T_t} \) is the target price which is assumed to be equal to the market price at time \( t \).
Figure 4-1. The demand curve and consumers' surplus

$DF_t$ is the quantity demanded at the market price $PT_t$ at time $t$.

In order to obtain the equation for $PN_t$, in the equation 4-6 $PN_t$ is substituted for $PT_t$ and the resulting demand equation is set equal to zero and is solved for $PN_t$. The resulting equation for $PN_t$ is:

$$PN_t = -\frac{b_0}{b_1} - \frac{b_2}{b_1} PT_t - \frac{b_3}{b_1} L_t - \frac{b_4}{b_1} P_{2t} - \frac{b_5}{b_1} M_t - \frac{e_2}{b_1}$$

(4-24)

Considering a linear function for the E.E.C. policy makers' objective function we have:

$$U_t = d_1 PT_t \cdot SF_t + d_2 IF_t + d_3 PI_t \cdot IF_t + d_4 TT_t + d_5 CS_t + e_5$$

(4-25)

$d_1 > 0 \quad d_2 < 0 \quad d_3 < 0 \quad d_4 > 0 \quad d_5 > 0$

Assuming that the E.E.C. policy makers set the target prices at the level that maximizes their objective function, the feed grains' target price equation is obtained by setting the partial derivative of the utility function, equation 4-25, with respect to target price.
equal to zero and solving the resulting equation for the target price (First Order Condition).  

**First order condition**

\[
\frac{\partial U_t}{\partial P_t} = d_1 SF_t + d_1 PT_t \cdot \frac{\partial SF_t}{\partial P_t} + d_2 \frac{\partial IF_t}{\partial P_t} + d_3 \frac{\partial IF_t}{\partial P_t} \cdot P_t + \\
d_3 \frac{\partial IF_t}{\partial P_t} + d_4 \frac{\partial IF_t}{\partial P_t} + d_5 \frac{\partial IF_t}{\partial P_t} = 0
\]  

(4-26)

From equation 4-4:

\[
\frac{\partial SF_t}{\partial P_t} = a_1
\]  

(4-27)

From equation 4-9:

\[
\frac{\partial IF_t}{\partial P_t} = c_1 + c_4 \frac{\partial L_t}{\partial P_t}
\]  

(4-28)

From equation 4-10:

\[
\frac{\partial L_t}{\partial P_t} = g_1
\]  

(4-29)

Substituting from 4-29 for \(\frac{\partial L_t}{\partial P_t}\) in 4-28 we have:

\[
\frac{\partial IF_t}{\partial P_t} = c_1 + c_4 \cdot g_1
\]  

(4-30)

For simplicity we assume the \(c_1 + c_4 \cdot g_1 = \varepsilon\)  

(4-31)

The sign of \(\varepsilon\) is negative.

---

1Here, for simplicity, the effect of the target price on the future level of utility has not been considered. That is, since the lagged level of target price, through its effect on supply influences the current level of utility, the present level of the target price will also influence the future level of utility. For a more precise analysis, the present value of the future stream of utilities as well as the present level of utility should be included in the welfare function. This so-called welfare function could then be maximized with respect to target price.
Rewriting 4-30 we have:

\[
\frac{\partial IF_t}{\partial PT_t} = \epsilon \tag{4-32}
\]

From equation 4-19:

\[
\frac{\partial PI_t}{\partial PT_t} = J_3 \tag{4-33}
\]

From equation 4-22:

\[
\frac{\partial TT_t}{\partial PT_t} = \left(1 - \frac{\partial PI_t}{\partial PT_t}\right) \cdot IF_t + (PT_t - Tr - PI_t) \cdot \frac{\partial IF_t}{\partial PT_t} \tag{4-34}
\]

Substituting 4-33 and 4-32 for \(\frac{\partial PI_t}{\partial PT_t}\) and \(\frac{\partial IF_t}{\partial PT_t}\) in equation 4-34 we have:

\[
\frac{\partial TT_t}{\partial PT_t} = (1 - J_3) \cdot IF_t + (PT_t - Tr - PI_t) \cdot \epsilon \tag{4-35}
\]

From 4-23 we have:

\[
\frac{\partial CS_t}{\partial PT_t} = \frac{1}{2} \left[ \frac{\partial PN_t}{\partial PT_t} - 1 \right] \cdot DF_t + \frac{1}{2} \left[ PN_t - PT_t \right] \cdot \frac{\partial DF_t}{\partial PT_t} \tag{4-36}
\]

From equation 4-24:

\[
\frac{\partial PN_t}{\partial PT_t} = \frac{-b_3}{b'_l} \cdot \frac{\partial L_t}{\partial PT_t} = \frac{-b_3}{b'_l} \cdot g_1 \tag{4-37}
\]

From equation 4-6:

\[
\frac{\partial DF_t}{\partial PT_t} = b'_l + b_3 \cdot \frac{\partial L_t}{\partial PT_t} = b'_l + b_3 \cdot g_1 \tag{4-38}
\]

Substituting for \(\frac{\partial PN_t}{\partial PT_t}\) and \(\frac{\partial DF_t}{\partial PT_t}\) and \(PN_t\) from equations 4-37, 4-38, and 4-24 in 4-36 we have:
By dividing equation 4-6 by \((-b'_1)\) we have:

\[
\frac{DF}{b'_1} = \frac{-b'_0 - PT_t - b'_2 Y_t - b'_3 L_t - b'_4 POIL_t - b'_5 MA_t}{b'_1} = \frac{-e_2}{b'_1} - \frac{DF}{b'_1}
\]

(4-40)

Substituting \(\frac{DF}{b'_1}\) for all the factors in the bracket \(A\) in equation 4-39 we have:

\[
\frac{3CS_t}{\partial PT_t} = \frac{1}{2} \left[ -\frac{b'_3}{b'_1} g_1 - 1 \right] DF_t + \frac{1}{2} \left[ \frac{-b'_0}{b'_1} - \frac{b'_2}{b'_1} Y_t - \frac{b'_3}{b'_1} L_t - \frac{b'_4}{b'_1} POIL_t - \frac{b'_5}{b'_1} MA_t \right] \cdot \left[ b'_1 + b'_3 g_1 \right] \cdot (4-39)
\]

For simplicity from now on the term \(\frac{b'_3 g_1}{b'_1} + 1\) is referred to as "p" which has a positive sign.

Equation 4-41 can now be re-written as:

\[
\frac{3CS_t}{\partial PT_t} = -pDF_t = -p'_0 - p'b'_1 PT_t - p'b'_2 Y_t - p'_3 L_t - p'_4 POIL_t\]

\[-p'b'_5 MA_t\]

(4-42)

By substituting equations 4-4, 4-27, 4-32, 4-33, 4-35, and 4-42 into equation 4-26 we have:
\[
\frac{3U_t}{\delta PT_t} = d_1 [a'_o + a_1 PT_t + a'_2 PT_{t-1} + a_3 PTW_t + a_5 T
+ e_1] + d_1 PT_t \cdot a_1 + d_2 e + d_3 \cdot \epsilon \cdot PI_t + d_3 \cdot J_3 \cdot IF_t +
\]
\[
d_4 (1 - J_3) IF_t + d_4 \cdot (PT_t - Tr - PI_t) \cdot \epsilon + d_5 [-pb'_o - pb'_1 PT_t
- pb_2 Y_t - pb_3 L_t - pb_4 POII_t - pb_5 MA_t - pe_2] = 0 \quad (4-43)
\]

Now by solving for PT_t we obtain:
\[
PT_t = \frac{(d_1 a'_o + d_1 e_1 + d_2 e - d_5 pb'_o - d_5 pe_2)}{\Delta} - \frac{d_1 a'_2}{\Delta} PT_{t-1}
\]
\[
+ \frac{d_1 a_3}{\Delta} PO_{t-1} - \frac{d_1 a_4}{\Delta} PTW_t - \frac{d_1 a_5}{\Delta} T - \frac{(d_3 \epsilon - d_4 \epsilon)}{\Delta} PI_t
\]
\[
- \frac{(d_3 J_3 + d_4 - d_4 J_3)}{\Delta} IF_t + \frac{d_5 pb_2}{\Delta} Y_t + \frac{d_5 pb_3}{\Delta} L_t + \frac{d_5 pb_4}{\Delta} POII_t +
\]
\[
\frac{d_5 pb_5}{\Delta} MA_t + \frac{d_4 \epsilon}{\Delta} Tr \quad (4-44)
\]

where: \( \Delta = 2d_1 a_1 + d_2 \epsilon \cdot \epsilon \cdot pb_5 b'_1 \)

or we can unite:
\[
PT_t = \frac{\gamma_0}{\Delta} + \frac{\gamma_1}{\Delta} PT_{t-1} + \frac{\gamma_2}{\Delta} PO_{t-1} + \frac{\gamma_3}{\Delta} PTW_t + \frac{\gamma_4}{\Delta} T + \frac{\gamma_5}{\Delta} PI_t
\]
\[
+ \frac{\gamma_6}{\Delta} IF_t + \frac{\gamma_7}{\Delta} Y_t + \frac{\gamma_8}{\Delta} L_t + \frac{\gamma_9}{\Delta} POII_t + \frac{\gamma_{10}}{\Delta} MA_t + \frac{\gamma_{11}}{\Delta} Tr \quad (4-45)
\]
\[
\gamma_1, \gamma_4, \gamma_5, \gamma_6, \gamma_{10}, \gamma_{11} < 0 \quad \gamma_8, \gamma_2, \gamma_3 > 0 \quad \gamma_7, \gamma_9 \geq 0
\]

Since data on Tr, transportation and handling cost, were not available, time trend was used as a proxy for Tr. Therefore, in equation 4-45, \( \frac{\gamma_{11}}{\Delta} \) Tr is removed and \( \frac{\gamma_4}{\Delta} T \) is supposed to capture its effect on PT_t.

The sign of \( \Delta \) is undetermined. But assuming that the sign of \( \Delta \) is positive we will have:
\[ PT_t = e_0 + e_1 PT_{t-1} + e_2 PO_{t-1} + e_3 PTW_t + e_4 T + e_5 PI_t + e_6 IF_t \\
+ e_7 Y_t + e_8 L_t + e_9 POIL_t + e_{10} MA_t \]  
\[ (4-46) \]

\[ e_1, e_4, e_5, e_6, e_{10} < 0 \quad e_2, e_3, e_8 > 0 \quad e_7, e_9 \neq 0 \]

That is, if \( A \) is positive the sign of \( e_1 \) (the coefficient for lagged feed grains' target price) is negative which indicates that as the previous period's target price increases, the previous period's supply increases and demand decreases. Therefore, the policy makers set the current target prices lower to increase the quantity demanded and to reduce the quantity supplied. Also, if \( A > 0 \), the sign of \( e_2 \) (the coefficient for input prices) is positive. That seems quite rational because as the cost of producing feed grains increases, the policy makers will set the target prices higher to compensate producers for the increased cost. If \( A > 0 \), the sign of \( e_3 \) (the coefficient for the soft wheat target price) is positive, which shows that if the price of soft wheat (which is supposed to be a substitute for feed grains' production) increases, the target prices for feed grains are set higher in order to prevent producers from transferring their production from feed grains to soft wheat. If \( A > 0 \), the sign of \( e_4 \) (the coefficient for time trend) is negative, which means as yield increases because of technological developments over time, the target prices will be set lower to prevent surpluses.

Since \( PI_t \) (world price of feed grains), \( IF_t \) (E.E.C. imports of feed grains), and \( L_t \) (the E.E.C. livestock inventory) are endogenous
to the system, not much could be said about the positive or negative effect they have on target prices.

The sign of $e_{10}$ (the coefficient for manioc consumed in the Community) is negative if $A > 0$. This may indicate that as the quantity of manioc consumed in the Community increases, the target price for feed grains will be set lower to encourage more consumption of feed grains in the Community.

Second order condition

The second order condition for utility maximization requires that \[ \frac{\partial^2 U_t}{\partial P_t^2} \] to be negative. For the specified utility function:

\[
\frac{\partial^2 U_t}{\partial P_t^2} = 2d_1a_1 + d_4e - d_5p_1 - d_5p_3 \cdot \frac{\partial L_t}{\partial P_t} + (d_3e - d_4e) \cdot \frac{\partial F_t}{\partial P_t}
\]

Substituting equations 4-29, 4-33 and 4-32 into the appropriate places we have:

\[
\frac{\partial^2 U_t}{\partial P_t^2} = 2d_1a_1 + 2d_4e + 2d_3eJ_3 - 2d_4eJ_3 - d_5p_1 - d_5p_3g_1
\]

The sign of \[ \frac{\partial^2 U_t}{\partial P_t^2} \] is undetermined.

Since $A = 2d_1a_1 + d_4e - pd_5b_1$ then:

\[
\frac{\partial^2 U_t}{\partial P_t^2} = A + d_4e + 2d_3eJ_3 - 2d_4eJ_3 - d_5p_3g_1
\]
From the second order condition, we cannot really say anything about the sign of \( \Delta \). Delta can be positive or negative and still satisfy the second order condition.

The General Model (Model 4-1)

The general model that will be investigated in this study is simultaneous and consists of four equations for the EC-6. The general model is:

\[
IF_t = C_0 + C_1PT_t + C_2PT_{t-1} + C_3t + C_4L_t + C_5POIL_t + C_6PO_{t-1} + C_7PTW_t + C_8T + C_9MA_t + C_{10}Dl + e_3
\]

\[
L_t = g_o + g_1PT_t + g_2PL_t + g_3PLO_t + g_4PT_{t-1} + g_5PL_{t-1} + g_6PLO_{t-1} + e_4
\]

\[
PI_t = J_0 + J_1PROW_t + J_2YROW_t + J_3PT_t + e
\]

\[
PT_t = e_o + e_1PT_{t-1} + e_2PO_{t-1} + e_3PTW_t + e_4T + e_5PT_t + e_6IF_t + e_7Y_t + e_8L_t + e_9POIL_t + e_{10}MA_t
\]

The endogenous variables in the general model are: \( IF_t \), \( L_t \), \( PI_t \), and \( PT_t \). The predetermined variables are \( PT_{t-1} \), \( Y_t \), \( POIL_t \), \( PO_{t-1} \), \( PTW_t \), \( T \), \( MA_t \), \( Dl \), \( PL_t \), \( PLO_t \), \( PL_{t-1} \), \( PLO_{t-1} \), \( PROW_t \), and \( YROW_t \).
CHAPTER V. DATA

Because feed grains and livestock are not homogenous commodities, and because in this project all types of feed grains are studied as a single unit and all types of livestock as another single unit, a way must be developed to aggregate the data on prices and quantities of these variables. This chapter describes the aggregation methods used in this study as well as the construction and sources of data.

Aggregations

The aggregation for feed grains

In order to aggregate all types of feed grains (corn, barley, sorghum, oats and rye), they have to be converted into a common unit. The unit used in this study is "feed unit."

Feed Unit (FU):^1

Definition: Feed Unit is the feed value of one kilogram of barley.

Coefficients: To convert each type of feed grains into feed units, the following coefficients were used:^2

1 kilogram of rye = 1.02 FU
1 kilogram of corn = 1.11 FU

^1Information about definition and conversion coefficients is from John Dunmore, Situation and Outlook Section, Western Europe Branch, International Economic Division, U.S.D.A.

^2The quantity of each type of feed grains is multiplied by the relevant coefficient.
1 kilogram of barley = 1.00 FU
1 kilogram of sorghum = 0.95 FU
1 kilogram of oats = 0.81 FU

These coefficients can be reproduced by dividing the data on production and imports of each type of feed grains expressed in feed units by the relevant data expressed in product weight (1000 metric tons).

The aggregation of livestock inventories, $L_t$

The data for livestock inventory were available for the numbers of cattle, hogs, sheep and goats, all in units of thousand heads; poultry meat production in units of thousand metric tons; and number of eggs in units of millions of eggs. In order to aggregate all of the above, each type of livestock, poultry meat, and eggs was converted into livestock units:

Livestock Unit (LU): $^2$

Definition: One livestock unit consumes 2600 kilograms of feed units, the amount required to maintain a dairy animal's body and its milk production, i.e., 2600 feed units are required to maintain one livestock unit.

---

1 The source of data is The Statistical Office of the European Communities, Eurostat, Feed Balance Sheet [1976].

2 Information about definition and conversion coefficients is from John Dunmore, Situation and Outlook Section, Western Europe Branch, International Economic Division, U.S.D.A.
Coefficients: The coefficients for converting each type of livestock to livestock units are as follows:\(^1\)

1.29 cattle = 1.00 LU
4.05 pigs = 1.00 LU
0.785 [poultry meat (in metric tons) + eggs (in metric tons)] = 1.00 LU
10.2 sheep and goats = 1.00 LU
1 horse = 1.00 LU

These coefficients can be reproduced by dividing data for cattle, pigs, sheep and goats expressed in thousand of heads by the data stated in livestock units.\(^2\) Also the coefficient for poultry meat and eggs can be reproduced by dividing the data for eggs and poultry meat in metric tons, by poultry in livestock units. The calculation was done for the period of 1973-1977 and for the data for EC-9.

The data on eggs were reported in terms of thousands of eggs. In order to convert eggs into LUs, data should be converted from number of eggs to metric tons of eggs. The conversion factor was calculated by dividing the data for eggs in metric tons by the data...\(^1\)

\(^1\)FAO, Production Yearbook also gives similar conversion factors for the whole world in general, as:

- Buffalo, horses, and mules = 1.0
- Cattle and asses = 1/0.8 = 1.25
- Pigs = 1/0.2 = 5.0
- Sheep and goats = 1/0.1 = 10

\(^2\)The source of data is Statistical Office of the European Communities, Eurostat, Animal Production [1978].
The calculated coefficient for the data from 1962 to 1971 is 57, that is:

1 million eggs = 57 metric tons of eggs

By the use of this coefficient, data on egg production in millions of eggs were converted to eggs in metric tons and then added to the poultry meat data in metric tons. By applying the relevant coefficient (0.785), eggs and poultry meat production in metric tons was converted into livestock units.

Construction and Sources of Data

Collecting data was one of the most difficult problems in this study. Data on most variables, especially price variables, were not available in a consistent form for all the years under study (the crop years from 1962/63 to 1978/79), so data collected from various sources had to be combined to obtain a complete set. For some years price data were available from one source on a crop year basis, and for other years from another source on a calendar year basis.

Because of the nature of the product under study, feed grains, and the fact that fixed prices are set each year for the coming crop year, it was appropriate to use the crop year basis data for all the variables. The goal was to use the information included in the

1 The source of data is FAO, Production Yearbook.

2 This is the year data for this study started because this is the first year that support prices were set for grains in the E.E.C. countries.
calendar year basis data set to complete the crop year basis data.
In order to do so, the calendar year basis data were converted to crop year basis. The method of conversion used in this study is as follows:

If data were to be converted to a July-June\(^1\) basis, the simple mean of every two successive calendar year data, \(P'_{t}\) and \(P'_{t+1}\),\(^2\) was calculated to represent the crop year data, \(P_{t, \ t+1}\) or \(P_{t}\).\(^3\) In other words, the weights given to each of the two subsequent calendar year data are \(\frac{1}{2} = 6/12\). This weighting is reasonable because July to December and January to June constitute six months of every two subsequent calendar years (years \(t\) and \(t+1\)). However, if the crop year data were on an August-July basis, the weights were \(5/12\) for \(P'_{t}\) and \(7/12\) for \(P'_{t+1}\). This is, again, because August-July of the crop year \(t, t+1\) (or year \(t\)) can be divided into August to December of the calendar year \(t\) (five months out of twelve) and January to July of the calendar year \((t+1)\) (seven months out of twelve). In the mathematical form, the following equations were used for converting

\[P'_{t} = \frac{P_{t} + P_{t+1}}{2}\]

\[P'_{t+1} = \frac{P_{t} + P_{t+1}}{2}\]

\(^1\)The crop year data are usually either on a July-June basis or an August-July basis. The former refers to the crop year starting July 1 of year \(t\) (e.g., calendar years 1964, 1965, ... ) and ending June 30 of year \(t+1\) (e.g., calendar years 1965, 1966, ... ). The latter refers to the crop year starting August 1 of year \(t\) and ending July 31 of year \(t+1\).

\(^2\)The symbol "Prime" above the variable and the subscript \(t\) or \(t-1\) or \(t+1\) next to it refers to calendar year \(t\), \(t-1\), or \(t+1\).

\(^3\)The variable name, without the symbol "Prime" indicates that the data for that variable are on a crop year basis. Also, the subscript "\(t, t+1\)" or just "\(t\)" refers to the crop year starting in the calendar year "\(t\)" and ending in the calendar year "\(t+1\)."
calendar year prices, $P'_t$ and $P'_{t+1}$, to July-June crop year basis prices, $P_t$, $t+1$ or $P'_t$, where:

$$P_t = \frac{1}{2}P'_t + \frac{1}{2}P'_{t+1}$$

or to August-July crop year basis prices, $P_t$, $t+1$, or $P'_t$, where:

$$P_t = \frac{5}{12}P'_t + \frac{7}{12}P'_{t+1}$$

After converting the calendar year basis data to the crop year basis, there were then two sets of prices for the same variable. One is the set of data that had originally been collected on a crop year basis, and which will be referred to as "original crop year data." The other is the crop year base data that were calculated from the calendar year base data, and which will be referred to as "converted crop year data." The information in the "converted crop year data" was used to complete the "original crop year data" for those years for which the latter data were missing. To see how this works, suppose that data from 1962/63 through 1975/76 were available from the "original crop year data" and that data from 1975/76 through 1978/79 were available from the "converted crop year data." From the latter data set, the percentage changes in prices for every two subsequent years were calculated for the years 1975/76 and subsequent years, and then these percentage changes were applied to the former set of data to construct data for 1976/77 and subsequent years in this data set. In the mathematical form this can be shown as:

$$P_{t+1,o} = \frac{P_{t+1,c}}{P_{t,c}} \cdot P_{t,o} + P_{t,o}$$

$t= 1975/76, \ldots, 1977/78$
where:

\[ P_{t,0} \text{ and } P_{t+1,0} : \text{ are the "original collected crop year base data" on variable } P \text{ for the crop year } t = 1975/76 \text{ and are prices calculated by this method for } t = 1976/77 \text{ to } 1978/79. \]

\[ P_{t,c} \text{ and } P_{t+1,c} : \text{ are the "converted crop year base data," converted from the calendar year, on variable } P \text{ for the crop years } t \text{ and } t+1. \]

\[ \frac{P_{t+1,c} - P_{t,c}}{P_{t,c}} : \text{ is the percentage change in the prices in every two subsequent years (crop years } t \text{ and } t+1). \]

By this method, which is referred to as "method 1" in the subsequent sections, two or more sets of data could be combined to produce a complete set.

For consistency, all the price and value variables in the model should be in terms of one currency. Because the unit of account (U.A.) was introduced into the Community as a common denominator for the currencies of all member countries and because support prices have been expressed in terms of U.A., this study uses the data that were originally expressed in, or converted into, units of account. However, for most variables, data in units of account for the entire period were not available. For some years, data were available in terms of units of account, while for other years they were available only in terms of dollars or other national currencies. The purpose
here was, again, to complete the data that had originally been expressed in terms of units of account. For this purpose, data that were expressed in other currencies were first converted into dollar values by the use of IMF official exchange rate(s), then converted into units of account by the dollar/units of account exchange rate. Then "method 1" was applied to combine these data sets: one set being originally in terms of units of account, \( P_{t,0} \) and \( P_{t+1,0} \), and the other set(s) being the converted data into units of account from dollar or other currency(ies), \( P_{t,c} \) and \( P_{t+1,c} \).

In the following sections, the construction and sources of data for each variable in Model 4-1, p. 101 will be explained.

Index numbers of prices paid by farmers for agricultural inputs on a crop year basis, 1970/71 = 100; (\( P_{0,} \)).

Data for this variable were not available on an aggregate level for the E.E.C. Thus, a weighted average of the index of input prices for individual countries, the weights being in proportion to feed grains' production\(^1\) in each country, was used for the period 1962/63 to 1978/79. Data on feed grains' production for each member country in product weight (1000 M.T.\(^2\)) and on a crop year basis were available from U.S.D.A., Grains Supply-Distribution tables.

\(^1\) Feed grains' production is the summation of sorghum, barley, corn, oats, and rye production in feed units.

\(^2\) Abbreviation for metric tons.
The index of input prices was available for all the EC-6 member countries, except for Luxembourg,\textsuperscript{1} from the FAO, Production Yearbooks for the years from 1962/63 to 1977/78,\textsuperscript{2} and from the European Communities Commission, Agricultural, 1979 Report [1980] for recent years. Data from these two sources for most member countries were in agreement with one another.

The index of prices paid by farmers is an average of prices paid for agricultural inputs such as tractors and machinery, fertilizer, feed stuffs, seed, and energy.\textsuperscript{3}

Crop year basis data were collected for as many years as possible. For the years that data were available only on a calendar year basis, data were converted into a crop year basis by the method explained previously. The following will give an explanation of the construction of the index of prices paid by farmers for agricultural inputs for individual member countries:

West Germany: Data for the years 1962/63 to 1975/76 were published on a crop year (July-June) basis. Data from 1976 to 1979 were available only on a calendar year basis. These two sets of

\textsuperscript{1}Luxembourg was omitted from the EC-6 input cost calculations. However, considering the small size of Luxembourg, omission of this country from the EC-6 input cost index should not cause any significant loss in information.

\textsuperscript{2}For Italy data were available for the period from 1962/63 to 1976/77.

data were combined by "method 1," and thus the crop year basis data set was completed for the missing data for 1976/77 and the years after.

France: Data for the years 1962 to 1977 were published in FAO, Production Yearbooks on a calendar year basis. Quarterly data for September 1962 to June 1975 were available from the FAO, Monthly Bulletin of Agricultural Economics and Statistics. Calendar year base data were converted into crop year by taking simple mean of every two subsequent years. Crop year data constructed in this way and the crop year averages from quarterly data agreed with one another (within 6%).

Italy: For Italy there was a break in the series in 1967. Data prior to 1967 were published on a crop year (July-June) basis, whereas data for the years following 1967 were published on a calendar year basis. Calendar year data from 1966 to 1979 were converted into the crop year (July-June) basis, and then these two sets of data (that prior to 1967 which was available on a crop year basis and that for the years following 1967 which was converted into crop year from calendar year basis) were combined by "method 1."

The Netherlands: Data on P0 for the Netherlands were available on a crop year (July-June) basis from 1962/63 to 1977/78. In order to obtain the data for 1978/79, the simple mean of data for the years 1973 to 1979 available from the Statistical Office Data Bank in Europe\(^1\) was calculated and the converted crop year data were combined with the original crop year data by "method 1."

\(^1\)The data from this office were obtained through the European Community Information Office in Washington, D.C.
Belgium: For Belgium data on the index of input cost were available only on a calendar year basis. Crop year data were computed as the simple mean of every two subsequent calendar year data. These results and the July-June averages from the monthly data which were available from FAO, Monthly Bulletin of Agricultural Economics and Statistics agreed with one another (within 5%).

Index number of prices paid by farmers for inputs other than feed grains used for livestock production, 1970/71 = 100; (PLO_p).

Data on this variable were not available for any of the EC-6 member countries. Therefore, the data on P0_p for each country were used to represent the data on PLO_p. However, to construct an aggregate EC-6 index for PLO_p, data for individual countries were weighted in proportion to their livestock inventories.

Index number of prices received by farmers for livestock and livestock products, 1970/71 = 100; (PL_t).

Data for this variable were not available on an aggregate level for the EC-6. In order to construct an aggregate, the EC-6 index for PL_t data for individual countries were weighted in proportion to their livestock inventory.

The indexes of prices received by farmers for livestock and livestock products were available for all the EC-6 member countries, except for Luxembourg, from the FAO, Production Yearbooks for the

1 Luxembourg was omitted from the PL_t calculations for the EC-6. However, considering the small size of Luxembourg, omission of this country from the EC-6 index for PL_t should not cause any significant loss in information.
period from 1962/63 to 1976/77, and from the European Communities Commission, Agricultural Reports for 1975 [1976], 1976 [1977], 1977 [1978], 1978 [1979], and 1979 [1980]. Data from these two sources were in agreement with one another.

The following explains the construction of $PL_t$ for each member country.

West Germany: From 1962/63 to 1974/75 data on $PL_t$ were available on a crop year (July-June) basis. To complete the crop year data, calendar year base data which were available from 1968 to 1979 were used. Method 1 was used to combine these two data sets. In the completed data set the base year is $1961/62 - 1962/63$; i.e., $1961/62 - 1962/63 = 100$.

France: Data for $PL_t$ for France were available only on a calendar year basis. However, the base year for the data from 1965 to 1979 was 1970, while the base year for the data from 1962 to 1977 was 1955. In order to have a complete set of data with the year 1970 as the base year, all the figures in the latter set were divided by the figure for 1970 in that set. The completed calendar year basis data (all with the base year 1970) were then converted into the crop year basis by taking the simple mean of every two successive calendar years.

Italy: As with $P_0$, data on this variable ($PL_t$) had a break in the series in 1967. Data prior to 1967 were published on a crop year basis but reported only the index numbers of prices received by farmers for all agricultural products including crops and livestock
However, from 1967 on, data were available only on a calendar year basis, but they included data for the prices received by farmers for livestock and livestock products \( (PL_t) \), as well as data for prices received by farmers for all agricultural products \( (PLA_t) \). The latter sets of data for \( PL_t \) and \( PLA_t \) were converted into crop year data by taking the simple mean of every two successive years. Then by "method 1" the two sets of data on prices received by farmers for all agricultural products \( (PLA_t) \) were combined; as a result a complete set of crop year basis data was obtained for prices received for all agricultural products.

In order to estimate \( PL_t \) for the period from 1962/63 to 1965/66, the following procedure was used.

Because data from 1966/67 to 1978/79 were available for both variables, \( PL_t \) and \( PLA_t \), the regression between \( PLA_t \) and \( PL_t \) was estimated. Then based on the estimated regression parameters and the available data for \( PLA_t \), the data on \( PL_t \) were completed for the years 1962/63 to 1965/66. The estimation results were:

\[
\hat{PL}_t = 18.49 + 0.816 \cdot PLA_t \\
R^2 = 0.9936 \quad F \text{ ratio} = 1704.47
\]

The high values for \( R^2 \) and the \( F \) ratio indicate that the coefficients in the regression model are highly significant.

\(^1\)One set including data prior to 1967 which was originally stated on a crop year basis and the other set including data for 1967 and subsequent years which was obtained by converting the calendar year basis data to crop year basis.
Belgium: Data on PL for Belgium were available only on a calendar year basis. The calendar year basis data were converted into the crop year basis by calculating the simple mean of the data for every two successive years.

The Netherlands: Data for the Netherlands on PL were available on a crop year basis for the period from 1962/63 to 1977/78. To calculate the figure for 1978/79, the calendar year base data from the European Communities Commission, Agricultural, 1979 Report [1980] were used. From this source data for the years 1977, 1978, and 1979 were converted from the calendar year to a crop year basis and then by the use of "method 1" were combined with the "original crop year base data."

Livestock inventory in the E.E.C., expressed in thousands of livestock units; (L). This variable measures the inventory of all feed grains' consuming units in the E.E.C., including the stock of cattle, hogs, sheep and goats, and poultry. Data on the number of poultry units in the E.E.C. were not available; therefore, the flow of poultry meat and eggs in a given year was used as a proxy for the stock of poultry in that year.

Data on the number of cattle, hogs, sheep and goats, measured in units of thousand heads, for each member country for the period 1962 to 1980 were published in various issues of U.S.D.A., Foreign Agricultural Circular, Livestock and Meat. Various dates of enumeration were used by the countries reporting livestock inventory;
however, the data were classified as close as January 1 as possible. As a result, livestock inventory for year $t$ ($L_t$) is comparable to data on other variables for the crop year $t-1/t$. Data on poultry meat production measured in units of thousand metric tons, and eggs measured in units of millions of eggs for the years from 1964 to 1980 were published in the various issues of U.S.D.A., Foreign Agricultural Circular, Poultry and Eggs. This source reported data on the production of poultry meat and eggs from January 1 to December 30 of the year stated for each member country. Data prior to 1964 were not available from this source. However, FAO, Production Yearbooks published data on poultry meat and egg production for each member country for the years prior to 1964 as well as for the years after. By "method 1," this latter set of data was used to complete the former set and, as a result, a complete set of data for poultry meat and egg production in each member country was produced for the period from 1962 to 1980.

At this stage, sets of data for each member country for the period 1962 to 1980 were complete: the number of cattle, hogs, sheep and goats, all in units of thousand heads and on a crop year basis and the number of eggs in units of millions of eggs and on a calendar year basis. Data for poultry meat and egg production were then converted into the August-July crop year basis.

In order to obtain data on the livestock inventory of each member country, the available data on the number of cattle, hogs, sheep and goats in units of thousand heads, and the production of poultry meat in units of thousand metric tons, and number of eggs in units of
millions of eggs were converted into livestock units by the method described earlier in this chapter for the aggregation of livestock inventories. The data converted to livestock units were then aggregated for each member country to give a measure of livestock inventory in that country.

To obtain the data on livestock inventory for the E.E.C., the data on livestock inventory (in livestock units) for all the six original member countries were added together.

The E.E.C. quantity of net imports of feed grains from the rest of the world\(^1\) expressed in millions of feed units; \((\text{IF}_t)\).

U.S.D.A., Grains Supply-Distribution tables give data on quantities of imports and exports of feed grains by each of the E.E.C. member countries. The data were available on a crop year basis (July–June) for the years from 1962 to 1980 for each type of feed grains. To obtain the net import figures, total exports were subtracted from total imports for each member country. Net imports of all types of feed grains for the individual EC-6 member countries, after being converted to feed units, were aggregated to give data on \(\text{IF}_t\).

Feed grains' production in the rest of the world expressed in millions of feed units; \((\text{PROW}_t)\).

This is equal to the world production minus the EC-6 production of feed grains.

\(^1\)In this study all the countries in the world except for the EC-6 countries are referred to as the rest of the world.
Data on production of feed grains for the world and the EC-6 were available from U.S.D.A., Grains Supply-Distribution tables for the years 1962 to 1980 on a July-June crop year basis. These tables give data for each type of feed grains in each member country and the world. The data obtained from this source were converted from product weight in thousand metric tons to feed units and were then aggregated over all types of feed grains to give the production of feed grains for the world and the EC-6.

Index number of the rest of the world real income, 1974/75 = 100; \(Y_{ROW}^W\).

As was explained in Chapter IV, p. 89, footnote 1, because of the data problems, instead of using data on real income for the rest of the world, the data on real income for the whole world (including the EC-6) were used.

Data on real income of the whole world \(Y^W_t\) were available from the U.N., Yearbook of National Accounts Statistics [1980]. This source gives index numbers of gross domestic product by the kind of economic activity. This index contains data for all the market economies on an aggregate level\(^1\) and for the years from 1962 to 1978 on a calendar year basis, with the year 1975 as the base year (1975 = 100). This index is a weighted average of the individual countries' indices of their GDP at 1973 prices. For example, developed market economies have a weight of 81.4 and developing market economies have a weight of 18.6.

\(^1\)Data are also available for individual countries with market economies.

From the World Bank, 1980 Annual Report, the preliminary data on the 1979 annual rate of growth in total GNP for all developing regions is 4.6\% and for industrialized countries is 3.3\%. These rates were weighted by 18.6 and 81.4 respectively, and the weighted average was used to obtain the 1979 rate of growth of the market economies' GDP. This figure was used to complete the data available from the U.N. Yearbook of National Accounts Statistics. The calculation procedures used are:

\[
(3.3 \cdot 81.4) + (4.6 \cdot 18.6) = 3.54
\]

\[
y^W_{1979} = y^W_{1978} \cdot 0.0354 + y^W_{1978}
\]

where: \(y^W_{1978}\) is the world (market economies) GDP at constant prices for 1978, available from the U.N., Yearbook of National Accounts Statistics.

The index numbers of GDP were then transferred from a calendar year basis to an August-July crop year basis.

\(^1\)Agrees completely for industrialized countries and is consistent within 5\% for developing nations.
The EC-6 real income at 1970 prices and 1970 exchange rates expressed in thousand million Eurs; \( \{ Y_t \} \).

Data on this variable were available from the Statistical Office of the European Communities, Eurostat, National Accounts. The 1977 issue of this source contains data on the EC-6 GDP at 1970 prices and 1970 exchange rates, in thousand million Eurs\(^1\) for the years from 1960 to 1976. However, starting with the 1978 issue and thereafter the national account statistics were reported in "Purchasing Power Standards" instead of Eurs.

Because in this study all the price variables are in terms of units of accounts or Eurs, to be consistent, the data in the 1977 Eurostat National Accounts issue which reports GDP in Eur, were used. To complete the data for the years 1977 and 1978, the information on percentage change of the GDP volume indices\(^2\) was used. For each country, the percentage change in volume indices for every two successive years, starting from 1976, was calculated and it was then applied to the real GDP indices published by the Statistical Office of the European Communities, Eurostat, National Accounts \([1977]\), that is for \( t = 1976 \):

\[
(Y_{t+1})_{\text{EC-6},i}^\text{EC-6,1} = \frac{(Y_{t+1})^v,i - (Y_t)^v,i}{(Y_t)^v,i} Y_t^{\text{EC-6,1}} + Y_t^{\text{EC-6,1}}
\]

\(^1\)The Community currency unit that was used for statistical purposes during 1975-76.

\(^2\)The source is the Statistical Office of the European Communities, Eurostat, National Accounts \([1980]\).
where: $Y_{t}^{EC-6,i}$ presents data on the $i^{th}$ member country's index of GDP at 1970 prices and 1970 exchange rates, in terms of Eur, for $t = 1976$.

$(Y_{t+1}^{EC-6,i})$ presents the calculated figure from this method for 1977.

$(Y_{t}^{V,i})$ and $(Y_{t+1}^{V,i})$ present data on the $i^{th}$ member country's GDP volume indices for year $t$ and $t+1$.

For 1979, real GDP for EC-6 is calculated from the data available from the European Communities Commission, Agricultural, 1979 Report [1980]. Note that all the data on GDP were on a calendar year basis. Therefore, they were converted into an August-July crop year basis before being applied.

Manioc Consumption by the E.E.C., expressed in thousands of metric tons; $(MA_t)$.

Since a complete set of data was not available for this variable and since most manioc consumed in the Community is imported and mainly from Thailand, manioc imports of the Community from Thailand were used as a proxy for manioc consumption in the E.E.C.

Data on manioc imports of Belgium, West Germany, and the Netherlands from Thailand were published in the Bank of Thailand, Annual Economic Report [1980] on a calendar year basis. The data were then converted into the August-July crop year and were used as a proxy for $MA_t$.

Dollar/Unit of Account Exchange Rate; $(k)$. 
As was described in Chapter II, in the section on the developments in the E.E.C. agrimonetary system, various currency units were used in the Community for statistical purposes. The unit of account (U.A.) was introduced in 1962. The Eur was used for a two-year period from 1975 to 1976, and the EUA was used from January 1977. Starting in March 1979 the European Currency Unit (ECU) has been used for statistical purposes.

By comparing world prices in units of account and in dollar terms, it was concluded that for most years and for most feed grains the exchange rate used by the Commission for converting price data from U.A. to Dollars or vice versa was the Eur/$ exchange rate. Data for $/Eur exchange rate for the period from January 1962 to December 1974 were available from Collins [1980]. From January 1975 until May 1978, the $/Eur exchange rates were calculated by dividing the EUA/Eur exchange rates by the EUA/$ rates. The data on EUA/$ and EUA/Eur exchange rates were available from the Statistical Office of the European Communities, Agricultural Price Statistics [1978]. Data for the period June 1978 to February 1979 were calculated by dividing data on EUA/Eur exchange rates by data on EUA/$ exchange rates that were available from Collins [1980]. Also from the Commission of the European Communities, Agricultural Markets [June 1980], a consistent set of data on the U.A./$ exchange rates for the period from 1959/60 to 1978/79 was available.

\[\text{\textsuperscript{1}}\text{Data from this source were in agreement with the data from Collins [1980].}\]
World price of feed grains, expressed in units of account per metric ton; \((P_{i,t})\).

The world price of feed grains was calculated as a weighted average of the world prices of each type of feed grains: corn, barley, sorghum, oats, and rye. The weights were equal to the coefficients that were used to convert each type of feed grains from product weight into feed units.

To be consistent, all the prices in this study, including the world prices are expressed in terms of units of account. The following will give an explanation of the construction and sources of data on the world price for each type of feed grain.

Corn: World Price of U.S. #3 yellow corn in units of account per metric ton (U.A./M.T.).

Monthly data for the world price of corn (c.i.f. Rotterdam) in U.A./M.T. were available from Collins [1980, Corn 18] for the period from July 1967 to July 1979. Collins [1980, Corn 47] gives data for the world price of corn in $/H.T. for the period January 1963 to December 1979. This latter set of data was used to complete the former, and as a result, data on the world price of corn were obtained for the period 1963/64 to 1978/79. The procedure applied is very similar to "method 1," except that in this case instead of proceeding from year \(t\) to year \(t+1\), we proceed from year \(t\) to year \(t-1\), that is:

\[\text{Since for the period 1960/61 to 1970/71, $1 = 1 \text{ U.A. there was no need to convert the data from dollar terms to Units of Account.}\]
\[ P_{t-1} = \frac{P_{t-1,c} - P_{t,c}}{P_{t,c}} \cdot P_t + P_t \]

where: \( P_{t-1,c} \) and \( P_{t,c} \) are prices from the latter set, corn 47.

\( P_{t-1} \) and \( P_t \) are prices from the former set of data, corn 18.

In order to obtain the 1962/63 figure, two different sets of monthly prices available from Collins [1980] were used. The figures for the period January 1963 to December 1979 were obtained from Collins [1980, Corn 47]. To complete this set for the period from August 1962 to December 1963, Collins [1980, Corn 11] which gave data on world prices of U.S. #2 yellow corn in D.M./M.T. for the period January 1961 to August 1971, was used. The data from this set were converted from D.M./M.T. to $/M.T. by using IMF official exchange rates. This latter set of data was then combined with the data from Collins [1980, Corn 47], and the figure for 1962/63 (average of August to July prices) corn world price was obtained.

The simple mean of this figure and the figure calculated from the average of January to December prices from Collins [1980, Corn 47] represented the 1962/63 world price of corn.

Sorghum: World price of #5 yellow grain sorghum in units of account per metric ton.

Data in terms of U.A./M.T. were only available for the period from July 1964 to July 1979, which came from Collins [1980, Sorghum 02]. To complete this set of data for the period August 1962 to June 1964, two sets of data were used: Collins [1980, Sorghum 23] which gave data from January 1963 to July 1971 in $/M.T. and Collins [1980,
Sorghum 05] which gave data for the world price of U.S. #2 yellow grain sorghum for 1961 to 1979, in D.M./M.T. The latter set of data was converted from D.M./M.T. into $/M.T. and was combined with the former set. The procedure used was the same as the one for corn.

Crop year averages were calculated, and, therefore, a complete set of world prices for sorghum was obtained.

**Barley:** World price of U.S. #3 barley in units of account per metric ton.

Collins [1980, Barley 07] gave data on the world price of barley at Rotterdam for the period July 1964 to July 1979 in units of account per metric ton.

The 1962/63 and 1963/64 data were calculated from the FAO, Production Yearbooks which gave data on the import price of U.S. #2 and #3 barley at North Sea ports. The data from this source were reported on a calendar year basis and were expressed in terms of dollars per metric ton. These prices were converted into August-July crop year basis and were combined with the data from Collins [1980, Barley 07].

**Oats:** World price of U.S. extra heavy white oats in units of account per metric tons.


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\(^1\)Jitendar Mann is an Agricultural Economist in the World Analysis Branch, International Economics Division of the U.S. Department of Agriculture.
These two sets of data are in complete agreement with one another for the years prior to 1971. Therefore, the 1962/63 figure from Mann's data was used without any adjustments to complete Collins' [1980, Oats 07] data.

However, neither data set included the figure for 1969/70. Considering that the world prices of different types of feed grains are highly correlated, the 1969/70 oat world price was estimated based on the prices for other feed grains for the period from 1962/63 to 1978/79 (except for 1969/70). The estimation results are as the following:

\[
P_{\text{O}} = -2.688 + 0.4121 \times P_{\text{C}} - 0.094 \times P_{\text{S}} + 0.689 \times P_{\text{B}}
\]

\[
t \text{ ratios } = (1.2117) \quad (-0.3895) \quad (3.6390)
\]

\[
R^2 = 0.9910 \quad F \text{ ratio } = 329.94
\]

The variables \( P_{\text{O}}, P_{\text{C}}, P_{\text{S}}, \) and \( P_{\text{B}} \) stand for the world price of oats, corn, sorghum, and barley.

---

\(^1\) Data sent by Mann are in terms of S/M/T. However, since until 1971 one dollar was equal to one unit of account, the comparison of the two data sets for the years prior to 1971 is appropriate.

\(^2\) Using the data from 1966/67 to 1978/79 (except for the year 1969/70), the correlation coefficients between the world price of oats (\( P_{\text{O}} \)), world price of barley (\( P_{\text{B}} \)), world price of sorghum (\( P_{\text{S}} \)), world price of corn (\( P_{\text{C}} \)), and world price of rye (\( P_{\text{R}} \)) were calculated. The obtained correlation coefficients were very high and significantly different from zero at one percent level. The calculated correlation coefficient between:

- \( P_{\text{O}} \) and \( P_{\text{B}} \) = 0.99,
- \( P_{\text{O}} \) and \( P_{\text{S}} \) = 0.95,
- \( P_{\text{O}} \) and \( P_{\text{C}} \) = 0.97,
- \( P_{\text{O}} \) and \( P_{\text{R}} \) = 0.97.
The calculated t ratios are presented in the parentheses under the parameters. Comparing the calculated t ratios with tabulated t with 12 degrees of freedom, we fail to reject the null hypothesis that \( H_0: \alpha_1 = 0 \) and \( \alpha_2 = 0 \) where \( \alpha_1 \) and \( \alpha_2 \) are the coefficients for PIC and PIS, respectively.\(^1\) The only significant coefficient is the coefficient for PIB.

However, all three variables, PIC, PIS, and PIB, were used to estimate the 1969/70 value for PIO.\(^2\) The estimated value for the 1969/70 of PIO is 50.53. This figure was substituted in the data set for the 1969/70 oat world price to complete this set.

Rye: World price of U.S. #2 rye in units of account per metric tons.


In order to obtain the 1966/67 and 1978/79 world price of rye, the data provided by Mann, U.S.D.A., which gave the world price of rye in terms of dollars per metric ton for the period from 1966/67 to 1978/79, were used.

\(^1\)This is reasonable because one reason for the calculated t ratio to show non-significance of the variables is the existence of multi-collinearity among independent variables. However, by looking at the figures for \( R^2 \) and F ratio, it can be concluded that PIC, PIS, and PIB can explain a significant amount of the variability in PIO.

\(^2\)Note that the world price of rye (PIR) was not included. This is because, as will be explained in the following section, data on PIR were completed based on the data for PIO.
Data on the world price of rye for 1962/63 to 1965/66 were estimated based on the prices for other feed grains for 1966/67 to 1978/79. The estimation results were as the following:

\[ PIR = 2.644 + 0.359 \text{PIC} + 0.1179 \text{PIS} - 0.4168 \text{PIB} + 0.899 \text{PIO} \]

\[ t \text{ ratios} = (0.597) \quad (0.2160) \quad (-0.738) \quad (1.54) \]

\[ R^2 = 0.9892 \quad F \text{ ratio} = 91.69 \]

From the calculated t ratios (presented in the parameters below the coefficient) it can be concluded that all the coefficients are significantly different from zero. Based on the estimated parameters, the values of PIR for the years 1962/63, 1963/64, 1964/65, and 1965/66, are 53.63, 56.79, 58.09, and 57.40, respectively.

Price of oilseed meal, expressed in units of account, per metric ton; \((POIL_t)\).

Since soybean meal imports from the U.S. account for a large proportion of the oilseed meal fed to livestock in the E.E.C., and because there are no tariffs or other trade restrictions on soybean meal imports, U.S. soybean meal prices at Rotterdam were used as a proxy for domestic meal prices in Europe.

Sources of data: Various issues of U.S.D.A. Foreign Agricultural Circulars on Oilseeds and Products and on Fats and Oils provided monthly data on U.S. soybean meal prices, 44\%, c.i.f. at European ports in terms of dollars per metric ton from January 1968 to June 1980. Prior to this period, data were only available for Canadian soybean meal prices, 45\%, c.i.f. at European ports. These prices were reported from January 1962 to December 1970. The latter set
of data, Canadian soybean meal prices, could not be used to complete the former set, U.S. soybean meal prices, because these two sets of data were not consistent. In order to complete the data on the price of U.S. soybean meal at European ports, the domestic soybean meal wholesale price at Chicago, to which transportation cost from the U.S. to the European ports was added, was used. Various issues of the FAO, Production Yearbook provided data on the wholesale price of soybean meal at Chicago. And various issues of the FAO, Production Yearbook and the FAO, Trade Yearbook provided data on the maritime freight rates from St. Lawrence to Rotterdam for grains. Since data on soybean meal transportation cost were not available, transportation cost for grains was used as a proxy for soybean meal transportation cost. Then the completed set of data on price of U.S. soybean meal at European ports was converted from dollars to units of account by the use of Eur/$ exchange rate.

Feed grains' fixed price; expressed in units of account per metric ton; \( (P^T_t) \).

As was explained in Chapter II, fixed prices for each type of grain are set by the Commission each year prior to the crop year that they apply to. These prices are set for the month of August and are increased by given (and usually equal) increments to produce prices for the months following August. These increments are to account for storage and other costs which arise from storing the grain instead of selling it. Since August prices represent the crop year prices, and since the purpose of this study is to explain
the prices that are set for each crop year, fixed prices set for the month of August were used to represent crop year fixed prices.

Among the three types of fixed prices, target, threshold, and intervention prices, threshold price had the most complete data. Therefore, threshold prices were used to represent fixed prices. Feed grains' threshold price was calculated as a weighted average of the threshold price of each type of feed grains: corn, barley, sorghum, oats, and rye. The weights were equal to the coefficients that were used to convert each type of feed grains from product weight into feed units.

The formula used for this purpose is:

\[
PT_t = \frac{(PTC \cdot 1.11) + (PTE \cdot 1.00) + (PTR \cdot 1.02) + (PTS \cdot 0.95) + (PTO \cdot 0.81)}{4.89}
\]

where:
- PTC is the threshold price of corn.
- PTE is the threshold price of barley.
- PTS is the threshold price of sorghum.
- PTO is the threshold price of oats.
- PTR is the threshold price of rye.

Sources of data: Data for the E.E.C. threshold price of common (soft) wheat, corn, rye, and barley were available from Collins [1980] for the crop years 1963/64 to 1966/67. Data for sorghum and oats were available from this source for the crop years 1964/65 to 1966/67. Various E.E.C. publications provided data for threshold prices of various types of grains and for the years from 1967/68 to 1978/79: European Communities Commission, the Agricultural Situation in the Community [1976, 1977, 1978, 1979, 1980]; Commission of the European
Communities, Agricultural Markets, Vegetable Products [July 1978]; and the Statistical Office of the European Communities, Eurostat, Agricultural Price Statistics [1976, 1978]. Data from these sources were in agreement with the Collins' data.

Monthly data for threshold price of sorghum, wheat, barley, and corn were available from Collins' [1980] data, for the years from 1962/63 to 1978/79 and for West Germany, France, Italy, and Belgium. These monthly prices along with market prices for rye and oats (Source: Commission of the European Communities, Agricultural Markets, prices received by farmers [June 1980]) were used to estimate the missing data on the EC threshold prices for the year 1962/63 for wheat, corn, rye, and barley; and for the year 1962/63 and 1963/64 for sorghum and oats.

Several types of regression were tried to estimate these missing data.

Oats: The EC threshold price of oats was regressed on the market prices of oats in West Germany, France, Italy, Belgium, and Luxembourg using annual data from 1965/66 to 1978/79. The following equation, equation 5-2, was used for this regression:

\[ P_{TO\ EC} = \alpha_0 + \alpha_1 P_{MOG} + \alpha_2 P_{MOF} + \alpha_3 P_{MOI} + \alpha_4 P_{MOB} + \alpha_5 P_{MON} \] (5-2)

where: \( P_{TO\ EC} \) stands for the threshold price of oats.

\( P_{MO\ ST} \) stands for the market price of oats.

and the last letter (latters in the case of EC) specifies (specify) the country (region) that the price is applicable to, i.e., G for West Germany, F for France, I for Italy, B for Belgium and Luxembourg, and
N for the Netherlands.

For example, PMOF represents the market price of oats in France and PTOEC represents the EC threshold price of oats:

The regression results were as follows:

\[
PTOEC = 3.14 + 0.818 \text{ PMOG} + 0.139 \text{ PMOF} + 0.327 \text{ PMOI} - 0.071 \text{ PMOB} - 0.287 \text{ PMON}\\
(1.58) \quad (0.23) \quad (1.65) \quad (-0.128) (-0.69)\\
\]

\[R^2 = 0.9537 \quad \text{F ratio} = 37.10\]

By comparing the calculated t ratios (in parentheses under the parameters) with tabulated t, we fail to reject the null hypothesis that each of the parameters is equal to zero. However, the high \(R^2\) and F ratio indicate the possible existence of multicollinearity. That is "because of strong interrelationships among the independent variables, it becomes difficult to disentangle their separate effects on the dependent variable" [Madala, 1977, p. 183]. Since the purpose was not to investigate the separate effects of each of the independent variables on the dependent variable, it was decided that equation 5-2 would be used to estimate the EC threshold price of oats for 1962/63 and 1963/64 given the individual country prices for these two years.

Rye: An equation similar to equation 5-2 was used to estimate the threshold price of rye for the year 1962/63:

\[
PTREC = \alpha_0 + \alpha_1 \text{ PMRG} + \alpha_2 \text{ PMRF} + \alpha_3 \text{ PMRI} + \alpha_4 \text{ PMRB} + \alpha_5 \text{ PMRN} + \alpha_6 \text{ PMRL}
\]
where: PTR stands for the threshold price of rye.

PMR stands for the market price of rye.

Similar to the symbols that were used for oats, the last letter (letters in the case of EC) specifies (specify) the country (region) that the price is applicable to, i.e., G for West Germany, L for Luxembourg, B for Belgium .... For example, PMRF represents the market price of rye in France, and PTREC represents the EC threshold price of rye.

Using the crop year data from 1963/64 to 1978/79, the parameters of this equation were estimated. The regression results were as follows:

\[
\begin{align*}
PTREC &= -8.08 + 0.382 \text{ PMRG} - 0.414 \text{ PMRF} + 0.690 \text{ PMRI} + 0.668 \text{ PMRB} \\
&\quad + 0.534 \text{ PMRN} - 0.839 \text{ PMRL} \\
&\quad (1.06) \quad (-0.857) \quad (2.988) \quad (1.133) \\
&\quad (1.248) \quad (-2.6435)
\end{align*}
\]

\[R^2 = 0.9767 \quad F \text{ ratio} = 62.82\]

Other feed grains: In order to estimate the 1962/63 threshold price of corn, barley, and wheat, and the 1962/63 and 1963/64 threshold price of sorghum, individual countries' threshold prices for the years 1962/63 and thereafter were used.\(^1\) The goal was to obtain a relationship between the threshold price in individual EC countries and the EC threshold price, in other words to estimate the EC threshold price.

\(^1\)Note that in the case of oats and rye threshold prices for individual countries were not available, therefore, market prices were used as explained in preceding sections.
as a weighted average of the member country threshold prices. Data for the years 1967/68 and thereafter could not be used because of the single price system that became effective in 1967/68. In this system, threshold prices were equal among all the E.E.C. member countries and these prices also represented the EC threshold price. In all the estimations, August prices were used to represent crop year prices.¹

Therefore, the number of observations was limited to four for corn, barley, and wheat, and to three for sorghum. This low number of observations and degrees of freedom was the major problem in estimating the missing data for 1962/63 (and 1963/64 for sorghum).

One procedure tried was to estimate the following equation, equation 5-3, for each type of feed grains by various methods.²

\[
PTEC = \alpha_0 + \alpha_1 PTG + \alpha_2 PTF + \alpha_3 PTI + \alpha_4 PTB \tag{5-3}
\]

where: PT stands for the threshold price and the letter (letters for EC) following PT represents (represent) the country (or region) that the threshold price applies to, i.e., G for West Germany, F for France, I for Italy, and B for Belgium.

Since we knew that the coefficient for each variable should be positive,³ if the estimation results indicated negative coefficient(s),

¹ Including threshold prices for other months would not add to the information already provided by August prices because these other prices are calculated from August prices.

² Because of the lack of data for the Netherlands, this country was excluded while estimating the EC threshold price for other feed grains.

³ This is because countries cannot have negative weights.
that method was rejected. In cases that equation 5-3 was estimated with no intercept, the restriction that the sum of coefficients (weights) should be equal to one was also included.

The estimation results for equation 5-3 were not satisfactory; therefore, in order to decrease the number of variables in this equation, the following method was used. This method takes into account the assumption that when estimating equation 5-3 with no intercept the sum of coefficients should be equal to one, that is:

\[ \text{PTEC} = \alpha_1 \text{PTG} + \alpha_2 \text{PTF} + \alpha_3 \text{PTI} + \alpha_4 \text{PTB} \]  \hspace{1cm} (5-4)

\[ \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1 \]  \hspace{1cm} (5-5)

Solving for \( \alpha_4 \) we have:

\[ \alpha_4 = 1 - (\alpha_1 + \alpha_2 + \alpha_3) \]  \hspace{1cm} (5-6)

Substituting 5-6 in 5-4 we have:

\[ \text{PTEC} = \alpha_1 \text{PTC} + \alpha_2 \text{PTF} + \alpha_3 \text{PTI} + \left[ 1 - (\alpha_1 + \alpha_2 + \alpha_3) \right] \text{PTB} \]

or:

\[ (\text{PTEC} - \text{PTB}) = \alpha_1 (\text{PTG} - \text{PTB}) + \alpha_2 (\text{PTF} - \text{PTB}) + \alpha_3 (\text{PTI} - \text{PTB}) \]

or:

\[ Z_1 = \alpha_1 Z_2 + \alpha_2 Z_3 + \alpha_3 Z_4 \]  \hspace{1cm} (5-7)

where:

- \( Z_1 = \text{PTEC} - \text{PTB} \)
- \( Z_2 = \text{PTG} - \text{PTB} \)
- \( Z_3 = \text{PTF} - \text{PTB} \)
- \( Z_4 = \text{PTI} - \text{PTB} \)

\( Z_1 \) was regressed on \( Z_2, Z_3, \) and \( Z_4 \) with the restriction that each coefficient should be positive, that is:
The following results were obtained from estimating equation 5-7 and from equation 5-6:

For sorghum: \( a_1 = 0 \) \( a_2 = 0.3515 \) \( a_3 = 0 \) and \( a_4 = 0.65 \)

For barley: \( a_1 = 0 \) \( a_2 = 0.566 \) \( a_3 = 0.001 \), and \( a_4 = 0.433 \)

For wheat: \( a_1 = 0.25 \) \( a_2 = 0.275 \) \( a_3 = 0.25 \), and \( a_4 = 0.225 \)

However, because of the very low number of observations and, therefore, a very limited degrees of freedom, these results were not very reliable.

Monthly data were also used to estimate the parameters of equations 5-3 and 5-4, but results were not satisfactory.

Finally, monthly data on threshold prices were plotted versus time for each type of feed grains. Each plot contained the trend on monthly threshold prices in each member country and the EC in general.

The goal was to estimate the weights applicable to each member country threshold price, i.e., \( a_1 \), \( a_2 \), \( a_3 \), and \( a_4 \) in equation 5-4, and ultimately to estimate the EC threshold price for 1962/63 (and 1963/64 for sorghum).

In other words the estimation of the coefficients in equation 5-4 was made based on graphical analysis of the data. By looking at the plots it was decided that for sorghum, corn, and barley a weight equal to 0.75 be given to the Belgian's threshold price, i.e., \( a_4 = 0.75 \), while a weight equal to 0.25 be given to French threshold price, i.e., \( a_2 = 0.25 \), \( a_1 = 0 \), and \( a_3 = 0 \).

For wheat, Belgian and French threshold prices each were given a weight equal to 0.50, i.e.:

\[
\hat{a}_1 = 0 \quad \hat{a}_2 = 0.50 \quad \hat{a}_3 = 0 \quad \hat{a}_4 = 0.50
\]
CHAPTER VI. ESTIMATION PROCEDURES

In order to estimate the structural parameters of the general model, ordinary least squares (OLS) and two-stage least squares (TSLS) methods of estimation were used. However, because this study used time series data, the autoregression of the disturbance terms was also taken into account. That is the OLS and TSLS methods of estimation were used considering both the presence and the absence of the autoregressive errors.

In the first part of this chapter, the identification problem and the TSLS method of estimation will be discussed. In the second part, serial correlation, Cochrane-Orcutt iterative process, and the procedure used for estimating simultaneous equations with autocorrelated errors will be discussed. Finally, the estimation of the reduced form multipliers will be explained and presented.

Identification Problem

In order to estimate the structural parameters of a simultaneous equation model, each of the structural equations should be identified. Each equation that is identified can be "just identified" or "over identified." For a "just identified" equation there is only a unique way of calculating its parameters from the reduced form parameters, whereas for an "over identified" equation, there is more than one way of calculating its parameters from the reduced form parameters.
Order condition

The necessary condition for identification is that the total number of variables excluded from the equation be at least as great as the total number of endogenous variables in the system less one. That is:

\[(g - g_1) + (k - k_1) \geq g - 1\]  \hspace{1cm} (6-1)

where:

- \(k\) is the total number of the predetermined (exogenous and lagged endogenous) variables in the system.
- \(g\) is the total number of the endogenous variables in the system (number of equations in the model).
- \(k_1\) is the number of predetermined variables included in the equation.
- \(g_1\) is the number of endogenous variables included in the equation.

Inequality (6-1) can also be written as:

\[k - k_1 \geq g_1 - 1\]  \hspace{1cm} (6-2)

The necessary condition is referred to as the "order condition."

To see whether or not the "order condition" is satisfied for the equations in model 4-1, each equation will be examined.

In model 4-1, \(k = 14\) and \(g = 4\).

For equation (4-9): \(k_1 = 8\), \(g_1 = 3\)

\[
\frac{k - k_1}{14 - 8} \quad \frac{g_1 - 1}{3 - 1} \quad \text{The equation is:} \quad \text{overidentified}
\]

\[^1\text{These equations refer to the equations presented in Chapter IV, Model 4-1, p. 101.}\]
For equation (4-10): $k = 5$, \( g_1 = 2 \), the equation is overidentified.

For equation (4-19): $k = 2$, \( g_1 = 2 \), overidentified.

For equation (4-46): $k = 7$, \( g_1 = 4 \), overidentified.

So we can see that by "order condition" all the equations of the system are "overidentified." But as was explained before the "order condition" is just a necessary condition for identification. The necessary and sufficient condition for identification is the "rank condition."

**Rank condition**

The structural form of simultaneous equations can be presented as follows:

\[
Y_{nxg}g_{xg} + X_{nxk}k_{xg} = \epsilon_{nxg}
\]  

and the reduced form as:

\[
Y = X\Pi + U
\]  

where:

\[\Pi = -gT^{-1}\]  

The first equation can be written as:

\[
\begin{bmatrix}
\gamma_{11} & \cdots & \gamma_{1g} \\
\gamma_{21} & \cdots & \gamma_{2g} \\
\vdots & \ddots & \vdots \\
\gamma_{g1} & \cdots & \gamma_{gg}
\end{bmatrix} [y_1 \  y_2 \ \cdots \  y_g] +
\begin{bmatrix}
0^1 \\
\vdots \\
0
\end{bmatrix} +
\begin{bmatrix}
\gamma_{11} & \cdots & \gamma_{1g} \\
\gamma_{21} & \cdots & \gamma_{2g} \\
\vdots & \ddots & \vdots \\
\gamma_{g1} & \cdots & \gamma_{gg}
\end{bmatrix} 
\begin{bmatrix}
x_1 \\
x_2 \\
\vdots \\
x_g
\end{bmatrix}
= \epsilon_1
\]

These equations refer to the equations presented in Chapter IV, Model 4-1, p. 101.

This section is mainly from Intriligator [1978, Chapter 10].
This equation contains $g_1$ of the endogenous variables in the system and $k_1$ of the predetermined variables in the system. Note that here the order of variables has been changed so that any zeros come at the end of the column vectors of parameters.

Now, considering the first column of $T$ and $\beta$, corresponding to the first equation of the structural form, $6-6$ can be written as:

$$\begin{bmatrix}
\Pi_1 \\
\Pi_2 \\
\Pi_3 \\
\Pi_4 
\end{bmatrix} \cdot 
\begin{bmatrix}
k - k_1 \\
\kappa_1 \\
g - g_1
\end{bmatrix} = 
\begin{bmatrix}
\gamma_{11} \\
\gamma_{21} \\
\vdots \\
g_{11} \\
0 \\
\vdots \\
0
\end{bmatrix} - 
\begin{bmatrix}
\beta_{11} \\
\beta_{21} \\
\vdots \\
\beta_{k_1}
\end{bmatrix}
$$

Matrix multiplication produces the following set of equations:

$$\begin{bmatrix}
\gamma_{11} \\
\gamma_{21} \\
\vdots \\
g_{11} \\
0 \\
\vdots \\
0
\end{bmatrix} \cdot 
\begin{bmatrix}
\Pi_1 \\
\vdots \\
\Pi_4
\end{bmatrix} = 
\begin{bmatrix}
\beta_{11} \\
\beta_{21} \\
\vdots \\
\beta_{k_1}
\end{bmatrix} \quad (k_1 \text{ equations})
$$

$$\begin{bmatrix}
\gamma_{11} \\
\gamma_{21} \\
\vdots \\
g_{11} \\
0 \\
\vdots \\
0
\end{bmatrix} \cdot 
\begin{bmatrix}
k_1 \\
g_1
\end{bmatrix} = 0 \quad (k - k_1 \text{ equations})
$$

Equations in 6-8 and 6-9 can be solved for the $\gamma$'s if the coefficient matrix satisfied the rank condition, i.e.:

$$\rho (\Pi_2) = g_1 - 1 \quad (6-10)$$
where:

\( \rho(\Pi_2) \) is the rank of matrix \( \Pi_2 \).

The necessary and sufficient conditions for identification are:

If: \( \rho(\Pi_2) = g_1 - 1 \) and \( k - k_1 > g_1 - 1 \), the equation is over-identified.

\( \rho(\Pi_2) = g_1 - 1 \) and \( k - k_1 = g_1 - 1 \), the equation is just identified.

\( \rho(\Pi_2) = g_1 - 1 \) and \( k - k_1 < g_1 - 1 \), the equation is under-identified.

\( \rho(\Pi_2) < g_1 - 1 \) and \( k - k_1 \geq g_1 - 1 \), the equation is under-identified.

However, the rank condition is not very convenient to use because it requires the computation of the inverse matrix \( T^{-1} \) which is used to calculate \( \Pi \). A more convenient way of checking the rank condition is suggested as the following [Intriligator, 1978, p. 349]. Let \( A \) be the matrix of all structural coefficients as:

\[
A(g + k) \cdot g = \begin{bmatrix} T_{y_1,1} & \cdots & T_{y_1, g_1} \\ \vdots & \ddots & \vdots \\ T_{y_{g_1}, 1} & \cdots & T_{y_{g_1}, g_1} \\ T_{x_1, 1} & \cdots & T_{x_1, k_1} \\ \vdots & \ddots & \vdots \\ T_{x_{k_1}, 1} & \cdots & T_{x_{k_1}, k_1} \\ 0 & \cdots & 0 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_{11} \\ \vdots \\ \beta_{g_1} \\ \beta_{1, k_1} \\ \vdots \\ \beta_{k_1} \\ 0 \end{bmatrix} = \begin{bmatrix} g_1 \\ g_1 - 1 \\ \vdots \\ k_1 \\ k - k_1 \end{bmatrix}
\]
where:

\[ T_0, T_1, \beta_0, \text{ and } \beta_1 \text{ are submatrices forming the } g - 1 \text{ columns of } T \text{ and } \beta. \]

The rank condition: \( \rho(\Pi_2) = g_1 - 1 \), is equivalent to the condition that:

\[
\rho \begin{bmatrix} T_1 \\ \beta_1 \end{bmatrix} = g - 1 \quad (6-12)
\]

By applying the rank condition 6-12 along with the order condition to each of the equations 4-9, 4-10, 4-19, and 4-46 in model 4-1 it can be concluded that all of the four equations are overidentified and as a result the whole structural system is identified.

**Two Stage Least Squares (TSLS)**

Considering that in a system of simultaneous equations the explanatory variables are not statistically independent of the stochastic disturbance terms, OLS method of estimation will yield biased and generally inconsistent (for large samples) estimators. This is because the OLS method applies to each equation of the model separately and ignores all the information concerning variables not included in the equation being estimated and also ignores the distinction between explanatory endogenous and included exogenous variables.

Two stage least squares method of estimation is used to solve these problems. It is applied to each equation in the system separately, and as appears from its name, it involves two stages. In the first stage the coefficients of the reduced form equations
(\hat{\Pi}) are estimated by least square method. Then the estimates of these coefficients (\hat{\Pi}) along with the data on all exogenous variables are used to estimate the endogenous variables (\hat{Y}). In the second stage all the explanatory endogenous variables are replaced by their values estimated from the reduced form. Then by least-square method, the estimates of the structural form parameters are obtained.

To see how the TSLS method of estimation works, consider the first equation to be estimated. This equation is presented in the following form:

$$y_1 = Y_1\gamma_1 + X_1\beta_1 + \epsilon_1$$

In TSLS method, matrix $Y_1$ is replaced by a computed matrix $\hat{Y}_1$ which is purged of the stochastic element and then the OLS regression of $y$ on $\hat{Y}_1$ and $X_1$ is performed \cite{Johnston1972, p. 381}. In the first stage, $\hat{Y}_1$ is computed by regressing each variable in $Y_1$ on all the exogenous variables in the complete model and then replacing the actual observations on the variables in $Y_1$ by the corresponding regression values.

In the matrix form:

$$Y_1 = \Pi_1 + U$$

$$\hat{\Pi}_1 = (X'X)^{-1} X'Y_1$$

$$\hat{Y}_1 = \hat{\Pi}_1 = X(X'X)^{-1} X'Y_1$$

In the second stage, $y_1$ is regressed on $\hat{Y}_1$ and $X_1$ and, thus, the estimates of the structural parameters $\gamma_1$ and $\beta_1$ are obtained as follows:
\[ y_1 = \hat{Y}_1 Y_1 + X_1 \beta_1 + v \]

where:

\[ \begin{bmatrix} Y_1 \\ \beta_1 \end{bmatrix}_{TSL} = \begin{bmatrix} \hat{Y}_1' Y_1 \\ \hat{X}_1' X_1 \end{bmatrix} \cdot \begin{bmatrix} \hat{Y}_1' \\ X_1' \end{bmatrix} \cdot y_1 \]

By replacing the \( Y_1 \) with \( \hat{Y}_1 \), the estimated value of each observation using the reduced form equations, the explanatory endogenous variables \( (Y_1) \) are "purged" of their endogenous nature by subtracting the \( \hat{u}_1 \) residuals [Intriligator, 1978, p. 388]. As a result the TSLS estimators are consistent estimators. However, it can be proved that they are generally biased.\(^1\)

But in spite of this problem (biasedness), TSLS method is used as one method for estimating the parameters of the equations in model 4-1. The use of this method can be justified as is stated in [Johnston, 1972, p. 418]:

The experiments conducted give no clear guidelines for the choice of an estimator for econometric models. They indicate that the ambiguities to be found in earlier sampling experiments genuinely reflect properties of the simultaneous equation estimators. The results suggest that, because the consistent estimators do not differ greatly and their relative performances are sensitive to the data and structure studies, TSLS may well be the best estimator to choose since it is the cheapest and easiest method to compute.

\(^1\) For the proof of consistency and general biasedness refer to Intriligator [1978, pp. 389-391].
However, considering the limited number of observations in this study, and because it has not been established that the properties of the coefficients estimated by simultaneous methods of estimation are superior to those of the OLS method in small samples, OLS was also used as one method of estimation applied to each equation separately. As it is stated in Intriligator [1978, p. 379]:

While OLS yields estimators that are biased and inconsistent, it should not be totally rejected as an estimation technique for simultaneous-equations system. The OLS estimators tend to exhibit both efficiency and insensitivity to specific error. Furthermore, as little is known concerning the finite-sample properties of any estimator, OLS may be as good as any other method of estimation, even the consistent estimators to be presented later in this chapter.

Serial Correlation

All the statistical estimation methods explained prior to this point (OLS and TSLS) are based on the assumption of the absence of serial correlation of the error terms (no autoregression). This implies that the disturbance occurring at one time is not correlated with any other disturbance at any other time. However, the assumption of nonautoregression of the disturbance terms is very likely to be violated in the case of relations estimated from time series data. Considering that this study is based on time series data, it is appropriate at this point to explain those methods of estimation which take into account the autoregression of the disturbances.

In the following simple regression model:

\[ Y_t = \beta X_t + \varepsilon_t \]

or in the matrix form:
The autoregressive disturbances can be shown as:
\[ E(\varepsilon_t, \varepsilon_{t-s}) \neq 0 \quad (t > s) \]
which states that the disturbance occurring at time \( t \) is related to the disturbance occurring at time \( (t-s) \). The covariance of the disturbances are:
\[ \text{cov} (\varepsilon_t, \varepsilon_{t-s}) = E(\varepsilon_t, \varepsilon_{t-s}) = \rho^s \sigma^2 \quad (t > s) \]
The first-order autoregressive scheme can be presented as follows:
\[
\varepsilon_t = \rho \varepsilon_{t-1} + U_t = \rho^t \varepsilon_0 + \rho^{t-1} U_1 + \rho^{t-2} U_2 + \ldots + \rho^2 U_{t-2} + \rho U_{t-1} + U_t
\]
\[ U_t \sim N(0, \sigma^2 u) \text{ for all } t \]
\[ E(U_t U_s) = 0 \quad \text{for all } t \neq s \]
\[ \varepsilon_0 \sim N(0, \frac{\sigma^2 u}{1 - \rho^2}) \]
where:
\[ \rho = \frac{\text{cov} (\varepsilon_t, \varepsilon_{t-1})}{\sigma^2} \]
and:
\[ \sigma^2 = \text{var} (\varepsilon_t) = \text{var} (\varepsilon_{t-1}) \]
In the existence of serial correlation, it can be shown that while the OLS estimator is still linear and unbiased it is no longer efficient and results in the failure of the usual statistical tests of significance.

One method for estimating regression equations with autoregressive disturbances is the Cochrane-Orcutt iterative process. To explain
this method, consider the following simple regression model:

\[ Y_t = \alpha + \beta X_t + \varepsilon_t \quad t = 1, 2, \ldots, n \quad (6-13) \]

where the disturbance terms, \( \varepsilon_t \), follows a first-order autoregressive scheme.

\[ \varepsilon_t = \rho \varepsilon_{t-1} + U_t \quad (6-14) \]

By lagging 6-13 by one time period and multiplying the obtained equation by \( \rho \) we have:

\[ \rho Y_{t-1} = \rho \alpha + \beta \rho X_{t-1} + \rho \varepsilon_{t-1} \quad (6-15) \]

Subtracting 6-15 from 6-13 we get:

\[ Y_t - \rho Y_{t-1} = \alpha (1 - \rho) + \beta (X_t - \rho X_{t-1}) + U_t \quad (6-16) \]

If \( a, b, \) and \( r \) are estimates of \( \alpha, \beta, \) and \( \rho \), the sum of squared residuals from 6-16 is given by:

\[ \sum_{t=1}^{n} e_t^2 = \sum_{t=1}^{n} [(Y_t - r Y_{t-1}) - a(1-r) - b(X_t - r X_{t-1})]^2 \quad (6-17) \]

The Cochrane-Orcutt iterative process approximates the values of \( a, b, \) and \( r \) which minimizes the sum of squares in 6-17. This method starts with an arbitrary value for \( r \), say \( r_1 \), then minimizes the sum of squares in 6-17 with respect to the parameters \( a \) and \( b \), obtaining values for \( a_1 \) and \( b_1 \). The next step minimizes the sum of squares with respect to \( r \), keeping \( a \) and \( b \) fixed at \( a_1 \) and \( b_1 \), obtaining \( r_2 \). This process continues until estimates for \( a, b, \) and \( r \) that are obtained do not significantly differ. This process always converges, but it can converge to a local rather than a global minimum for the sum of squares.

If we start with \( r_1 = 0 \), this procedure will consist of two steps. The first step involves obtaining OLS estimates of
\[ Y_t = \alpha + \beta X_t + \varepsilon_t, \] and calculating the residuals \( \hat{\varepsilon}_1, \hat{\varepsilon}_2, \ldots, \hat{\varepsilon}_n \). Then estimate \( \rho \), say \( \hat{\rho} \), by \( \hat{\rho} = \frac{\sum_{t=2}^{n} \hat{\varepsilon}_t \hat{\varepsilon}_{t-1}}{\sum_{t=2}^{n} \hat{\varepsilon}_t^2} (t = 2, 3, \ldots, n) \). In the second step new variables \( (Y_t - \hat{\rho}Y_{t-1}) \) and \( (X_t - \hat{\rho}X_{t-1}) \) will be constructed and the OLS estimates of \( (Y_t - \hat{\rho}Y_{t-1}) = \alpha^* + \beta (X_t - \hat{\rho}X_{t-1}) + U_t \) where \( \alpha^* = \alpha(1 - \varepsilon) \) are obtained. Then the process continues, as was explained before, until the values of the estimators converge. The final round estimates of \( \alpha \) and \( \beta \), coincide with the values of the maximum likelihood estimators.

By stopping after obtaining the "second round" estimates of \( \alpha \) and \( \beta \) based on the "first round" value of \( \rho \), the iterative procedure can be reduced to a two-stage procedure.

The method used in estimating equations with second-order (or higher order)\(^1\) autoregression is very similar to the method explained for first-order autoregression. That is, the procedure starts with an initial set of estimates of the parameters and advances to improve on these estimates. The iteration process continues until there is no change in the estimated parameters.

---

\(^1\) If \( \varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + U_t \), then \( \varepsilon_t \) is said to follow an autoregressive process of the second order. And, in general, if \( \varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + \ldots + \rho_k \varepsilon_{t-k} + U_t \), then \( \varepsilon_t \) is said to follow an autoregressive process of the kth order [Madala, 1977, p. 275].
There are also other iteration methods of estimation which will not be discussed here.¹

It is known that the various iterative or two-step methods are asymptotically more efficient than the OLS. But does this gain in efficiency actually show up in small samples, and is there any variation in the small-sample efficiency of the various two-step estimates?

A Monte Carlo study by Griliches and Rao compared OLS, two-step Cochrane-Orcutt, Paris-Winston, Durbin, and non-linear methods. The first main conclusion of this study as described in [Johnston, 1972, p. 265] is that:

OLS is less efficient than the other estimators for the samples of size 20 used in this study. This is especially true when |ρ| > 0.3; for low values of ρ there may be a little loss in efficiency in using the more complicated methods compared with OLS. The second main conclusion is that the Durbin method of estimation ρ is probably better than the others and that a two-stage estimator using the Durbin ρ in the T₁ matrix is likely to do best over a wider range of parameters than any of the other estimators examined ... . Finally it appears that the nonlinear method shows no improvement over the simpler two-stage procedures.

In some cases, we may not want to assume that the model is or is not autoregressive. In this case, we may want to test the hypothesis of no autoregression

H₀: ρ = 0

against the alternative hypothesis of the existence of positive autoregression:

¹For more information refer to [Johnston, 1972, Chapter 8].
In large samples the maximum likelihood estimator of $p$ is approximately normally distributed with estimated variance:

$$S^2_\Delta = \frac{1 - \rho^2}{n}$$

where $\Delta$ stands for maximum likelihood estimator.

In small samples this estimated variance can be used as an approximation.

The acceptance region for the null hypothesis is

$$\frac{\rho}{S_\Delta} < t_\alpha$$

where $1 - \alpha$ is the significance level. An alternative test is known as the Durbin Watson test. The value of a statistic $d$ is calculated as:

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

where the $e$'s represent OLS residuals.

By comparing the calculated $d$ with the tabulated $d$, the hypothesis of the presence of positive autoregression can be tested. It should be noted that in the regression equations in which one explanatory variable is the lagged value of the dependent variable, the Durbin Watson test is not applicable.

If the test results indicate no autoregression, then least-squares estimates can be used without fearing a loss of efficiency and a bias of the estimated standard errors. However, if the test results indicate autoregression, we can use one of the estimation methods designed for the models with serially autocorrelated errors, e.g., maximum likelihood,
or the two-stage procedure. Another alternative is to re-specify the model since, as is explained in Kmenta [1971, p. 296], "The autoregression of the disturbance may simply reflect the presence of some unexplained systematic influence on the dependent variable."

Simultaneous Equations with Autocorrelated Errors

Estimation of a single equation in a system when the errors are assumed to satisfy a first-order autoregressive process

Suppose that the equation of interest is:

\[ Y_1 = Y_2 \beta + X_1 Y_1 + Y_{3,-1} Y_3 + U_1 \]  \hspace{1cm} (6-18)

where the elements of \( U_1 \) are assumed to satisfy:

\[ U_{t1} = \rho_1 U_{t-1,1} + \varepsilon_t \hspace{1cm} |\rho_1| < 1 \]

\[ \varepsilon_t \sim \text{NID}(0, \sigma^2) \]

and it is also assumed that \( U_t \) is independent of the lagged values of all endogenous variables in the system. In equation 6-18 and in the model that includes equation 6-18:

- \( Y_2 \) is the matrix of observations on the endogenous variables (other than \( Y_1 \) in the equation).
- \( X_1 \) is a matrix of exogenous variables.
- \( Y_{3,-1} \) is a matrix of observations on lagged endogenous variables.
- \( X_2 \) is a matrix of exogenous variables included in the system but not in the equation.

---

1 This method was developed by Dr. Wayne Fuller, Statistics Department, Iowa State University. The notations, definitions, and the equations that are used to explain this method are the same as in Fuller [1978].
$Y_{4,-1}$ is the matrix of observations on lagged endogenous variables entering the system but not the equation.

It is assumed that the elements of $X = (X_1 : X_2)$ are uniformly bounded.

Here, an estimation procedure which is a simple adaptation of the one step Gauss-Newton procedure to the simultaneous equations case is outlined in five steps.

1. Regress $Y_2$ and $Y_{3,-1}$ on exogenous and lagged exogenous variables and obtain $\hat{Y}_2$ and $\hat{Y}_{3,-1}$ for these variables.

2. By regressing $Y_1$ on $\hat{Y}_2$, $X_1$ and $Y_{3,-1}$, obtain estimates of $\beta$, $\gamma_1$ and $\gamma_3$.

These instrumental variables estimators, $\hat{\beta}$, $\hat{\gamma}_1$ and $\hat{\gamma}_3$ differ from the true parameters by quantities equal to $o_p(\sqrt{n})$.

3. Calculate the estimated residual vector as the following:

$$\hat{U}_{t,1} = Y_{1,t} - \hat{Y}_2 \beta - X_1 \hat{\gamma}_1 - Y_{3,-1} \hat{\gamma}_3$$

and estimate $\rho_1$ by:

$$\hat{\rho}_1 = \frac{\sum_{t=2}^{n} \hat{U}_{t,1} \hat{U}_{t-1,1}}{\sum_{t=2}^{n} \hat{U}_{t,1}^2}$$

4. Transform all of the variables in the system using $\hat{\rho}_1$.

For example:

$$\hat{W}_{1t} = \sqrt{1 - \hat{\rho}_1^2} \hat{Y}_{1t} \quad \text{for } t = 1$$

and:

$$\hat{W}_{1t} = Y_{1t} - \hat{\rho}_1 Y_{1,t-1} \quad \text{for } t = 2, 3, \ldots, n$$
In matrix form:

\[
\begin{bmatrix}
\sqrt{1 - \rho^2} & 0 & 0 & \ldots & 0 \\
-\rho & 1 & 0 & \ldots & 0 \\
0 & -\rho & 1 & \ldots & 0 \\
. & . & . & . & . \\
. & . & . & . & . \\
0 & 0 & 0 & \ldots & 1
\end{bmatrix}
\]

\[ W_1 = T_1 Y_1 \text{ where } T_1 = \begin{bmatrix}
\sqrt{1 - \rho^2} & 0 & 0 & \ldots & 0 \\
-\rho & 1 & 0 & \ldots & 0 \\
0 & -\rho & 1 & \ldots & 0 \\
. & . & . & . & . \\
. & . & . & . & . \\
0 & 0 & 0 & \ldots & 1
\end{bmatrix} \]

The transformed matrices for \( Y_1, X_1, X_2, \gamma_2, \gamma_3, \gamma_4 \) and \( Y_4, X_4 \) are then denoted by \( W_1, H_1, H_2, W_2, W_3, W_4 \), and \( W_4, W_4 \).

5. Using the Taylor series approximation employed in the Gauss-Newton procedure we write equation 6-18 as:

\[ W_1 = W_2 + H_1 Y_1 + W_3, Y_3 + \hat{U}_{1,-1} \Delta \rho + \epsilon + \text{Remainder (6-19)} \]

where \( \hat{U}_{1,-1} \) is the vector with \( \hat{U}_{t-1,1} \) as the \( t^{\text{th}} \) element for \( t = 2, 3, \ldots, n \) and \( \hat{U}_{0,1} = 0 \).

Any of the single equation methods, such as two-stage least squares can estimate the parameters in equation 6-19. The matrices \( H_1, H_2, W_3, W_4, \hat{U}_{1,-1} \) are used in the first-stage calculation of the reduced form. Note that \( \hat{U}_{1,-1} \) is a predetermined variable in the analysis. This method will be quite efficient if all equations in the system have nearly the same autocorrelation structure.

**Estimation of a single equation in a system when the errors are assumed to satisfy a second-order autoregressive process**

The method that is used in this case is a modified version of the method used when the errors are assumed to satisfy a first-order autoregressive process.
Suppose the equation of interest is the same as 6-18. However, in this case the elements of $\varepsilon$ are assumed to satisfy:

$$U_{t1} = \rho_1 U_{t-1,1} + \rho_2 U_{t-2,1} + \varepsilon_t \quad t = 3, \ldots, n$$

$$\varepsilon_t \sim \text{NID}(\sigma, \sigma^2) \quad |\rho_1| < 1 \quad |\rho_2| < 1$$

It is also assumed that $U_t$ is independent of the lagged values of all endogenous variables in the system. The estimation procedure is again a simple adaptation of the one-step Gauss-Newton procedure to the simultaneous equations case which is outlined in the five steps. The first two steps are exactly the same as was explained before, for the case where the errors are assumed to satisfy a first-order autoregressive process. The third, fourth, and fifth step are as follows:

3. Calculate the estimated residual vector:

$$\hat{U}_{ol} = Y_1 - Y_2 \hat{\beta} - X_1 \hat{Y}_1 - Y_{3,-1} \hat{Y}_3$$

and estimate $\rho_1$ and $\rho_2$ by:

$$\begin{bmatrix} \hat{\rho}_1 \\ \hat{\rho}_2 \end{bmatrix} = \begin{bmatrix} \sum_{t=3}^{n} U_{t-1,1}^2 \\ \sum_{t=3}^{n} U_{t-1,1} U_{t-2,1} \end{bmatrix} \begin{bmatrix} \sum_{t=3}^{n} U_{t-1,1} U_{t-1,1} \\ \sum_{t=3}^{n} U_{t-2,1} U_{t-2,1} \end{bmatrix}^{-1} \begin{bmatrix} \sum_{t=3}^{n} U_{t1} U_{t-1,1} \\ \sum_{t=3}^{n} U_{t1} U_{t-2,1} \end{bmatrix}$$

4. Transform all the variables in the system using $\hat{\rho}_1$ and $\hat{\rho}_2$.

The transformed matrices for $Y_1$, $X_1$, $X_2$, $Y_2$, $Y_{3,-1}$, and $Y_{4,-1}$ are denoted by $W_1$, $H_1$, $H_2$, $W_2$, $W_{3,-1}$ and $W_{4,-1}$.

5. Using the Taylor series approximation employed in the Gauss-Newton Procedure we write equation 6-18 as:

$$W_1 = W_2 \hat{\beta} + H_1 \hat{Y}_1 + W_{3,-1} \hat{Y}_{3,-1} + \hat{U}_{1,-2} \Delta \rho_1 \Delta \rho_2 + \varepsilon + \text{Remainder}$$

(6-20)
where $U_{t,-1}$ is the vector with $U_{t-1,1}$ as the $t^{th}$ element for $t = 2, 3, \ldots, n$ and $U_{0,1} = 0$. Also $U_{2,-2}$ is the vector with $U_{t-2,2}$ as the $t^{th}$ element for $t = 3, \ldots, n$ and $U_{0,1} = 0$ and $U_{0,2} = 0$.

Any of the single equation methods, such as TSLS, can estimate the parameters in equation 6-20. The matrices $H_1, H_2, W_3, W_4, H_1', H_2', W_3', W_4'$, $\hat{U}_{1,-1}$ and $\hat{U}_{2,-2}$ are used in the first-stage calculation of the reduced form. Note that $\hat{U}_{1,-1}$ and $\hat{U}_{2,-2}$ are treated as predetermined variables in the analysis.

Because the remainder in equation 6-20 is a function of the error in $\hat{\beta}, \hat{\gamma}_1, \text{and } \hat{\gamma}_3$ it follows that the two-stage least squares estimates of 6-20 are consistent.

**Estimation of the Reduced Form Equations**

The structural equations in a simultaneous system can be solved for the endogenous variables to give the reduced form of the model. "The reduced form equations show explicitly how the endogenous variables are jointly dependent on the predetermined variables and the disturbances of the system" [Kmenta, 1971, p. 533]. The reduced form equations can be used for short-term forecasting. The reduced form coefficients are called reduced form multipliers.

To derive the reduced form equations, let the structural form of a simultaneous equation system in the matrix form be:

$$\beta Y_t + TX_t = U_t \quad (6-21)$$
where $\beta$ is a $G \times G$ matrix of the coefficients of the endogenous variables, $Y$ is a $G \times 1$ vector of endogenous variables, $T$ is a $G \times k$ matrix of the coefficients of the exogenous variables, and $X$ is a $k \times 1$ vector of exogenous variables.

The reduced form equations can be derived explicitly by solving 6-21 for $Y_t$:

$$Y_t = -\beta^{-1} TX_t + \beta^{-1} U_t$$

or:

$$Y_t = \Pi X_t + V_t$$

where:

$$\Pi = -\beta^{-1} T$$ is the $G \times k$ matrix of the reduced form multipliers, and $V_t = \beta^{-1} U_t$.

Before concluding this chapter, it should be pointed out that the data used in this study, like most economic observations, are likely to contain measurement errors. However, neither the size, nor the properties of these errors is known, and, therefore, dealing with them is very difficult; thus, they (measurement errors) are ignored in this study.
CHAPTER VII. RESULTS

This chapter gives the results of the statistical analysis of the model presented in Chapter IV (Model 4-1).

In the first part of this chapter, the signs of the estimated coefficients from the full model and the various ways to improve these coefficients are discussed. In the second part, the experiments undertaken to obtain the final reduced model are reviewed. Also, in this part, the statistical results of the final reduced model and the reduced form equations are presented and discussed.

The Full Model

Estimation results

The parameters of the full model, model 4-1, were estimated by the OLS estimation procedure. However, the results were very unsatisfactory. Table 7-1 presents the coefficient estimates and their standard deviations for each equation in the full model 4-1. As is observed in table 7-1, the signs for many of the estimated coefficients turned out to be the opposite of what was expected from economic theory\(^1\) and although the coefficient of determination, \(R^2\), was relatively high for each equation, none of the coefficients which had the correct sign was significantly different from zero at 5% level.\(^2\)

\(^1\)The expected signs for the coefficients in each equation were explained in Chapter IV.

\(^2\)The only exception to this was the estimated coefficient for PLO\(_{t-1}\) in the equation for \(L_t\) that not only had the correct sign, but was significantly different from zero at 1% level.
Table 7-1. The OLS estimates of the full model.

\[
\begin{align*}
IF_t &= -106562 - 184.75 PT_t + 35.57 PT_{t-1} - 14.56 Y_t + 1.19 L_t + 13.91 POIL_t \\
&(159295)^a (741.09) (585.73) (248.45) (1.38) (36.19) \\
&+ 97.68 PO_{t-1} + 426.93 PTW_t - 1331.17 T - 8.05 MA_t - 1889.5 D1 \\
&(390.57) (627.46) (6746.64) (6.77) (4568.15) \\
R^2 &= 0.6214 \quad F \text{ ratio } = 0.8
\end{align*}
\]

\[
\begin{align*}
L_t &= 34241.05^{**} + 285.49 PT_t - 87.25 PL_t + 268.32 PLO_{t-1} + 274.13 PT_{t-1} \\
&(4252.92) (145.36) (94.98) (70.04) (133.19) \\
&- 39.86 PL_{t-1} - 387.40 PLO_{t-1} \\
&(122.19) (70.57) \\
R^2 &= 0.956 \quad F \text{ ratio } = 32.9
\end{align*}
\]

\[
\begin{align*}
PIT &= 50.84 - 0.00038 PROW_t + 2.55 YROW_t + 0.0021 PT_t \\
&(36.92) (0.00025) (1.18) (0.53) \\
R^2 &= 0.54 \quad F \text{ ratio } = 4.7
\end{align*}
\]

\[
\begin{align*}
PT_t &= -139.04 + 0.41 PT_{t-1} + 0.74 PO_{t-1} + 0.14 PTW_t - 2.83 T - 0.14 PI_t \\
&(153.4) (0.25) (0.55) (0.41) (5.8) (0.12) \\
&- 0.0000016 IF_t + 0.075 Y_t + 0.002 L_t + 0.02 POIL_t - 0.01 MA_t \\
R^2 &= 0.998 \quad F \text{ ratio } = 296.3
\end{align*}
\]

\(^a\) Standard deviations are in parentheses.

\(^*\) Significantly different from zero at the 5% level.

\(^{**}\) Significantly different from zero at the 1% level.
Problems faced in estimating the full model and the various ways to solve them

One of the major problems in the estimation of the full model, model 4-1, dealt with the degrees of freedom. The study contained only sixteen observations for each variable, while the equation for IF$_t$ contained ten, the equation for PT$_t$ ten, the equation for PI$_t$ three, and the equation for L$_t$ six variables on the right hand side.

Another problem faced in estimating the full model was multicollinearity. Multicollinearity refers to a situation where "...because of strong interrelationships among the independent variables, it becomes difficult to disentangle their separate effects on the dependent variable" [Madala, 1977, p. 183]. The relatively high $R^2$s, the very low t ratios, and the high correlation coefficients between the dependent variables$^1$ indicate the existence of multicollinearity. One solution to the multicollinearity problem is to drop variables$^2$ [Madala, 1977, p. 190].

As will be discussed later in this chapter, after dropping some variables from each equation of model 4-1, the signs of many coefficients were changed to the correct sign and also the t ratios were improved so that the coefficients were significantly different from zero at 5% or 1% level.

$^1$The correlation coefficients are presented in Appendix.

$^2$It should be mentioned that the estimated parameters after dropping some variables (omitted-variable estimators) are biased [Madala, 1977].
Another solution which was used in this study along with dropping variables was grouping the variables so that after grouping there were fewer independent variables in each equation. Grouping was done by taking ratios of two variables or summing them with the proper sign after transforming the data from actual values into indices. The variables included in the grouping were chosen so that after taking ratios or sums the resulting variable still had economic meaning. For example, livestock product price \((PL_t)\) divided by input price \((PLO_t)\) in the livestock inventory equation, or \(PL_t - PLO_t\), was computed to represent the net return.\(^1\)

The Final Reduced Model

The results from the OLS method of estimation

By using different combinations of dropping or grouping variables,\(^2\) several forms for each of the four structural equations of the model were estimated.\(^3\)

Then for each of the endogenous variables among all the estimated equations, the equation(s) that contained the highest number of variables with the correct sign and the lowest standard errors was (were) selected. The chosen equation(s) based on these criteria is (are) referred to as the best equation(s). The coefficient of determination, \(R^2\), was also considered when selecting the best equation(s).

\(^1\)Another example is \(PT_{t-1}\) divided by \(P0_{t-1}\) in the \(IF_t\) or \(PT_t\) equation.
\(^2\)The four endogenous variables; \(IF_t\), \(L_t\), \(PI_t\), and \(PT_t\) were never dropped if they appeared in the right hand side of any of the four equations.
\(^3\)The OLS method of estimation was used.
Table 7-2 presents the estimation results of the final reduced model which is composed of the best equations selected from the OLS equations.

Table 7-2. The OLS estimates of the reduced model

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-statistic</th>
<th>R^2</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF_t = -57452.3 - 70.72 PT_t + 0.79 L_t - 4.89 MA_t + 499.6 PTW_t - 46.73 Y_t</td>
<td>(39748.3)</td>
<td>(0.79)</td>
<td>(345.88)</td>
<td>(1.86)</td>
<td>(334.5)</td>
</tr>
<tr>
<td>L_t = 2914.5 - 88.09 PT_t + 71.99 PL_t + 0.98 LTLAG_t</td>
<td>(5911.13)</td>
<td>(80.77)</td>
<td>(54.18)</td>
<td>(0.14)</td>
<td>R^2 = 0.96</td>
</tr>
<tr>
<td>PT_t = 48.52 - 0.0004 PTW_t + 3.0 YROW_t - 0.16 PT_t</td>
<td>(39.35)</td>
<td>(0.00024)</td>
<td>(1.35)</td>
<td>(0.54)</td>
<td>R^2 = 0.54</td>
</tr>
<tr>
<td>PT_t = 50.02 - 0.00035 PROW_t - 0.0013 PREC_t + 3.47 YROW_t - 0.43 PT_t</td>
<td>(40.94)</td>
<td>(0.00026)</td>
<td>(0.0020)</td>
<td>(1.72)</td>
<td>(0.79)</td>
</tr>
<tr>
<td>PT_t = -53.315** + 0.715 PO_t** + 0.00153 L_t** - 0.163 PT_t** + 0.00025 IF_t</td>
<td>(13.14)</td>
<td>(0.097)</td>
<td>(0.00023)</td>
<td>(0.041)</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>PT_t = 24.74 - 141.61 PTLDPOL** + 0.004 L_t** - 0.45 PT_t** + 0.0007 IF_t</td>
<td>(37.57)</td>
<td>(18.1)</td>
<td>(0.00043)</td>
<td>(0.093)</td>
<td>(0.00045)</td>
</tr>
</tbody>
</table>

*Standard deviations are in parentheses.
*Significantly different from zero at the 5% level.
**Significantly different from zero at the 1% level.
In the final reduced model, as can be observed from table 7-2, all the coefficients of the included variables in the equations for $P_{t}$, $I_{t}$, and $L_{t}$ had the correct signs\(^1\) and many were significantly different from zero at 1% or 5% level. In the following section, the selection of the best equation(s) for each of the endogenous variables will be explained.

Selecting the best equation for $I_{t}$

In all of the estimated equations for $I_{t}$, the coefficients for $M_{t}$ and $P_{t}$ had the correct sign, and the coefficient for $M_{t}$ was significantly different from zero at 5% level in most of the estimated equations. The coefficient for $Y_{t}$ was negative and non-significant in the equations that included this variable.

The best equation for $I_{t}$, equation 7-1 in table 7-2, included these variables: $M_{t}$, $P_{t}$, and $Y_{t}$, plus $P_{t}$ and $L_{t}$. As mentioned before, an endogenous variable was never dropped if it appeared in the right hand side of the equation.

Only in some of the estimated equations for $I_{t}$ did the coefficient for $P_{t}$ have the correct sign; however, it was non-significant. In many of the estimated equations the coefficient for $P_{t}$ was positive (opposite of what was expected) and non-significant.

\(^1\) The correct signs are those which are expected from economic theory and which were discussed in Chapter IV. However, the correct sign for the coefficients of the variables on $P_{t}$ equation, as was explained in Chapter IV, cannot be determined from economic theory. This is because the determination of the signs of these coefficients depends on the sign of $\Delta$ (this symbol was explained in Chapter IV) which itself is undetermined. But, if we assume that $\Delta$ is positive then all of the estimated coefficients in the PT equation have the correct sign, except for the coefficient for $I_{t}$.\(^1\)
The coefficient for $L_t$ was negative (opposite of what was expected) and non-significant in most of the estimated equations. Only in some of them did this coefficient have the correct sign; however, it was always non-significant.

The remaining variables, $PT_{t-1}$, $POIL_t$, $PO_{t-1}$, $T$, and $Dl$, were dropped from the $IF_t$ equation in the full model in order to obtain the best equation for $IF_t$.

The coefficient for $PO_{t-1}$ had the correct sign in most of the estimated equations; however, it was non-significant in all of them.

The coefficient for $PT_{t-1}$ had the correct sign in some of the equations, but it was non-significant.

The coefficient for $POIL_t$, $T$, and $Dl$ were non-significant in all of the estimated equations for $IF_t$ which included these variables.

The coefficient for $POIL_t$ was positive in all of the estimated equations. The positive coefficient indicates the substitutability of oilseed meal and feed grains.

From the estimation results it was observed that by dropping $POIL_t$, $T$, and $Dl$, the sign and significance level on other variables were improved.

Dropping the oilseed meal price ($POIL_t$) while keeping the manioc consumption by the Community ($MA_t$) in the equation for $IF_t$ does make economic sense. This is because, as was explained in Chapter IV, the mix of oilseed meal and manioc is used as a substitute for feed grains in the Community. Thus, including manioc consumption will
capture the substitution effect of both oilseed meal and manioc for feed grains.

Selecting the best equation for $L_t$ In choosing the best equation for $L_t$, equation 7-2 in table 7-2, the criterion that was considered was the correct sign for the coefficient of $PT_t$. In many of the estimated equations this coefficient (the coefficient for $PT_t$) had the wrong sign and was non-significant. Deleting $PL_t$, $PLO_t$, $PT_{t-1}$, and $PLO_{t-1}$ from the $L_t$ equation and instead adding the size of livestock inventory in the previous period (LTLAG) gave the best results (equation 7-2, table 7-2). That is, the sign of the remaining coefficients, $PT_t$ and $PL_{t-1}$, was changed to the correct sign, and the level of $R^2$ was increased.

This might be because the present price of livestock products and the price of inputs used in livestock production ($PL_t$ and $PLO_t$) do not have an immediate effect on the size of livestock inventory. A lag might exist between price changes and the livestock inventory adjustments. Adding LTLAG to the equation will capture the effect of $PT_{t-1}$ and $PLO_{t-1}$ on $L_t$. However, since the feed grains' target prices are set prior to the marketing year, the current size of livestock inventory can adjust to the current level of feed grains' target prices.

In some of the estimated equations for $L_t$, the coefficient for $PL_t$ had the wrong sign (opposite of what was expected) and in some it had the correct sign; however, it was always non-significant.
In most of the estimated equations, the coefficient of $PLO_t$ had the correct sign but was non-significant.

In all the estimated equations, the coefficient for $PT_{t-1}$ had the wrong sign and was non-significant.

In some of the equations, the coefficient for $PLO_{t-1}$ had the correct sign but it was always non-significant. The only time that this coefficient was significant and had the correct sign was when it was accompanied only by $PT$ in the $L_t$ equation. However, in this case the coefficient for $PT_t$ did not have the correct sign.

In all of the estimated equations for $L_t$, the coefficient for $PL_{t-1}$ had the correct sign, but was non-significant.

Selecting the best equation for $PI_t$ For the equation for $PI_t$ also several versions were estimated. In all versions, all of the variables from the full model were included. However, instead of $PROW_t$ in some equations total world feed grains' production ($PRW_t$) was used. And in the others the rest of the world feed grains' production ($PROW_t$) and the EC-6 feed grains' production ($PREC_t$) were included as separate variables. Note that:

$$PRW_t = PROW_t + PREC_t$$

By including these variables instead of $PROW_t$, the sign of the coefficient of $PT_t$ changed to the correct sign.

In all of the estimated equations, $YROW_t$ had a positive coefficient that was significant in some cases.
Selecting the best equation for $PT_t$. Two equations were selected as the best. In one equation, $PT_{t-1}$, $PTW_t$, $T$, $Y_t$, and $POIL_t$ were deleted from the $PT_t$ equation in the full model (equation 7-5, table 7-2). In the other equation, in addition to these variables, $PO_{t-1}$ and $MA_t$ were also deleted, and the ratio of $PT_{t-1}$ to $PO_{t-1}$ ($PTLDPOL = \frac{PT_{t-1}}{PO_{t-1}}$) was added to the equation (equation 7-6, table 7-2).

The coefficient for $PT_{t-1}$ had the incorrect sign (positive) in all of the estimated equations and was always non-significant.

The coefficient for $PTW_t$ had always the correct sign and most of the times it was significant. However, dropping this variable improved the signs and the significance level on the included variables in $PT_t$ equation in the reduced model.

The coefficient for $T$ had the correct sign but was non-significant in every estimated equation.

The coefficient for $Y_t$ was positive but non-significant in most cases.

The coefficient for $POIL_t$ was positive and non-significant in all the estimated equations.

The coefficient for $PO_{t-1}$ had the correct sign and was significant in all the estimated equations.

\[1\text{Note that the correct signs in this case are those that are consistent with what is expected from economic theory assuming } \Delta \text{ in equation 4-45, Chapter IV being positive.}\]
The coefficient for $\text{MA}_t$ in most cases had the correct sign and was significant.

The coefficient for $\text{PTLDPOL}$ had the correct sign and was significant in most cases.

The coefficient for $L_t$ had the correct sign (positive) and was significant in most of the estimated equations. Only in a few cases was non-significant but it still had the correct sign.

The coefficient for $\text{PI}_t$ had always the correct sign (negative) and was significant in most of the estimated equations.

The coefficient for $\text{IF}_t$ had the wrong sign (positive) in most cases. Sometimes it was significant and sometimes non-significant. Only in a few cases did it have the correct sign (negative); however, it was non-significant in these cases.

Summary of the effect of exogenous variables on the four endogenous variables of the model from OLS estimations

The coefficient for $\text{PT}_{t-1}$ was mostly non-significant in the estimated equations for $\text{IF}_t$, $L_t$, and $\text{PT}_t$. It had the correct sign only for some of the estimated equations for $\text{IF}_t$. The only time that it had a significant effect was when it was divided by $\text{PO}_{t-1}$ and was used in the $\text{PT}_t$ equation as $\text{PTLDPOL}$ (equation 7-6, table 7-2).

The coefficients for $\text{POIL}_t$, $T$, $D_1$, $\text{PL}_t$, $\text{PLO}_t$, and $\text{PLO}_{t-1}$ were never significant in any of the estimated equations.

The coefficients for manioc consumption in the Community ($\text{MA}_t$) and soft wheat threshold price ($\text{PTW}_t$) had the correct sign and were
significant in the majority of the estimated equations for $IF_t$ and $PT_t$.\(^1\)

The coefficient for $Y_t$ had a negative sign and was non-significant in all of the estimated equations for the $IF_t$ that included it, while it had a positive sign and was non-significant in most of the estimated equations for $PT_t$.

The coefficient for $P0_{t-1}$ had the correct sign in the estimated equations for $IF_t$ and $PT_t$. However, this coefficient was not significant in the $IF_t$ equations, while it was significant in the estimated $PT_t$ equations.

The coefficient for $PL_{t-1}$ had always the correct sign but was non-significant in all of the estimated equations for $L_t$.

The coefficient for $PROW_t$ had always the correct sign but was non-significant, while the coefficient for $YROW_t$ was significant (and positive) in most of the estimated equations for $PI_t$.

The results from the TSLS method of estimation

The best selected equations which were estimated by the OLS method and which formed the reduced model presented in table 7-2 were also estimated by the TSLS method.\(^2\)

\(^1\) The coefficient for $PTW_t$ had the correct sign in all of the estimated equations for $IF_t$ and $PT_t$. The coefficient for $MA_t$ had the correct sign in all of the estimated equations for $IF_t$.

\(^2\) The two stage Principal Components could be used if instead of the reduced model the full model had to be estimated. This model, which was originally developed by Kloek and Mennes [1960], allows a limited number of principal components of exogenous variables in the first stage.
In order to do so, various possible combinations of the equations presented in table 7-2 were considered simultaneously. The system of simultaneous equations obtained in this way was identified and, therefore, the TSLS estimation was possible. The results of the TSLS estimation of equations 7-1, 7-2, 7-3, and 7-6, equations 7-1, 7-2, 7-4, and 7-5, equations 7-1, 7-2, 7-4 and 7-6, equations 7-1, 7-2, 7-3, and 7-5 are presented in tables 7-3, 7-4, 7-5, and 7-6, respectively.

From the relatively high $R^2$'s, by looking at the results in tables 7-2, 7-3, 7-4, 7-5, and 7-6, it can be concluded that the included variables seem to explain much of the variation in feed grains' threshold price and the size of livestock inventory.

Among all the variables included in the selected equations for $PI_t$ in the reduced model, equations 7-3 and 7-4 in table 7-2, and the $PI_t$ equations in table 7-3 and 7-6, the income in the rest of the world ($YROW_t$) was the only variable that had the correct sign and was significantly different from zero at 5% level. And this happened only when $PROW_t$ was used (as in equation 7-3, table 7-2) instead of a combination of $PROW_t$ and $PREC$ (as in equation 7-4, table 7-2).

In both selected equations for $PT_t$ in the reduced model, equations 7-5 and 7-6 in table 7-2, and the equations for $PT_t$ in tables 7-3, 7-4, 7-5, and 7-6, all of the included right hand side variables, except for $IF_t$, had coefficients that were significantly different from zero. The EC-6 feed grains' imports ($IF_t$) did not have a significant coefficient in any of the estimated equations for $PT_t$. 
Table 7-3. TSLS estimates of reduced model 1

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficients</th>
<th>Intercept</th>
<th>( R^2 )</th>
<th>F ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>( IF_t = -103226 - 369.91 PT_t + 1.72 L_t - 5.20 MA_t^* + 769.87 PTW_t - 67.60 Y_t )</td>
<td>( (79529.2)^a )</td>
<td>0.53</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>( L_t = 3120.55 - 82.12 PT + 68.19 PL_t - 0.97 LLAG^* )</td>
<td>( (5979.7) )</td>
<td>0.957</td>
<td>89.01</td>
<td></td>
</tr>
<tr>
<td>( PI_t = 53.78 - 0.00036 PKW_t + 2.78 YROW_t^* - 0.096 PT_t )</td>
<td>( (37.60) )</td>
<td>0.545</td>
<td>4.80</td>
<td></td>
</tr>
<tr>
<td>( PT_t = 1.60 - 145.67 PTLDPOL^* + 0.0043 L_t^* - 0.59 PI_t^* + 0.0014 IF_t )</td>
<td>( (47.42) )</td>
<td>0.962</td>
<td>69.28</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Standard deviations are in parentheses.

\(^*\) Significantly different from zero at the 5% level.

\(^**\) Significantly different from zero at the 1% level.
Table 7-4. TSLS estimates of reduced model 2

<table>
<thead>
<tr>
<th>Equation</th>
<th>Estimated Values</th>
<th>Standard Deviations</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF&lt;sub&gt;t&lt;/sub&gt; = -54370.5 + 72.06 PT&lt;sub&gt;t&lt;/sub&gt; + 0.86 L&lt;sub&gt;t&lt;/sub&gt; - 4.7 MA&lt;sup&gt;*&lt;/sup&gt;&lt;sub&gt;t&lt;/sub&gt; + 374.99 PTW&lt;sub&gt;t&lt;/sub&gt; - 61.58 Y&lt;sub&gt;t&lt;/sub&gt;</td>
<td>(55623.5)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(471.21)</td>
<td>(1.09)</td>
</tr>
<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt; = 0.55</td>
<td>F ratio = 2.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L&lt;sub&gt;t&lt;/sub&gt; = 2666.6 - 95.28 PT&lt;sub&gt;t&lt;/sub&gt; + 76.57 PL&lt;sub&gt;t-1&lt;/sub&gt; + 0.99 LTLAG**</td>
<td>(5985.4)</td>
<td>(85.15)</td>
<td>(56.83)</td>
</tr>
<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt; = 0.957</td>
<td>F ratio = 89.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PI&lt;sub&gt;t&lt;/sub&gt; = 55.20 - 0.00036 PROW&lt;sub&gt;t&lt;/sub&gt; - 0.00073 PREC&lt;sub&gt;t&lt;/sub&gt; + 2.91 YROW&lt;sub&gt;t&lt;/sub&gt; - 0.16 PT&lt;sub&gt;t&lt;/sub&gt;</td>
<td>(39.62)</td>
<td>(0.00026)</td>
<td>(0.0018)</td>
</tr>
<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt; = 0.957</td>
<td>F ratio = 3.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT&lt;sub&gt;t&lt;/sub&gt; = -58.22 + 0.71 PO&lt;sup&gt;<strong>&lt;/sup&gt;&lt;sub&gt;t-1&lt;/sub&gt; + 0.0016 L&lt;sup&gt;</strong>&lt;/sup&gt;&lt;sub&gt;t&lt;/sub&gt; - 0.18 PT&lt;sup&gt;**&lt;/sup&gt;&lt;sub&gt;t&lt;/sub&gt; + 0.00037 IF&lt;sub&gt;t&lt;/sub&gt;</td>
<td>(13.91)</td>
<td>(0.11)</td>
<td>(0.00024)</td>
</tr>
<tr>
<td>- 0.0055 MA&lt;sup&gt;*&lt;/sup&gt;&lt;sub&gt;t&lt;/sub&gt;</td>
<td>(0.0025)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt; = 0.996</td>
<td>F ratio = 475.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Standard deviations are in parentheses.

*Significantly different from zero at the 5% level.

**Significantly different from zero at the 1% level.
Table 7-5. The TSLS estimation of reduced model 3

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficients</th>
<th>Standard Errors</th>
<th>T-values</th>
<th>F-values</th>
<th>R²</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFₜ = -86555.1 - 203.98 PTₜ + 1.44 Lₜ - 5.01 MAₜ + 621.99 PTWₜ</td>
<td>(76125.4)</td>
<td>(584.08)</td>
<td>(1.51)</td>
<td>(1.98)</td>
<td>(540.18)</td>
<td>- 67.55</td>
</tr>
<tr>
<td>Lₜ = 3142.04 - 81.5 PTₜ + 67.80 PLₜ₋₁ + 0.97 LLAG**</td>
<td>(5977.5)</td>
<td>(84.70)</td>
<td>(56.56)</td>
<td>(0.15)</td>
<td>0.957</td>
<td>89.0</td>
</tr>
<tr>
<td>PLₜ = 55.13 - 0.00036 PROWₜ - 0.0008 PREC + 2.97 YROWₜ - 0.21 PT</td>
<td>(39.62)</td>
<td>(0.0003)</td>
<td>(0.002)</td>
<td>(1.55)</td>
<td>(0.73)</td>
<td>0.55</td>
</tr>
<tr>
<td>PTₜ = 16.35 - 148.23 PTLDPOL** + 0.004 Lₜ** - 0.56 PIₜ** + 0.00104 IFₜ</td>
<td>(41.96)</td>
<td>(20.56)</td>
<td>(0.00048)</td>
<td>(0.11)</td>
<td>(0.0005)</td>
<td>0.97</td>
</tr>
</tbody>
</table>

*Standard deviations are in parentheses.

*Significantly different from zero at the 5% level.

**Significantly different from zero at the 1% level.
Table 7-6. TSLS estimates of reduced model 4

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficients</th>
<th>t-values</th>
<th>Standard Deviation</th>
<th>F ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>( IF_t )</td>
<td>-122821</td>
<td>-529.62</td>
<td>(73692.03)</td>
<td>2.19</td>
</tr>
<tr>
<td></td>
<td>+ 2.08</td>
<td></td>
<td>(630.76)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( L_t )</td>
<td>-5.38</td>
<td>(2.20)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( MA_t )</td>
<td></td>
<td>(582.47)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ 912.99</td>
<td></td>
<td>(50.64)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( PTW_t )</td>
<td>-72.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( L_t )</td>
<td>2809.68</td>
<td>-91.13</td>
<td>(6004.9)</td>
<td>89.10</td>
</tr>
<tr>
<td></td>
<td>+ 73.93</td>
<td></td>
<td>(86.37)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( PL_{t-1} ) + 0.98 LTLAG**</td>
<td></td>
<td>(57.57)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.957</td>
<td></td>
<td>(0.15)</td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.945</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( PI_t )</td>
<td>54.07</td>
<td>-0.00038</td>
<td>(37.61)</td>
<td>4.80</td>
</tr>
<tr>
<td></td>
<td>+ 2.76 YROW*</td>
<td></td>
<td>(0.00024)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 0.07</td>
<td></td>
<td>(1.27)</td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.545</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( PT_t )</td>
<td>-57.76**</td>
<td>0.74</td>
<td>(13.73)</td>
<td>488.91</td>
</tr>
<tr>
<td></td>
<td>+ 0.0016</td>
<td></td>
<td>(0.11)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( L_t )</td>
<td>-0.18</td>
<td>(0.00024)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( PI_t )</td>
<td>+ 0.0027</td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( IF_t )</td>
<td>- 0.006</td>
<td>(0.0025)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Standard deviations are in parentheses.

\(^*\)Significantly different from zero at the 5\% level.

\(^**\)Significantly different from zero at the 1\% level.

In the equation for \( L_t \) (equation 7-2, table 7-2, and the \( L_t \) equations in tables 7-3, 7-4, 7-5 and 7-6), LTLAG was the only significant right hand side variable with the correct sign of the coefficient.
Estimation results of the reduced form equations

Finally, the derived reduced form coefficients of the equations presented in table 7-6 were obtained. The estimation results are presented in table 7-7.

Table 7-7. The estimation results for the reduced form equations from reduced model 4

\[
\begin{align*}
IF_t &= -65.33 - 0.038 \text{PRW}_t + 278.05 \text{YROW}_t - 1.27 \text{MA}_t + 777.34 \text{PTW}_t \\
&\quad - 61.59 Y_t - 401.34 \text{PO}_{t-1} + 67.05 \text{PL}_{t-1} + 0.89 \text{LTLAG} \\
L_t &= 9357.21 - 0.005 \text{PRIJ}_t + 35.25 \text{YROW}_t + 0.52 MA_t - 17.20 PTW_t \\
&\quad + 1.36 Y_t - 50.88 \text{PO}_{t-1} + 62.96 \text{PL}_{t-1} + 0.84 \text{LTLAG} \\
\text{PI}_t &= 59.36 - 0.0004 \text{PRW}_t + 2.79 \text{YROW}_t + 0.00042 \text{MA}_t - 0.014 \text{PTW}_t \\
&\quad + 0.0011 Y_t - 0.041 \text{PO}_{t-1} - 0.0088 \text{PL}_{t-1} - 0.0001 \text{LTLAG} \\
\text{PT}_t &= -71.85 + 0.00005 \text{PRW}_t - 0.387 \text{YROW}_t - 0.0057 \text{MA}_t + 0.189 \text{PTW}_t \\
&\quad - 0.015 Y_t + 0.558 \text{PO}_{t-1} + 0.12 \text{PL}_{t-1} + 0.0016 \text{LTLAG}
\end{align*}
\]

The set of equations presented in table 7-6 was selected rather than the other sets (presented in tables 7-3, 7-4, and 7-5) because it contained a relatively larger number of variables whose coefficients had the correct signs and were significantly different from zero at 1% or 5% level. Also the R^2's in this set were relatively higher.

As can be observed from table 7-7, total world feed grains' production expressed in millions of feed units (PRW_t) has a negative effect on IF_t (the E.E.C. net imports of feed grains, expressed in millions of feed units), L_t (livestock inventory in the E.E.C.,
expressed in 1000 livestock units), $PI_t$ (world price of feed grains expressed in U.A./M.T.), and a positive effect on $PT_t$ (E.E.C. feed grains' threshold price expressed in U.A./M.T.). The effect of $PRW_t$ on $PI_t$ was expected from economic theory to be negative. As the world production increases because of the increased supplies, world price should decrease.

The index number of the rest of the world real income ($Y_{ROW_t}$) has a positive effect on $IF_t$, $L_t$, $PI_t$, and a negative effect on $PT_t$.

The manioc consumption by the E.E.C. expressed in thousand metric tons ($MA_t$) had a negative effect on $L_t$ and $PI_t$. The effect of $MA_t$ on $IF_t$ is consistent with what is expected from economic theory. As manioc consumption in the E.E.C. increases, feed grains' imports should decrease because of the substitutability of feed grains and manioc.

Soft wheat threshold price in terms of U.A./M.T. ($PTW_t$) has a positive effect on $IF_t$ and $PT_t$, and a negative effect on $L_t$ and $PI_t$. The effect of $PTW_t$ on $IF_t$ is consistent with what is expected from economic theory. As soft wheat prices in the E.E.C. increase, the Community producers will shift production from feed grains to soft wheat which will lead to a greater need for feed grains' imports.

The E.E.C. real income expressed in thousand million Eurs ($Y_t$), has a negative effect on $IF_t$ and $PT_t$ and a positive effect on $L_t$ and $PI_t$.

Lagged index of input prices ($PO_{t-1}$) has a negative effect on $IF_t$, $L_t$, and $PI_t$, and a positive effect on $PT_t$. The negative effect
of $P_0_{t-1}$ on $IF_t$ is the opposite of what is expected from economic theory. As the cost of production increases, one expects production to decrease and ceteris paribus, imports to increase.

The lagged index number of prices received by farmers for livestock and livestock products ($PL_{t-1}$) has a positive effect on $IF_t$, $L_t$, and $PT_t$, and a negative effect on $PI_t$.

The positive effect of $PL_{t-1}$ on $L_t$ is to be expected from economic theory.

Lagged livestock inventory expressed in thousand livestock units ($LTLAG$) has a positive effect on $IF_t$, $L_t$, and $PT_t$, and a negative effect on $PI_t$. The positive effect of $LTLAG$ on $L_t$ is expected from economic theory.

The autoregressive least squares (ALS)

All the equations which were estimated by the OLS method of estimation were also estimated with a method similar to the Cochrane-Orcutt Method that allows for the presence of first, second, and third order autoregressive errors.\(^1\) Then among the estimated equations, the best were selected.\(^2\) The best constituted of one equation for $PI_t$, one for $IF_t$, one for $L_t$, and two for $PT_t$. These are presented in table 7-8. In the equation for $PI_t$ instead of the current value of the world feed grains' production, $PRW_t$, the lagged value of this

\(^1\)This method is used by SAS which is a computer system for data analysis.

\(^2\)The criteria used for choosing the best equations is the same as was explained in OLS.
Table 7-8. The ALS estimates of the reduced models

<table>
<thead>
<tr>
<th>Equation</th>
<th>Parameters</th>
<th>Standard Deviations</th>
<th>$R^2$</th>
<th>$T \rho_1$</th>
<th>$T \rho_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{IF}_t = -38603.9 - 45.7 \text{PT}_t + 0.36 \text{LT}_t - 4.7 \text{MA}^{**}_t + 473 \text{PTW}^{*}_t - 31.4 \text{Y}_t$</td>
<td>(20512.92)(^a)</td>
<td>(185.8)</td>
<td>(0.42)</td>
<td>0.906</td>
<td>3.98</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.27</td>
<td>2.317</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(160.47)</td>
<td>(15.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(second order autoregressive errors)</td>
</tr>
<tr>
<td>$\text{L}_t = 2953.8 - 88.14 \text{PT}<em>t + 72.24 \text{PL}</em>{t-1} + 0.98 \text{LTLAG}^{**}$</td>
<td>(5952.14) (^b)</td>
<td>(80.97)</td>
<td>(54.30)</td>
<td>0.96</td>
<td>-0.0389</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.145)</td>
<td>(first order autoregressive errors)</td>
</tr>
<tr>
<td>$\text{PI}<em>t = 21.2 - 0.00008 \text{PW}</em>{t-1} + 1.6 \text{YROW}_t - 0.42 \text{P}_t$</td>
<td>(24.47)</td>
<td>(0.00009)</td>
<td>(0.82)</td>
<td>0.51</td>
<td>4.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.64)</td>
<td>(second order autoregressive errors)</td>
</tr>
<tr>
<td>$\text{PT}<em>t = -49.25^{**} + 0.77 \text{PO}</em>{t-1}^{<strong>} + 0.0014 \text{LT}^{</strong>}_t - 0.18 \text{PI}^{<strong>}_t + 0.00011 \text{IF}^{</strong>}_t$</td>
<td>(6.54)</td>
<td>(0.067)</td>
<td>(0.00011)</td>
<td>0.066</td>
<td>MA(^{**})</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.022)</td>
<td>(0.00012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0015)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(second order autoregressive error)</td>
</tr>
<tr>
<td>$\text{PT}_t = -132.96 + 1.11 \text{PTW}^{<strong>}_t - 0.00013 \text{IF}_t + 0.002 \text{LT}^{</strong>}_t - 0.08 \text{PI}^{**}_t$</td>
<td>(15.17)</td>
<td>(0.14)</td>
<td>(0.0002)</td>
<td>0.996</td>
<td>2.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0002)</td>
<td>(0.025)</td>
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<td>(0.0018)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(first order autoregressive error)</td>
</tr>
</tbody>
</table>

\(^a\) Standard deviations are in parentheses.

\(^b\) $T \rho_1$ and $T \rho_2$ represent the $t$ ratios for $\rho_1$ and $\rho_2$ in a serial correlation in error terms: $e_t = \rho_1 e_{t-1} + \rho_2 e_{t-2} + U_t$.

* Significantly different from zero at the 5% level.

** Significantly different from zero at the 1% level.
variable, \( PRW_{t-1} \) was used. This was because using \( PRW_t \) in the equation resulted in incorrect signs for the coefficients. When this variable was replaced with \( PRW_{t-1} \), the signs were changed to be correct.

The selected equations for \( PI_t \), \( IF_t \) (equations 7-9 and 7-7 in table 7-8) and one of the equations for \( PT_t \) (equations 7-10 in table 7-8) demonstrated the existence of second-order autoregression in their error terms. The other equation for \( PT_t \) (equation 7-11) indicated the existence of the first-order autoregression. The equation for \( L_t \) did not indicate any autoregression in the error terms.

By comparing tables 7-8 and 7-2, one can see that the equations which were selected as the best from ALS method of estimation (presented in table 7-8) are very similar to those which were selected as the best from OLS method and are presented in table 7-2.

The variables that are included in the equation for \( IF_t \) and \( L_t \) (equations 7-1 and 7-2 in table 7-2, and equations 7-7 and 7-8 in table 7-8) are exactly the same in both cases, i.e., the selected equations from OLS and ALS method of estimation.

The selected equations for \( PI_t \) from the two methods are also very similar except that in the selected equation from the ALS method (equation 7-9 in table 7-8) instead of the current value of the world feed grains' production, \( PRW_t \), the lagged value of this variable, \( PRW_{t-1} \), was used. This was because using \( PRW_t \) in the equation resulted in incorrect signs for the coefficients of other included variables. When \( PRW_t \) was replaced with \( PRW_{t-1} \) the signs were changed to be correct.
And, finally, the variables included in one of the selected equations for $PT_t$ are exactly the same from both methods of estimation (ALS and OLS), equation 7-5 in table 7-2, and equation 7-10 in table 7-8. Therefore, the discussion of the results in this case (ALS) would be very similar to the discussion in OLS.

In order to estimate the simultaneous equations for $PI_t$, $IF_t$, $PT_t$, and $L_t$ by the TSLS method considering the autoregression of the error terms, the procedures which were explained in Chapter VI for estimating simultaneous equations with autocorrelated errors were used.\(^1\)

Tables 7-9 and 7-10 were generated using the above method. They present the estimation results of the simultaneous equations 7-7, 7-8, 7-9, and 7-11, and equations 7-7, 7-8, 7-9, and 7-10, respectively.

It should be noted that because of the small sample size (only sixteen observations), the estimates of the coefficients estimated by TSLS autoregressive errors may be biased and the t statistics are not expected to follow the large sample distribution.

The estimation results of the derived reduced form coefficients of the equations presented in table 7-10 are presented in table 7-11. The criteria for choosing the equations in table 7-10 rather than the ones in 7-9 are the same as was explained for the results of table 7-7.

\(^1\)Note that since the errors in the equation for $L_t$ indicates the absence of serial correlation, the ordinary TSLS procedure which assumes there are no autocorrelation in error terms was used to estimate the $L_t$ equation.
By comparing tables 7-7 and 7-11 one can see that all the right hand side variables and the direction of their effect on the left hand side variables are exactly the same with only one exception. Instead of $PBW_t$ in table 7-7, $PBW_{t-1}$ is used in table 7-11. Therefore, the discussion on the effect of each of the right hand side variables on endogenous variables would be exactly the same as the discussion followed table 7-7.
Table 7-9. The estimation results of the simultaneous equations with autocorrelated errors

\[
\begin{align*}
IF_t &= -53748.9 - 172.20 PT_t + 0.77 L_t - 4.11 MA_t^* + 536.7 PTW_t - 41.69 Y_t \\
&\quad - 0.797 U_{1,t-1} - 0.52 U_{2,t-2} \\
&\quad (44328.7)^a (366.73) (0.91) (1.51) (316.5) (26.8) \\
R^2 &= 0.996 \quad F \text{ ratio} = 234.23
\end{align*}
\]

\[
\begin{align*}
L_t &= 2138 - 110.6 PT_t + 86.33 PL_{t-1} + 1.0035 LTLAG** \\
&\quad (6028.5) (86.91) (57.92) (0.15) \\
R^2 &= 0.96 \quad F \text{ ratio} = 88.71
\end{align*}
\]

\[
\begin{align*}
PT_t &= 24.66 - 0.000063 PRW_{t-1} + 2.33 YROW_t - 1.19 PT_t + 1.18 U_{1,t-1} \\
&\quad (28.21) (0.0001) (1.43) (1.37) (0.275)^b \\
&\quad - 0.48 U_{2,t-2} \\
&\quad (0.372)^c \\
R^2 &= 0.965 \quad F \text{ ratio} = 46.36
\end{align*}
\]

\[
\begin{align*}
PT_t &= -139.17 + 1.03 PTW_t** + 0.00016 IF_t + 0.0022 L_t** - 0.102 PT_t^* \\
&\quad (18.65) (0.197) (0.00043) (0.00028) (0.038) \\
&\quad - 0.003 MA_t - 0.513 U_{1,t-1} \\
&\quad (0.0024) (0.301)^b \\
R^2 &= 0.999 \quad F \text{ ratio} = 16414.96
\end{align*}
\]

\[^a\text{Standard deviations are in parentheses.}\]

\[^b\text{The standard error applies to only } \Delta \rho_1; U_{1,t-1} = \rho_1 + \Delta \rho_1.\]

\[^c\text{The standard error applies to only } \Delta \rho_2; U_{2,t-2} = \rho_2 + \Delta \rho_2.\]

\[^*\text{Significantly different from zero at the 5% level.}\]

\[^**\text{Significantly different from zero at the 1% level.}\]
### Table 7-10. The estimation results of the simultaneous equations with autocorrelated errors

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficients</th>
<th>Standard Errors</th>
<th>t-values</th>
<th>p-values</th>
<th>F-ratio</th>
</tr>
</thead>
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<tr>
<td><strong>IF_t</strong></td>
<td>-80175.3 - 354.02 PT_t + 1.36 L_t - 3.98 MA_t + 678.37 PTW_t - 55.66 Y_t - 0.747 U_1,t-1 - 0.496 U_2,t-2</td>
<td>(43181.03) (382.36) (0.866) (1.796) (338.81) (28.33) (0.312) (0.341)</td>
<td>(0.15)</td>
<td>(0.0001) (1.38) (1.22)</td>
<td>0.994</td>
</tr>
<tr>
<td><strong>L_t</strong></td>
<td>2831.77 - 90.49 PT_t + 73.53 PL_t-1 + 0.98 LTLAG**</td>
<td>(5993.5) (85.711) (57.17) (0.15)</td>
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<tr>
<td><strong>PI_t</strong></td>
<td>24.77 - 0.000064 PRW_t-1 + 2.30 YROW_t - 1.16 PT_t + 1.17 U_1,t-1</td>
<td>(28.11) (0.0001) (1.38) (1.32) (0.27)</td>
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<tr>
<td><strong>PT_t</strong></td>
<td>-52.35 + 0.726 PO** + 0.0015 L** + 0.17 PI** + 0.00025 IF_t</td>
<td>(10.12) (0.16) (0.0002) (0.046) (0.0003)</td>
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</table>

*aStandard deviations are in parentheses.*

*bThe standard error applies to only Δρ_1; U_1,t-1 = ρ_1 + Δρ_1.*

*cThe standard error applies to only Δρ_2; U_2,t-2 = ρ_2 + Δρ_2.*

*Significantly different from zero at the 5% level.

**Significantly different from zero at the 1% level.*
Table 7-11. The estimated results of the derived reduced form equations

\[
IF_t = 44540.1 - 0.0048 PRW_{t-1} + 174.38 YROW_t - 1.011 MA_t + 600.4 PTW_t \\
- 49.27 Y_t - 326.29 PO_{t-1} + 39.08 PL_{t-1} + 0.52 LTLAG
\]

\[
L_t = 8958.5 - 0.00093 PRW_{t-1} + 33.06 YROW_t + 0.562 MA_t - 14.77 PTW_t \\
+ 1.212 Y_t - 61.8 PO_{t-1} + 61.94 PL_{t-1} + 0.82 LTLAG
\]

\[
PI_t = 103.04 - 0.000076 PRW_{t-1} + 2.72 YROW_t + 0.0072 MA_t - 0.189 PTW_t \\
+ 0.015 Y_t - 0.79 PO_{t-1} - 0.15 PL_{t-1} - 0.00197 LTLAG
\]

\[
PT_t = -67.71 + 0.00001 PRW_t - 0.365 YROW_t - 0.0062 MA_t + 0.163 PTW_t \\
- 0.0134 Y_t + 0.684 PO_{t-1} + 0.128 PL_{t-1} + 0.0017 LTLAG
\]
CHAPTER VIII. CONCLUDING REMARKS

Summary of the Objectives

The European Economic Community is the largest trading block and the largest market for U.S. feed grains' exports. Some argue that without the E.E.C.'s Common Agricultural Policy the volume of E.E.C. feed grains' imports from non-member countries would have been even larger.

The major aims of the Community's C.A.P. have been to increase agricultural productivity and self-sufficiency, to stabilize markets, and to ensure a fair standard of living for the farm population. To achieve these goals, the Community has established grain support prices, has removed all restrictions on trade among member countries, and has imposed trade barriers on imported grains from non-member countries. One of the most important elements in the system is the "target price" towards which the common market price should tend and which is supposed to provide a fair return to the producers.

The main objective of this study is to investigate the factors that influence the E.E.C. target price of feed grains. The size of the E.E.C.'s livestock inventory, feed grains' imports, and world prices are among the factors that influence the level of target price. However, not only do these variables affect feed grains' target price, but they are in turn affected by them. Therefore, in order to avoid simultaneous equation bias, the equations for the E.E.C. livestock
inventory, feed grains' imports, and world prices are also included in the model and are estimated with the target price equation.

Only the six original E.E.C. member countries are studied in this project, and they are treated as one large country.

Limitations of this Study

In almost every study, there are limitations that both the researcher and the reader should be aware of. The biggest problem in this study is absence of consistent data.

Information collected from various sources had to be combined to obtain a complete set of data. For example, data for some variables for some years were available in terms of one currency and on a crop-year basis and for other years in terms of another currency and on a calendar-year basis. Where the data for the same variable are not consistent from various sources the accuracy of the data chosen is questionable. Therefore, it may have been more appropriate to use an errors-in-variables model for estimation.

To be consistent, it was decided that data on all price and value variables would be collected in terms of or would be converted to units of account. Because the Community changed its currency unit many times during the period under study, calculation of the conversion rates from other currencies into units of account created many problems.

In this project, various types of feed grains (corn, sorghum, barley, oats, and rye) were aggregated and studied as one commodity. Also, all types of livestock and livestock products (cattle, pigs, poultry meat and eggs, sheep and goats) were aggregated and studied
as one. For value variables, the weighted average of prices for all
types of feed grains and the weighted average of prices for all types of
livestock products were used to represent the feed grains' price and
the livestock product price in general. These aggregations cause
difficulties in the analysis. That is, the effect of some right hand
side variables could be different if feed grains were modeled separately.
For example, it is possible that some feed grains such as barley are
used primarily for direct consumption by humans (in beer), while other
feed grains such as corn and sorghum are mainly used in feed concentrates
in the livestock industry. Therefore, the effect of the livestock
inventory on demand and subsequently on imports of one kind of feed
grains, say barley, could be quite different from its effect on other
kinds of feed grains, say corn or sorghum. The differences between
the effects of the right hand side variables on individual feed grains
are lost when feed grains are aggregated.

The measure of livestock and poultry inventory used here is
unsatisfactory. Inventory of livestock and poultry is properly
measured as a stock. But data on number of poultry on hand are not
available. The inventory measure used here is the sum of stock of
animals on hand plus flow of poultry and poultry products.

Moreover, studying all the six original E.E.C. member countries
as one large country creates some problems. Not all the countries
follow the same feeding patterns. Therefore, when it comes to the
substitutability of feed grains, it could well be different from one
country to another because of differences in feed rations. For
example, in some member countries the mix of manioc and soybean meal may represent a good substitute for feed grains while in the others this might not be the case. So the effect of the right hand side variables could be different from one country to another.

Another problem with treating all the EC-6 member countries as one large country is that it leads to the assumption that one level of common prices prevails throughout the six E.E.C. countries. In reality this assumption is not true. Because of the use of MCAs, while the target prices expressed in units of account are "common" throughout the E.E.C., the absolute level of prices expressed in national currencies differs from one member country to another.

The small number of degrees of freedom is also a major problem in estimating the Chapter IV full model. The regulations for grains were agreed upon in 1962. Therefore, the data for this study were collected for the 1962/63 crop year through the 1978/79 crop year. Considering the lagged variables in the model, this study had only sixteen crop year observations while the full model included four endogenous and fourteen predetermined variables.

Another problem in estimating the full model in Chapter IV is multicollinearity, correlation between the right hand side variables in an equation. This problem existed partly because of the presence of both current and lagged variables in the same equation.

In order to solve the degrees of freedom and multicollinearity problems, the reduced models were used. However, it is possible that multicollinearity is also present in the final reduced models.
Another problem, which is common to many studies in economics, is the limitation of analysis to partial equilibrium while the world economy is more likely to be of a general equilibrium in nature [Reed, 1979]. The feed grains' sector of the E.E.C. is modeled, but other sectors that probably affect the feed grains' sector are ignored. Some substitution for feed grains can occur on the demand and supply side that the analysis does not measure. Substitution between feed grains and some non-concentrated feeds, such as alfalfa and hay, is possible in some of the E.E.C. member countries.

This study is a partial policy analysis, because it treats the feed grains' support prices as endogenous while assuming livestock products' support prices to be exogenous. A more complete study would consider both the feed grains' target prices and livestock products' target prices as endogenous variables.

Implications of this Study for Future Research

Rationalizing policy decisions is a relatively new area in economic research. In the past, there has not been much work done in this area. Instead, policy variables have usually been treated as exogenous. Also, in most studies, the effect of trade barriers imposed by one country or a group of countries on world prices and trade relations has been ignored.

Despite the limitations of this study, the models (full and reduced) seem to explain much of the variation in the target price of feed grains and other endogenous variables in the system; the E.E.C. livestock inventory, feed grains' imports, and world prices.
For the target price equation in the estimated reduced models, all of the variables (except for $IF_t$) had significant coefficients. Significant coefficients were found for livestock inventory, world price of feed grains, manioc consumption by the Community, and lagged price of inputs in feed grains' production. In some estimated equations for the E.E.C. feed grains' target price, the ratio of lagged feed grains' target price to lagged input price, and the soft wheat target price, were significant in addition to the above mentioned variables. Manioc consumption by the Community was the only significant variable in some of the estimated equations for the E.E.C. feed grains' imports from the rest of the world.

It is hoped that one contribution of this study will be to increase the awareness of how important are not only any national government's decisions with respect to the level of agricultural support prices, but also the level of trade barriers on the world trade and prices.

The general Chapter IV model can be applied to any single country that is a major importer of an agricultural product and has trade barriers to support its domestic prices. For countries with fewer data problems, this model can also be used to give an indication of the volume of exports to these countries after any policy changes with regard to their domestic level of support prices.

Although its original purpose was explanation, the general Chapter IV model could be used to predict fluctuations in the exports of the major exporters to the E.E.C. as a result of variations in
the E.E.C. target price and the variable levy, ceteris paribus.

It would be interesting to see the results of the Chapter IV model if one treated not only feed grains' target price, but also the livestock products' support prices as being endogenous to the system. In order to do so, one could include the livestock sector in addition to the feed grains' sector in the utility function of the E.E.C. policy makers, and maximize the utility function not only with respect to feed grains' target price, but also with respect to livestock products' support price. However, one should consider that in this case, because of increasing the number of variables, the degrees of freedom problem would be worsened and, as a result, one would need somehow to increase the number of observations.
APPENDIX. THE MATRIX OF THE CORRELATION COEFFICIENTS OF THE PRE-DETERMINED AND ENDogenous VARIABLES IN THE CHAPTER IV GENERAL MODEL
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