1981

Macroeconometric model of the Thai economy

Kajonwan P. Itharattana

Iowa State University
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MACROECONOMETRIC MODEL OF THE THAI ECONOMY

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Macroeconometric model of the Thai economy

by

Kajonwan P. Itharattana

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
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Major: Economics

Approved:

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For the Major Department

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For the Graduate College

Iowa State University
Ames, Iowa

1981
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CHAPTER I. INTRODUCTION

Thailand is an agricultural country in Southeast Asia. About 80 per cent of her economically active population is employed in the agricultural sector. Rice is a major crop for both consumption and export. Rice exports produce a substantial volume of income to the country. Like other developing countries, Thailand faces problems of low income per capita, surplus labor, unequal income distribution, and small internal markets. It is thus necessary for the Thai government to have some policy to solve such problems. Development planning has served as a means of accelerating economic progress. Since the first national development plan was adopted in 1960, lack of adequate statistical data and trained manpower have slowed progress. The real effects of the plan were not achieved because the planning techniques used were not based upon sound theory. The Ministry of Agriculture and Cooperatives and some government agencies are in charge of agricultural planning in order to solve the problem in the agricultural sector. In July 1973, the Thailand Agricultural Sector Analysis Program, a cooperative project between the Ministry of Agriculture and Cooperatives (through its Division of Agricultural Economics), Iowa State University, and United States Overseas Mission/Thailand was started. The purpose of the project was to apply agricultural economic research in supporting development of Thailand's Fourth Five-Year Development Plan for the period B.E. 2520-2524 (1977-1981). A national linear programming model of Thai Agriculture, demand analysis, transportation, and marketing analysis were to be constructed. At the outset, the nonagricultural sector of the economy was not included in the project. As the agricultural modeling
proceeded, it was felt that an incomplete picture of Thai economy would result if the nonagricultural sector was not included. Therefore, the macroeconometric model of the Thai economy was initiated.

During September 1974 through August 1976, the macroeconometric model was constructed at the Division of Agricultural Economics, the Ministry of Agriculture and Cooperatives, Thailand. The ultimate purpose of the construction was to link an econometric model of the nonagricultural sector with a linear programming model of Thai agriculture. The preliminary results of a macroeconometric model were published in March 1977. When the model was constructed, there were some difficult problems in terms of econometrics and computer programming. Therefore, the equations in the model are estimated by Ordinary Least Squares. Two Stage Least Squares could not be used directly because of the small amount of time series data. These problems led to further study in this dissertation.

The objective of this research is to construct a model which can describe the Thai economy in a more extensive and disaggregate manner and to investigate the effect of alternative policy proposals with particular emphasis on increasing agricultural production and income. This means that the macro-modeling of the nonagricultural sector must be aimed at the interaction between the nonagricultural sector and the agricultural sector and at the effects of the international and financial sectors. There are also expansion and disaggregation in some sectors of the economy, such as in the international sector, monetary and price sector, and the income distribution sector. Foreign trade is regarded as one of the most influential sectors in a developing economy like Thailand. External economic and noneconomic factors have a substantial influence on internal economic
activities. The import and export sector, thus, will be developed in more detail. Sub-models for import and export commodities such as rice, rubber, sugar, etc., will be constructed. The monetary and price sector will be expanded greatly because it is one of the important ones for both the agricultural and nonagricultural sectors. A Balance of Payments sector is included. The income distribution sector is expanded considerably. This hopefully provides an explanation of the political and social effects of income distribution.

This dissertation will be presented in the following sequence.

Chapter II presents a description of the structure of the Thai economy. Chapter III presents the specification of the macroeconometric model. Chapter IV discusses the empirical results of the estimation of the model and the data used in the model. It also presents the estimated model. Chapter V presents the model simulation which is a test of the model. In Chapter VI, the conclusions and recommendations of the study will be presented.
CHAPTER II. OVERVIEW OF THE STRUCTURE OF THE THAI ECONOMY

Thailand covers an area of about 514,000 square kilometers and has a population of about 44 million in 1979. The population density is approximately 85 persons per square kilometer. But of the total land area, only about 20 percent can be cultivated (Thailand, Ministry of National Development, 1966, p. 13). Thailand is normally divided into four parts: the Central Plain, North, Northeast, and South.

The Thai economy presents many challenges to economic analysis. Many characteristics of developing countries are visible in Thailand. Per capita income is very low. Gross domestic product (GDP) per capita in 1979 was 12,869 baht in current price or 6,492 baht in 1972 prices. The problem of inequality of income distribution is substantial. The ratio of income of the agricultural to the nonagricultural sector is less than unity. This indicates the inequality of income between the two sectors. GDP has fluctuated considerably from year to year. Table 2.1 shows the growth rate of GDP from 1960 to 1979. The average rate of growth of GDP accelerated noticeably from year to year. An average annual growth rate during 1961-1966 was 7.96 percent, and it rose to 8.59 percent during the 1977-1979 period. The average growth rate during 1967-1971 decreased due to the construction decrease sharply in both the private and public sectors. The average growth rate during 1972-1976 also fell due to bad weather in 1972, which caused a decrease in agricultural production.

The structure of the Thai economy can be described by major sectors which the Office of National Economic and Social Development Board (NESDB) has described as the main sources of GDP.
Table 2.1. Sectoral growth rates

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Agriculture

Thailand has an unusually large agricultural sector both in terms of production and population. The economy of the nation is based primarily on agriculture. About 38.88 percent of the GDP originated in this agricultural sector during 1960-1966, and it gradually declined to 27.10 percent during 1977-1979. This indicates a declining position of the agricultural sector. However, agricultural output still constitutes the highest share of total GDP (see Table 2.2). Despite the decline, it is still greater than the other sectors. The percentage share of the nonagricultural sector increased considerably, indicating a relatively rapid advance of industrialization in the country. Agriculture remains large in terms of population as can be shown by the 1970 census. About 79.3 percent of the economically active population was engaged in agriculture. The large number of people leads to many problems in the sector, such as low productivity of labor and low income per capita. In 1979, GDP originating from agriculture per farm labor was 9,615 baht (approximately $480) in current prices while the
### Table 2.2. Gross domestic product originating by industry at 1972 prices (million baht)\(^a\)

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<td>14,460</td>
<td>15,684</td>
<td>67,604</td>
<td>13,521</td>
<td>9.80</td>
</tr>
<tr>
<td>Other</td>
<td>13,447</td>
<td>15,353</td>
<td>16,812</td>
<td>18,624</td>
<td>21,157</td>
<td>85,393</td>
<td>17,079</td>
<td>12.37</td>
</tr>
<tr>
<td>GDP</td>
<td>118,227</td>
<td>128,222</td>
<td>138,165</td>
<td>147,020</td>
<td>158,514</td>
<td>690,148</td>
<td>138,030</td>
<td>100.00</td>
</tr>
</tbody>
</table>

\(^a\)Source: Thailand, Office of the National Economic (1968-1980).
Table 2.2. (continued)

<table>
<thead>
<tr>
<th>Industrial origin</th>
<th>1972</th>
<th>1973</th>
<th>1974</th>
<th>1975</th>
<th>1976</th>
<th>Total</th>
<th>Average</th>
<th>% share of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>49,919</td>
<td>56,237</td>
<td>56,962</td>
<td>62,081</td>
<td>65,898</td>
<td>291,097</td>
<td>58,219</td>
<td>30.30</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>27,864</td>
<td>31,523</td>
<td>34,403</td>
<td>36,787</td>
<td>42,529</td>
<td>173,106</td>
<td>34,621</td>
<td>18.02</td>
</tr>
<tr>
<td>Construction</td>
<td>7,168</td>
<td>7,221</td>
<td>7,459</td>
<td>8,514</td>
<td>10,022</td>
<td>40,384</td>
<td>8,077</td>
<td>4.20</td>
</tr>
<tr>
<td>Transportation and communication</td>
<td>10,514</td>
<td>11,320</td>
<td>12,109</td>
<td>13,445</td>
<td>14,650</td>
<td>62,038</td>
<td>12,408</td>
<td>6.46</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>29,881</td>
<td>31,396</td>
<td>34,249</td>
<td>35,774</td>
<td>38,821</td>
<td>170,121</td>
<td>34,024</td>
<td>17.71</td>
</tr>
<tr>
<td>Services</td>
<td>16,844</td>
<td>18,519</td>
<td>18,801</td>
<td>19,704</td>
<td>21,276</td>
<td>95,144</td>
<td>19,029</td>
<td>9.90</td>
</tr>
<tr>
<td>Other</td>
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<td>23,930</td>
<td>25,967</td>
<td>27,209</td>
<td>29,313</td>
<td>128,855</td>
<td>25,771</td>
<td>13.41</td>
</tr>
<tr>
<td>GDP</td>
<td>164,626</td>
<td>180,146</td>
<td>189,950</td>
<td>203,514</td>
<td>222,509</td>
<td>960,745</td>
<td>192,149</td>
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</table>

<table>
<thead>
<tr>
<th>Industrial origin</th>
<th>1977</th>
<th>1978</th>
<th>1979</th>
<th>Total</th>
<th>Average</th>
<th>% share of GDP</th>
</tr>
</thead>
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<td>Agriculture</td>
<td>65,537</td>
<td>75,059</td>
<td>73,612</td>
<td>214,208</td>
<td>71,403</td>
<td>27.10</td>
</tr>
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<td>Manufacturing</td>
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<td>52,756</td>
<td>58,036</td>
<td>158,863</td>
<td>52,954</td>
<td>20.10</td>
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<tr>
<td>Construction</td>
<td>11,996</td>
<td>14,141</td>
<td>15,367</td>
<td>41,504</td>
<td>13,835</td>
<td>5.25</td>
</tr>
<tr>
<td>Transportation and communication</td>
<td>16,142</td>
<td>18,434</td>
<td>20,831</td>
<td>55,407</td>
<td>18,469</td>
<td>7.01</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>41,213</td>
<td>43,452</td>
<td>47,009</td>
<td>131,674</td>
<td>43,891</td>
<td>16.66</td>
</tr>
<tr>
<td>Services</td>
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<td>29,090</td>
<td>78,667</td>
<td>26,222</td>
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</tr>
<tr>
<td>Other</td>
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<td>36,681</td>
<td>40,802</td>
<td>110,105</td>
<td>36,702</td>
<td>13.93</td>
</tr>
<tr>
<td>GDP</td>
<td>238,841</td>
<td>266,840</td>
<td>284,747</td>
<td>790,428</td>
<td>263,476</td>
<td>100.00</td>
</tr>
</tbody>
</table>
nonfarm income was 83,465 (approximately $4,174) baht per capita. These figures show the inequality of income.

Agricultural production can be classified into crops, livestock, fisheries, and forestry. Rice is the most important crop. It is not only a major crop for domestic consumption, it also is the leading export commodity. Rice earns foreign exchange for the nation. It is grown in scattered locations over the country, but the main area of cultivation is the Central Plain. Rice farming follows a seasonal pattern. The method of production is traditional and relatively inefficient because modern technology has not been much adopted. For the last decade, the production of rice has been steady (see Table 2.3), but the percentage share of total GDP originating from agriculture fell from 42.96 percent in 1960 to 29.77 percent in 1979, indicating a decline in its importance. Farmers switched from rice to other crops or moved to the nonagricultural sector.

Rubber is another important crop in the Thai economy and is the second most important foreign exchange earner for Thailand. Thailand produces about 10 percent of the world's supply of natural rubber. Rubber is grown mostly in the south. About half of the GDP originating from agriculture in the south comes from rubber production (Sakarindr, 1979, p. 4). Its production increased from 172,000 tons in 1960 to 540,000 tons in 1979. Export price of rubber fluctuated with world demand. Today, because natural rubber has strong competition from synthetic rubber, the future of natural rubber production is in doubt. However, new high yield varieties are being introduced to replace the old varieties, a change that may make natural rubber successfully competitive.
Maize, the other important crop of Thailand, is not only produced for domestic consumption but is also an important export commodity. Since 1950, maize production rose remarkably, and through the 1960s, maize became an important crop. As rice declines in importance, maize is rising. Cultivated land which is not suitable for rice farming is being used and also newly cultivated land is being expanded. Production of maize has increased steadily from 1960 to 1979. Its GDP value in 1960 was only 573 million baht in 1972 prices, but it increased to 3,348 million baht in 1979. Its percentage share of GDP originating from agriculture also increased from 2.00 percent in 1960 to 4.55 percent in 1979 (see Table 2.3).

Table 2.3. The value of important crops in 1972 prices and percentage of total value of GDP originating in agriculture

<table>
<thead>
<tr>
<th>Year</th>
<th>AGOUT</th>
<th>RICE</th>
<th>% share of AGOUT</th>
<th>RUB</th>
<th>% share of AGOUT</th>
<th>MZE</th>
<th>% share of AGOUT</th>
<th>SG</th>
<th>% share of AGOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>28,624</td>
<td>12,298</td>
<td>42.96</td>
<td>853</td>
<td>2.98</td>
<td>573</td>
<td>2.00</td>
<td>786</td>
<td>2.75</td>
</tr>
<tr>
<td>1961</td>
<td>29,495</td>
<td>12,843</td>
<td>43.54</td>
<td>796</td>
<td>2.70</td>
<td>520</td>
<td>1.76</td>
<td>574</td>
<td>1.95</td>
</tr>
<tr>
<td>1962</td>
<td>31,717</td>
<td>14,599</td>
<td>46.03</td>
<td>837</td>
<td>2.64</td>
<td>638</td>
<td>2.01</td>
<td>452</td>
<td>1.43</td>
</tr>
<tr>
<td>1963</td>
<td>34,554</td>
<td>15,771</td>
<td>45.64</td>
<td>848</td>
<td>2.45</td>
<td>822</td>
<td>2.38</td>
<td>680</td>
<td>1.97</td>
</tr>
<tr>
<td>1964</td>
<td>34,869</td>
<td>15,068</td>
<td>43.21</td>
<td>903</td>
<td>2.59</td>
<td>914</td>
<td>2.62</td>
<td>728</td>
<td>2.09</td>
</tr>
<tr>
<td>1965</td>
<td>36,072</td>
<td>14,479</td>
<td>40.14</td>
<td>933</td>
<td>2.59</td>
<td>1,049</td>
<td>2.91</td>
<td>645</td>
<td>1.79</td>
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<tr>
<td>1966</td>
<td>41,225</td>
<td>17,633</td>
<td>42.77</td>
<td>922</td>
<td>2.24</td>
<td>1,182</td>
<td>2.87</td>
<td>548</td>
<td>1.33</td>
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<tr>
<td>1967</td>
<td>39,663</td>
<td>14,765</td>
<td>37.23</td>
<td>1,013</td>
<td>2.55</td>
<td>1,311</td>
<td>3.31</td>
<td>756</td>
<td>1.91</td>
</tr>
<tr>
<td>1968</td>
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<td>16,198</td>
<td>37.28</td>
<td>1,189</td>
<td>2.74</td>
<td>1,510</td>
<td>3.48</td>
<td>1,001</td>
<td>2.30</td>
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<tr>
<td>1969</td>
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<td>17,230</td>
<td>36.89</td>
<td>1,255</td>
<td>2.69</td>
<td>1,682</td>
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<td>1,046</td>
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<td>17,661</td>
<td>36.78</td>
<td>1,323</td>
<td>2.76</td>
<td>1,950</td>
<td>4.07</td>
<td>1,136</td>
<td>2.37</td>
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<tr>
<td>1971</td>
<td>50,484</td>
<td>17,717</td>
<td>35.09</td>
<td>1,434</td>
<td>2.84</td>
<td>2,358</td>
<td>4.67</td>
<td>952</td>
<td>1.89</td>
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<td>49,919</td>
<td>15,409</td>
<td>30.87</td>
<td>1,529</td>
<td>3.06</td>
<td>1,333</td>
<td>2.67</td>
<td>1,554</td>
<td>3.11</td>
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<td>1973</td>
<td>56,237</td>
<td>18,282</td>
<td>32.51</td>
<td>1,738</td>
<td>3.09</td>
<td>2,363</td>
<td>4.20</td>
<td>2,095</td>
<td>3.73</td>
</tr>
<tr>
<td>1974</td>
<td>56,962</td>
<td>17,639</td>
<td>30.97</td>
<td>1,721</td>
<td>3.02</td>
<td>2,690</td>
<td>4.72</td>
<td>2,268</td>
<td>3.98</td>
</tr>
<tr>
<td>1975</td>
<td>62,081</td>
<td>19,760</td>
<td>31.83</td>
<td>1,583</td>
<td>2.55</td>
<td>2,880</td>
<td>4.64</td>
<td>2,983</td>
<td>4.81</td>
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<tr>
<td>1976</td>
<td>65,898</td>
<td>19,508</td>
<td>29.60</td>
<td>1,779</td>
<td>2.70</td>
<td>2,690</td>
<td>4.08</td>
<td>4,104</td>
<td>6.23</td>
</tr>
<tr>
<td>1977</td>
<td>65,537</td>
<td>18,181</td>
<td>27.74</td>
<td>1,940</td>
<td>2.96</td>
<td>1,719</td>
<td>2.62</td>
<td>2,768</td>
<td>4.22</td>
</tr>
<tr>
<td>1978</td>
<td>75,059</td>
<td>21,551</td>
<td>28.71</td>
<td>2,128</td>
<td>2.84</td>
<td>2,871</td>
<td>3.82</td>
<td>3,102</td>
<td>4.13</td>
</tr>
<tr>
<td>1979</td>
<td>73,612</td>
<td>21,915</td>
<td>29.77</td>
<td>2,344</td>
<td>3.18</td>
<td>3,348</td>
<td>4.55</td>
<td>2,425</td>
<td>3.29</td>
</tr>
</tbody>
</table>
Sugar has been a problem commodity since the 1800s. There are three kinds of sugar produced in Thailand: coconut, palmyrs, and cane sugar, with cane sugar being the most important. Thai sugar is produced at cost above world prices. The government tries to help the infant sugar industry by imposing an import tax and subsidizing exports. Therefore, the sugar industry has been capable of supplying both domestic requirements and export quantities. In mid-1980, when the production of sugar cane decreased due to bad weather, the amount and the quality of cane sugar fell. There was a shortage of sugar for domestic consumption, and its prices started to rise greatly. During this crisis period, the government was pushed into action. Price controls were imposed to ensure a low domestic price, and in response to this, dealers began to hoard in anticipation of the price controls being removed. The crisis was alleviated when sugar was imported from England under a contract agreement that raw sugar would be shipped to England the following year.

Manufacturing

Manufacturing, an important sector, has had an average growth rate of about 10 percent per year. The percentage share of total GDP ranked second during 1972-1979. Thai manufacturing is mostly in the medium and small scale range. Most producers are private entrepreneurs. Government enterprises account for only 28 factories producing only 22 commodities. The manufacturing sector includes 160 industries, which are broken down into 20 groups. The most important activities are the agricultural product processing industries, viz., rice milling, slaughtering, saw milling, weaving, tobacco curing, and animal hide processing. The government
attempts to promote this sector by low taxes, relaxation of import and export restriction, etc. The sector has expanded rapidly, especially after the first national plan period.

Construction

The construction sector represents about 9 percent of GDP. The value added originating from this sector includes private, public, and military construction expenditures. During the first national plan period (1960-1966), production in the construction sector increased from 5.01 percent in 1961 to 21.54 percent in 1966. The average growth rate was 12.87 percent per annum. Since 1970, construction decreased in both the private and public sectors due to a shortage of building material and sharply rising prices of other materials and wages. At that time, the cost of iron rods used for construction doubled. The price of cement also increased due to changes in labor, fuel, and transportation costs. The withdrawal of U.S. forces was another factor. Since 1975, however, this sector has expanded considerably because the government allocated a greater budget for rural development. Until 1979, output fell a little due once again to a shortage of building materials.

Transportation and Communication

Transportation and communication are divided into two parts, government and private. Of the value added from this sector in 1979, about 77 percent originates in the private sector while the rest comes from government. The output constituted about 6 to 7 percent of GDP. Most of the output originates from transportation. Highway transport has played an important role in this sector because modern highways have been expanded
and improved throughout the country. Communication, comprised of postal,
telegraph and telephone service, has improved greatly. However, there is a
problem concerning the expansion of telephone lines. Because the expansion
is not coordinated with road construction and water supply, it causes
traffic difficulties and budget waste. If this problem can be solved, this
sector may have good prospects.

Wholesale and Retail Trade

During 1960 to 1971, the output originating in the wholesale and
retail trade sector ranked second in GDP, but during 1972 to 1979, its
importance decreased, ranking third to manufacturing sector. The highest
growth rate occurred during the second national plan period (1967-1971),
when the average annual growth rate was 10.18 percent. It was the result
of increases in the number of commodities and the opening of new urban and
rural markets. During 1972 to 1979, the average growth rate was increased
at a decreasing rate. This might be the result of tight money and
inflation.

Services

The service sector consists of many sub-sectors such as hotels and
restaurants, entertainment and recreation, medical and health services, and
education. This sector ranks fourth in GDP contribution. The percentage
average share of GDP was about 9 percent in 1961-1966. The average growth
rate was 7.64 percent in 1961-1966, 8.35 percent in 1967-1971, 6.33 percent
in 1972-1976, and 11.00 percent in 1977-1979. The most important part in
this sector is hotel and restaurant, largely because of the promotion of
tourism, a growing business that is expected to be a big source of foreign
The next most important activity in this sector is education. The value added in this sub-sector in GDP contribution has increased due to the revision of civil servant salaries and the improvement in education under the national plan.

Foreign Trade

Thailand is an open economy. She started international trade in 1855 and often experiences deficit trade balances due to imports of goods and services increasing more than exports (see Table 2.4). A rise in imports has resulted from the development of the country. The balance of payments was favorable from 1963 to 1968 and from 1972 to 1974 because the deficit trade balance was exceeded by unrequited transfer and net foreign capital inflow. From 1969 to 1971 and from 1975 to 1978, the balance of payment was in deficit because foreign aid to the central government and private transfers decreased. During 1972 to 1974, even though foreign aids to the government decreased, private transfers and net capital inflow rose to offset the deficit. After 1975, private transfers decreased again which caused the unfavorable balance of payments.

Thailand's main exports are agricultural commodities. Rice has been an export commodity since the 1800s. In the 1900s, rubber became a major export. In recent years, many agricultural products, maize, cassava, and others, have become important exports. Table 2.5 shows the value of principal export commodities and their percentage share of total exports. The percentage share of rice and rubber has declined gradually. Rice share decreased from 29.32 percent in 1962 to 9.99 percent in 1978, while rubber fell from 19.10 percent in 1962 to 7.69 percent in 1978. Maize, tapioca,
Table 2.4. Thailand's balance of payments 1963-1978* (millions of baht).

<table>
<thead>
<tr>
<th>Year</th>
<th>Total exports</th>
<th>Total imports</th>
<th>Unrequited capital transfers</th>
<th>Net foreign capital inflows</th>
<th>Errors and omissions</th>
<th>Balance of payments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>11426</td>
<td>13709</td>
<td>1138</td>
<td>1644</td>
<td>450</td>
<td>949</td>
</tr>
<tr>
<td>1964</td>
<td>14427</td>
<td>15545</td>
<td>775</td>
<td>1644</td>
<td>129</td>
<td>1430</td>
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<tr>
<td>1965</td>
<td>15913</td>
<td>16896</td>
<td>796</td>
<td>1675</td>
<td>497</td>
<td>1985</td>
</tr>
<tr>
<td>1966</td>
<td>20016</td>
<td>20265</td>
<td>964</td>
<td>1340</td>
<td>1249</td>
<td>3304</td>
</tr>
<tr>
<td>1967</td>
<td>22242</td>
<td>24334</td>
<td>1198</td>
<td>2250</td>
<td>-43</td>
<td>1313</td>
</tr>
<tr>
<td>1968</td>
<td>22438</td>
<td>26707</td>
<td>1548</td>
<td>2440</td>
<td>730</td>
<td>449</td>
</tr>
<tr>
<td>1969</td>
<td>23639</td>
<td>28854</td>
<td>1187</td>
<td>2897</td>
<td>217</td>
<td>-914</td>
</tr>
<tr>
<td>1970</td>
<td>24365</td>
<td>30466</td>
<td>1012</td>
<td>2479</td>
<td>42</td>
<td>-2652</td>
</tr>
<tr>
<td>1971</td>
<td>26592</td>
<td>31102</td>
<td>904</td>
<td>1733</td>
<td>1538</td>
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<td>33073</td>
<td>35385</td>
<td>1239</td>
<td>3643</td>
<td>1421</td>
<td>3991</td>
</tr>
<tr>
<td>1973</td>
<td>43975</td>
<td>47942</td>
<td>2969</td>
<td>2938</td>
<td>-1076</td>
<td>864</td>
</tr>
<tr>
<td>1974</td>
<td>64636</td>
<td>71339</td>
<td>4917</td>
<td>9055</td>
<td>743</td>
<td>8012</td>
</tr>
<tr>
<td>1975</td>
<td>60916</td>
<td>74917</td>
<td>1632</td>
<td>7754</td>
<td>1757</td>
<td>-2858</td>
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<td>1976</td>
<td>74354</td>
<td>83797</td>
<td>465</td>
<td>9263</td>
<td>-368</td>
<td>-83</td>
</tr>
<tr>
<td>1977</td>
<td>85235</td>
<td>108371</td>
<td>802</td>
<td>13967</td>
<td>829</td>
<td>-7538</td>
</tr>
<tr>
<td>1978</td>
<td>104375</td>
<td>127801</td>
<td>816</td>
<td>14858</td>
<td>-5546</td>
<td>-13,298</td>
</tr>
</tbody>
</table>


and sugar are gradually becoming more important exports, though their shares have not increased steadily. Export of services is also an important foreign exchange earner. During 1965-1972, the percentage share in total exports increased considerably due to the U.S. military bases in Thailand. After the Vietnam War, exports of services have fallen somewhat.

Thailand's total import trend has increased. The value of imports rose from 12,351 million baht in 1962 to 127,801 million baht in 1978. Table 2.6 presents the value of import commodities and the percentage share in total imports. The percentage share of consumer goods and of capital goods has declined considerably from 29.50 percent and 26.30 percent in
Table 2.5. Value of principal export commodities in current prices and percentage of total exports\(^a\) (value in million baht)

<table>
<thead>
<tr>
<th>Year</th>
<th>Rice</th>
<th>%</th>
<th>Rubber</th>
<th>%</th>
<th>Maize</th>
<th>%</th>
<th>Tapioca</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
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Table 2.6. Value of import commodities in current prices and percentage of total imports\(^a\) (value in million baht)

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\(^a\)Source: Bank of Thailand (1971-1980).
1962 to 10.13 percent and 24.50 percent in 1978, respectively, while that of intermediate goods and raw materials and fuel and lubricants have increased due to the expansion of the manufacturing sector. Imports of capital goods increased during the early 1960s to meet the objective of the national economic development plan. Construction, communication, and transportation of public facilities were accelerated. These stimulated imports of intermediate goods and raw materials and fuels and lubricants in later years.

Money and Banking

The Thai monetary system consists of the Bank of Thailand, commercial banks, and the government saving bank. Notes are issued by the Bank of Thailand, coins are issued by the Treasury Department, and demand and time deposits are liabilities of commercial and government saving banks. These financial assets are held by the government, the banks, and the public. The money supply is that part held by the public.

Bank of Thailand

The Bank of Thailand has been in existence since 1942. It is an independent agency. Its duties can be summarized as follows:

1. Note issuance
2. Banks' banker
3. Government's banker
4. Government's fiscal agent
5. Credit controller

In order to picture how the Bank of Thailand works, its balance sheet should be studied. Table 2.7 presents the summary of the major assets and
Table 2.7. Assets and liabilities of the Bank of Thailand\(^a\) (millions of baht)

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<td>463</td>
<td>78750</td>
<td>37075</td>
<td>238</td>
<td>5484</td>
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</tbody>
</table>

\(^a\)Source: Bank of Thailand (1971-1980).
liabilities of the Bank of Thailand from 1960-1978. Total assets increased from 11,518 million baht in 1960 to 78,750 million baht in 1978. Foreign assets have been the major assets of the Bank of Thailand. In 1978, they accounted for 45 percent of total assets. Foreign assets are comprised of gold, foreign exchange, holdings of SDR, and the gold contribution of IMF. Foreign exchange is the important item in foreign assets, with a percentage share of about 90 percent in 1978. Claims on the central government, also important, are second to foreign assets. Treasury bill and government bonds are the major part of this item. Claims on commercial banks are the smallest component of total assets. Notes in circulation are the most important item of the Bank liabilities, being 37,075 million baht in 1978. The bank issues notes under the Currency Act B.E. 2501 (1958), which was revised in 2516 (1973).

Commercial banks

Commercial banks are one of the important institutions of the Thai financial system. They are places where people deposit, lend, and exchange money. In 1955, there were only 115 bank offices in Thailand increasing to 731 bank offices in 1972. Their role in the Thai economy depends on the efficiency of their operation. The components of assets and liabilities from the balance sheets show their situation or their behavior. Table 2.8 presents the principal assets and liabilities of commercial banks from 1960-1978. Total assets increased about thirtyfold during this period, rising from 8,048 million baht in 1960 to 218,241 million baht in 1978. The increase in total assets was caused by an increase in demand, savings, and time deposits. As a result, it expanded credit on accelerated
Table 2.8. Assets and liabilities of commercial banks 1960-1978\(^a\) (million baht)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash on hand</th>
<th>Foreign deposits on hand</th>
<th>Deposits Government Bill, securities</th>
<th>other assets</th>
<th>Total assets liabilities</th>
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<tr>
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<td>1011</td>
<td>59</td>
<td>2611</td>
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<td>1974</td>
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<td>82</td>
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<td>170</td>
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<td>24439</td>
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\(^a\)Source: Bank of Thailand (1971-1980).
<table>
<thead>
<tr>
<th>Private demand deposits</th>
<th>Private saving deposits</th>
<th>Other demand deposits</th>
<th>Other saving deposits</th>
<th>Other demand liabilities</th>
<th>Borrowing from abroad</th>
<th>Borrowing from other banks</th>
<th>Other liabilities</th>
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investment. It can be seen that government securities holdings, bills, loans, and overdrafts increased significantly, rising from 418 to 5,397 million baht in 1960 to 24,439 and 158,600 million baht in 1978, respectively. The other source of expansion of commercial banks has been a borrowing from abroad. It increased from 976 million baht in 1960 to 24,805 million baht in 1978 and accounted for about 10 percent of the liabilities. The rapid growth of commercial banks led to good monetary prospects.

**Government saving bank**

The Government saving bank (GSB) is a government owned bank set up by the Government Saving Act 1946 and is a self-governing body under the general guidance of the Ministry of Finance (Soonthornsima, 1963). The GSB is a bank for low income savers and issues saving bonds and premium saving bonds.

Table 2.9 shows the assets and liabilities of the GSB. Among the assets, claims on government takes the highest share of total assets, increasing from 52.14 percent in 1963 to 88.89 percent in 1978. The GSB is an important source of loans for the government. Bank cash holdings have increased gradually since 1963 and reached a peak in 1978, accounting for 122 million baht. Loan and overdrafts have fluctuated because of the business and economic situation. On the liabilities side, savings and time deposits are the most important. Saving bonds and premium saving bonds take second rank. All deposits including saving bonds and premium saving bonds grow very rapidly at an annual average growth rate of about 12 percent.
Table 2.9. Assets and liabilities of the Government saving bank\(^a\) (million baht)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash on hand</th>
<th>Loans and over-drafts</th>
<th>Claim on government</th>
<th>Other assets</th>
<th>Total assets or liabilities</th>
<th>Private demand deposits</th>
<th>Savings and time deposits</th>
<th>Savings bonds and premium saving or demand deposits</th>
<th>Other liabilities</th>
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<td>406</td>
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<td>1683</td>
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</tbody>
</table>

\(^a\)Source: Bank of Thailand (1971-1980).
CHAPTER III. THE SPECIFICATION OF THE MACROECONOMETRIC MODEL

The specification of the Thai macroeconometric model is based generally on the Keynesian macroeconomic model. It begins with a set of national income accounting identities which represent income flow through the various parts of the circular flow such as the following:


The model will include a real sector, a monetary sector, and a foreign sector.

The Consumption Function

The concept of the consumption function was first proposed by Keynes in 1936. Keynes specified the consumption expenditure as a function of the absolute level of measured income.

\[ C_w = f(Y_w) \]

where \( C_w \) = consumption expenditure in terms of wage units
\( Y_w \) = level of income in terms of wage units

Thus, both consumption expenditure and income were measured in real terms.

The Keynesian consumption may be written in general form as:

\[ C = f(Y) \]

It may appear unrealistic since the consumer must pay taxes with some portion of \( Y \). Then taxes should be deducted from real income which is called real disposable income (PDY).
The function $C = f(Y)$ may be expressed as a linear form:

$$C = a_1 + a_2 Y$$

Keynes made the following assumptions about the consumption function.

1. "Men are disposed as a rule and on the average, to increase their consumption as their income increase, but not by as much as the increase in their income" (Keynes, 1936, p. 96).

That is, the marginal propensity to consume (MPC) is positive and less than unity ($0 < a_2 < 1$).

2. MPC is smaller than the average propensity to consume (APC).

3. APC would decline as income increased because it might take time for people to change their habits. Therefore, a rising income will often be accompanied by increased saving. At low levels of income, people dissave when consumption exceeds their income ($a_1 > 0$).

The Keynesian consumption function in various forms was used in business cycle theory. On the basis of research done in the late 1930s and 1940s, there were three observed phenomena which a theory of consumption must account for.

1. Cross-sectional budget studies showed APC declining as $Y$ rises, so that in cross-section data, $MPC < APC$.

2. Business cycle or short-run data showed that APC is smaller than average during a slump, so that in the short run, as income fluctuates, $MPC < APC$.

3. Long-run trend data showed no tendency for APC to change over the long run, so that as income grows along the trend, $MPC = APC$ (Branson, 1979, p. 186).
Theories of consumption function were developed by Duesenberry (1949), Modigliani and Brumberg (1954), and Friedman (1957). All explained consumption behavior on the basis of microeconomic theory. Both Friedman's and Modigliani's hypotheses are similar in the sense that consumers attempt to maximize their utility by allocating a lifetime stream of income to an optimum lifetime pattern of consumption. Here only the Friedman permanent income hypothesis will be discussed.

The discussion will be started with the Fisherian model of saving. The utility function is expressed as a function of real consumption during an entire lifetime period.

\[ U = U(C_0, C_1, \ldots, C_T) \]

where \( U \) = lifetime utility
\( C_t \) = real consumption in all time periods up to \( T \)

The consumer is assumed to maximize his utility subject to the constraint that the present value of total the consumption stream does not exceed the present value of his total income stream, i.e.,

\[ \sum_{t=0}^{T} \frac{Y_t}{(1+r)^t} = \sum_{t=0}^{T} \frac{C_t}{(1+r)^t} \]

where \( T \) = individual's expected lifetime
\( r \) = interest rate
\( Y_t \) = real income received in year \( t \)

The relation between the present value of income stream and current consumption can be written as

\[ C_t = f(PV_t) \quad f' > 0 \]
where $PV_t$ = the present value of current and future income at time $t$

$$PV_t = \sum_{t=0}^{T} \frac{Y_t}{(1+r)^t}$$

The individual's consumption at time $t$ is an increasing function of the present value of his income at time $t$.

Friedman bases his theory of consumption behavior on the theory of rational consumer behavior over time. The relation between an individual's consumption and present value of income stream is obtained from the assumption of individual consumer utility maximization.

$$C_i = f_i(PV_i)$$

Friedman assumes that consumption is proportional to the present value of the income stream.

$$C_i = h_i PV_i$$

Then the aggregate consumption can be written as

$$C_t = h_t PV_t$$

Friedman also introduces the permanent income, which is the perpetual income stream supported by wealth. It is equal to the rate of return on wealth.

$$Y_t = r.PV_t$$

So that the consumption function becomes

$$C_t = h \left( \frac{Y_t}{r} \right)$$

which can be rewritten as

$$C_t = k(r, w, u)Y_t$$
where \( k \) depends on interest rate (\( r \)), the ratio of nonhuman wealth to permanent income (\( w \)) and the variable which will vary with the age and family composition of the individuals (\( u \)).

The permanent income hypothesis is reconciled with long run time series data because Kuznets used decade average data that could be a good proxy of permanent income. In short run data, Friedman argued that measured income is not a good proxy for permanent income. Therefore, he assumes that permanent income is a weighted average of all past measured income with the weights decreasing geometrically.

\[
Y_p = (1-\lambda)(Y_t + \lambda Y_{t-1} + \lambda^2 Y_{t-2} + \ldots)
\]

where \( 0 < \lambda < 1 \)

\( Y_p \) = permanent income

\( Y_t \) = measured income in \( t \) period

Let \( C_t \) be a linear function of \( Y_p \)

\[
C_t = \gamma_0 + \gamma_1(1-\lambda)(Y_t + \lambda Y_{t-1} + \lambda^2 Y_{t-2} + \ldots)
\]

Applying the Koyck transformation

\[
\lambda C_{t-1} = \lambda Y_0 + \gamma_1(1-\lambda)(\lambda Y_{t-1} + \lambda^2 Y_{t-2} + \ldots)
\]

\[
C_t = \lambda C_{t-1} = \gamma_0(1-\lambda) + \gamma_1(1-\lambda)Y_t
\]

\[
C_t = \gamma_0(1-\lambda) + \gamma_1(1-\lambda)Y_t + \lambda C_{t-1}
\]

This is the basic form of consumption function which will be used for estimation. Prices of commodities will be added in the function when consumption expenditure is disaggregated into various commodities.
The Investment Function

A theory of investment behavior based on neoclassical theory of optimal capital accumulation requires maximization of the utility of a stream of consumption which may be combined with a set of technological possibilities of production and economic possibilities of transformation of the results into a stream of consumption. The technological possibilities may be described by a production function relating the flow of output to flows of labor services and capital services. The firm supplies capital services to itself through the acquisition of investment goods; the rate of change of capital services is proportional to the rate of acquisition of investment goods less the rate of replacement of previously acquired investment goods. The results of the productive process may be transformed into a stream of consumption under fixed prices for output, labor services, investment goods, and consumption goods.

The problem of maximizing utility may be carried out in two stages. First, a production plan is chosen so as to maximize the present value of the productive enterprises. Second, a consumption stream is chosen so as to maximize utility subject to the present value determined by production (Jorgenson and Stephenson, 1967, p. 170).

To develop the theory of investment behavior, consider the neoclassical theory of optimal accumulation of capital which maximizes the present value of the firm subject to the production function and net investment.

Assuming that output, Q, depends on two inputs, labor (L) and capital (K), the production function which represents the relationship among them is:

$$Q(t) = F(L(t), K(t))$$
Net investment (\( \dot{K} \)) is equal to total investment (I) less replacement, where replacement is proportional to capital.

The net return of the firm is the difference between revenue and outlay of production

\[
R(t) = P(t) Q(t) - W(t) L(t) - q(t) I(t)
\]

where \( R(t) \) = a flow of net return of the firm
\( Q(t) \) = a flow of output
\( L(t) \) = a flow of labor services
\( I(t) \) = the amount of capital acquired at time \( t \)
\( P(t) \) = price of output
\( W(t) \) = price of labor services
\( q(t) \) = price of investment goods

The present value of the firm (PV) is defined as the integral of discounted revenue less discounted outlays, and \( r \) is the rate of discount.

\[
PV = \int_{0}^{\infty} e^{-rt} [P(t)Q(t) - W(t)L(t) - q(t)I(t)] dt
\]

To maximize the present value subject to two constraints, the Lagrangean expression is formed as

\[
\mathcal{L} = \int_{0}^{\infty} e^{-rt} [R(t) + \lambda_0(t)[Q(t) - F(L(t)K(t))] + \lambda_1(t)[K^\circ(t) - I(t) + \delta K(t)]] dt
\]

where \( K^\circ(t) = \frac{dK(t)}{dt} \)

After manipulating the maximization problem, the marginal productivity condition for labor and capital are obtained

\[
\frac{\partial Q(t)}{\partial L(t)} = \frac{W(t)}{P(t)}
\]
\[ \frac{\partial Q(t)}{\partial K(t)} = \frac{q(t)(\delta + r - \frac{q(t)}{q(t)})}{P(t)} = \frac{C(t)}{P(t)} \]

where \( C(t) = q(t)(\delta + r - \frac{q(t)}{q(t)}) \) = user cost of capital

If the production function is assumed to have the Cobb-Douglas form, the marginal productivity condition for capital services is

\[ \frac{\alpha Q}{K^*} = \frac{C}{P} \]

where \( \alpha \) is the elasticity of output with respect to input of capital services and \( K^* \) is desired capital. Solving for desired capital yields:

\[ K^* = \frac{\alpha P Q}{\beta Q} = \beta Q \]

where \( \beta = \frac{\alpha P}{C} \)

Investment can occur only when there is a discrepancy between the desired capital stock and the actual capital stock. Thus, we add an adjustment cost to the model. In order to move the actual capital stock to desired capital stock, there is a cost which is called the adjustment cost. Therefore, the adjustment of capital stock occurs slowly due to the adjustment cost.

When embodying a distributed lag response of actual net investment to changes in the desired stock of capital, the net investment function becomes:

\[ I(t) = \mu(S)(K^*_t - K^*_{t-1}) \]

where \( \mu(S) = \) a power series in the lag operator, \( S \)

If \( \mu(S) \) is a rational function, it may be written as

\[ \mu(S) = \frac{\mu(S)}{\nu(S)} \]
Then \[ I(t) = \frac{u(S)}{v(S)}(K_t^* - K_{t-1}^*) \]

Jorgensen and Stephenson suggest that the flexible accelerator of Chenery (1952) and Koyck (1954) is a special case of this theory of investment behavior, corresponding to a geometric distribution of completions of new investment projects. In this case, a rational distributed lag function can be represented by

\[ u(S) = 1 - \lambda \]
\[ v(S) = 1 - \lambda S \]
\[ I(t) = \frac{1 - \lambda}{1 - \lambda S} (K_t^* - K_{t-1}^*) \]

Thus, the flexible accelerator becomes

\[ I_t = \lambda I_{t-1} = (1 - \lambda) (K_t^* - K_{t-1}^*) \]
\[ I_t = (1 - \lambda) (K_t^* - K_{t-1}^*) + \lambda I_{t-1} \]

Substituting \( K_t^* = \beta Q_t \)

\[ I_t = \lambda I_{t-1} + (1 - \lambda) \beta (Q_t - Q_{t-1}) \]

The limitation of accelerator principle occurs when output is falling. The capital goods industry may experience idle capacity. Thus, a modification is to assume that the firm bases its capital requirement on the previous period's output rather than current output. \( K_t^* \) then is proportional to \( Q_{t-1} \) rather than \( Q_t \).

\[ K_t^* = \beta Q_{t-1} \]
\[ I_t = \lambda I_{t-1} + (1 - \lambda) \beta (Q_{t-1} - Q_{t-2}) \]

Another variant of the accelerator hypothesis by Goodwin and Chenery is in the form as follows:
\[ I_t = \lambda I_{t-1} + (1-\lambda)(K_t^* - K_{t-1}) \]
\[ = \lambda I_{t-1} + (1-\lambda)(\beta Q_t - K_{t-1}) \]
\[ = \lambda I_{t-1} + (1-\lambda)\beta Q_t - (1-\lambda)\beta K_{t-1} \]

In order to obtain a gross investment function, depreciation must be added. Assuming depreciation (D) is proportional to past capital stock,

\[ D = \delta K_{t-1} \]

\[ I_t + \delta K_{t-1} = \lambda I_{t-1} + \delta K_{t-2} + (1-\lambda)\beta(Q_t - Q_{t-1}) \]
\[ I_t = \lambda I_{t-1} + (1-\lambda)\beta(Q_t - Q_{t-1}) - \delta(K_{t-1} - K_{t-2}) \]

The basic form of gross fixed capital formation will be used as follows:

\[ I_t = f(I_{t-1}, Q_t - Q_{t-1}, K_{t-1} - K_{t-2}) \]

or \[ I_t = f(I_{t-1}, Q_t, K_{t-1}) \]

or \[ I_t = f(I_{t-1}, Q_{t-1} - Q_{t-2}) \]

or \[ I_t = f(I_{t-1}, Q_t - Q_{t-1}) \]

The Import Function

The import function is based on the theory of demand. Assuming that the consumer has a well-defined utility function (U) and he attempts to allocate his income among consumable commodities, both domestic and import commodities, in an effort to achieve maximum satisfaction,

\[ U = U(D, IMP) \]

where \[ D = \text{domestic commodity} \]

\[ \text{IMP} = \text{import commodity} \]
The consumer maximizes his utility subject to budget constraint

\[ P_D^D + P_{IMP}^\text{IMP} = Y \]

where \( P_D \) = price of domestic commodity
\( P_{IMP} \) = price of import commodity
\( Y \) = domestic money income

Applying the Lagrangean and differentiating, an import demand function can be derived as

\[ IMP = f(P_{IMP}, P_D, Y) \]

or \[ IMP = \left( \frac{P_{IMP}}{P_D}, \frac{Y}{P_D} \right) \]

Prachowny (1969) suggests that the relationship between imports and income is a special case of the consumption function. However, in general the total merchandise imports in each country are subdivided into different categories, namely, a) imports of consumer goods, b) imports of investment goods, and c) imports of raw materials. Therefore, each category must be specified differently. Imports of consumer goods can be treated by some form of a consumption function, which is related to disposable income (PDY).

Prachowny also suggests that the other two categories of imports are more correctly treated as an investment function. More specifically, imports of investment goods are defined as a special case of the theory of fixed investment while imports of raw materials are a special case of inventory investment. However, in his study, he makes an assumption about the relationship between imports of investment goods and total domestic investment. He assumes that imports of investment goods are a constant fraction of total domestic investment. He also adds prices of imported
investment goods and domestically produced investment goods in the function in order to reflect the substitutability between those two.

In the imports of raw materials, he assumes that imports of these goods are directly related to industrial production in the industries which use them and to changes in inventory holdings.

Finally, Prachowny specifies the functional form of the import demands as follows:

(1) Imports of consumer goods \((M_C)\)

\[ M_C = f_1(PDY, \frac{P_{M_C}}{P_D}) \]

(2) Imports of raw materials \((M_R)\)

\[ M_R = f_2(IP, DINV, \frac{P_{M_R}}{P_D}) \]

(3) Imports of investment goods \((M_I)\)

\[ M_I = f_3(TINV, \frac{P_{M_I}}{P_D}) \]

where IP = index of industrial production

PDY = personal disposable income

\(M_i\) = import of \(i\)th goods \(i = C, R, I\)

\(P_{M_i}\) = price index of import of \(i\)th goods

\(P_D\) = domestic price index

DINV = changes in inventories

TINV = total domestic investment
The Export Function

The export demand function can be derived analogously to the import function. The rest of the world importers are regarded as a consumer who tries to maximize his satisfaction by allocation of the commodity exported from exporter and his domestic commodity.

\[ U_{ROW} = U(X, ROW) \]

where \( U_{ROW} \) = the rest of the world utility

\[ X \] = commodity exported from exporter

\[ ROW \] = domestic commodities

The rest of the world budget constraint is

\[ P_X X + P_{ROW} ROW = Y_{ROW} \]

where \( P_X \) = exported price

\( P_{ROW} \) = domestic price

\( Y_{ROW} \) = the rest of the world income

Finally, the export demand function can be written as

\[ X = X \left( \frac{Y_{ROW}}{P_{ROW}} \cdot \frac{P_X}{P_{ROW}} \right) \]

Prachowny suggests that world total exports is a good proxy for world income (\( Y_{ROW} \)). Rhomberg and Boissonneault used GNP prices of the other countries while Balassa used the prices of the competitive country, \( P_{ROW} \) (as cited in Prachowny, 1969).

Therefore, the export demand function can be written as

\[ X = f \left( \frac{W_X}{P_r}, \frac{P_X}{P_{ROW}} \right) \]

\[ X \] = commodity exported

\( W_X \) = world total export
Pf = GDP price deflator of foreign country
Px = export price deflator

The Output Functions

The general form of output equations in each industry is represented by a production function. It represents the relationship between output and factor of production.

\[ Y = f(L,K) \]

where

\[ Y = \text{output} \]
\[ L = \text{labor} \]
\[ K = \text{capital} \]

In cases where data on capital stock are lacking but investment data are available, an approximation of capital stock can be shown by

\[ K_T = \sum_{t=1959}^{1959} I_t + \sum_{t=1960}^{T} I_t \]

where \( K_T \) = capital stock at time \( T \)
\( I_t \) = net investment at time \( t \)

Assuming that \( \sum_{t=\infty}^{1959} I_t \), which is the value of capital stock at the end of year 1959, is constant, this term will appear in the output function as the intercept.

Finally, the output function can be written as

\[ Y_T = f(L_T, \sum_{t=1960}^{T} I_t) \]
Net Private Capital Movements

The theory of international capital movements is based on the hypothesis of interest arbitrage. National capital movements, especially short-run capital, depend on the difference between domestic and foreign interest rates. A high foreign interest rate results in a flow of funds abroad.

Trade credit is also considered as a crucial factor in private capital movements because of its role in the financing of international trade. Thus, the relationship between trade credit and quantity of exports will be discussed.

Suppose the relationship can be specified as

\[ TC = TC(X) \]

where \( TC \) = trade credit

\( X \) = exports

Now let us simplify it as a linear and homogeneous relationship

\[ TC_t = gX_t \]

Net capital flows for trade credit in any period can be represented as follows:

\[ NTC_t = TC_t - RTC_t \]

where \( NTC_t \) = net trade credit extended in period \( t \)

\( RTC_t \) = repayment of previous trade credit at time \( t \)

It is assumed that the repayments are a constant fraction of trade credit extended in the past. That is, trade credit is repaid in equal payment for \( n \) period.

\[ RTC_t = \frac{1}{n} \sum_{i=1}^{n} TC_{t-i} \]
\[ NTC_t = TC_t - \frac{1}{n} \sum_{i=1}^{n} TC_{t-i} \]
\[ = gX_t - \frac{1}{n} \sum_{i=1}^{n} gX_{t-i} \]

Since \( TC_t = gX_t \)
then \( TC_{t-i} = gX_{t-i} \)

Therefore,
\[ NTC_t = g(X_t - \frac{1}{n} \sum_{i=1}^{n} X_{t-i}) \]

It is assumed that \( \frac{1}{n} \sum_{i=1}^{n} X_{t-i} \) is constant so that \( X_t \) is the variable which will be used as independent variable.

There is one problem left, that is, the problem of stocks and flows. Capital movements are a flow phenomenon. It is necessary to relate flows to stocks. Leamer and Stern (1970) have discussed how to relate the flow of capital to an explanatory stock variable. It is similar to the case of investment and capital. Suppose that the actual stock \( K \) is related to explanatory variable (\( X \)) as follows:
\[ K_t = k + \sum_{i=0}^{\infty} \alpha_i X_{t-i} \]

Then the flow \( K_t - K_{t-1} \) is given by
\[ K_t - K_{t-1} = \alpha_0 X_t + \sum_{i=0}^{\infty} (\alpha_{i+1} - \alpha_i)X_{t-i-1} \]

If the value of the \( \alpha \)'s are such that \( \alpha_{i+1} \geq \alpha_i \) for all \( i \) then the flow equation becomes
Monetary Sector

Keynes' theory of the demand for money

Keynes formulated the theory of the demand for money in terms of three motives that individuals and firms have for holding cash balances: the transactions demand, the precautionary demand, and the speculative demand.

The transactions demand for money is based on the theory that people hold money as a medium of exchange. People hold money because it is convenient to purchase goods and services. Keynes argued that the transactions demand is determined by the level of income.

The precautionary demand was the result of providing for contingencies and unplanned expenditures. The basic argument for the precautionary demand that Keynes used is the same as the transaction demand. He hypothesized that the precautionary demand is determined by the level of income.

The demand for money for speculative purposes depends on the interest rate. If the interest rate increases, people will hold more bonds because they yield an interest return. If it decreases, people hold more money.

According to Keynes, the demand for real money is the sum of the transactions, precautionary, and speculative demands which can be written as:

$$\frac{M^d}{P} = k(Y) + l(r)$$
**Friedman's modern quantity theory**

Friedman develops the demand for money within the context of the traditional microeconomic theories of consumer behavior and of the producer's demand for inputs. Consumers hold money because it yields utility in the form of convenience, security, pride of possession, and so on. Business firms hold money as a durable producer's good which can be treated as an intermediate product, and these services may be entered into the production function.

Friedman's demand for money function can be written as:

\[
\frac{M^d}{P} = f(Y_p, \Omega, i, \frac{\Delta P}{P}, u)
\]

where

- \( \frac{M^d}{P} \) = real money balance
- \( Y_p \) = real permanent income
- \( \Omega \) = ratio of nonhuman wealth to total wealth
- \( i \) = nominal interest rate
- \( \frac{\Delta P}{P} \) = rate of price change
- \( u \) = other factors which influence the utility of money
CHAPTER IV. THE MODEL

Statistical Data and Sources

Time series data are used in this study. Most of them were obtained from the National Income Accounts of Thailand of the Office of the Prime Minister, the Monthly Bulletin of the Bank of Thailand, Agricultural Statistics of Thailand of the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, FAO's Trade Yearbook, and the International Financial Statistics of the International Monetary Fund. Problems in the construction of an econometric model are always encountered in studies of developing countries, i.e., the limitation of time series data. Researchers attempt to avoid the problems by using estimated or adjusted data.

The National Income Accounts of Thailand, at current prices, are available from 1960 to 1979, but data in constant prices are divided into two series. The first series goes from 1960 to 1976 at 1962 prices, and the second extends from 1972 to 1979 in 1972 prices. Therefore, in order to make these data suitable for analysis, data at 1962 prices need to be converted into 1972 prices. This adjustment can be done in three steps.

1. First, the value of 1962 and 1972 price deflators is computed by dividing the current price series by the constant one.

2. Starting from a benchmark year, 1972, going back to 1960, the adjusted 1972 deflators are computed by dividing 1962 price deflator in year t by 1962 price deflator in year 1972 and multiplying by 100. The computation may be written as follows:

\[
\text{Adjusted 1972 price deflator}_t = \left( \frac{\text{1962 price deflator}_t}{\text{1962 price deflator}_{1972}} \right) \times 100
\]

where t goes from 1972 back to 1960.
Whenever the true value of 1972 price deflators from 1972 to 1979 are available, they are then used directly.

3. When the 1972 price deflator is obtained, the value of current price variables is adjusted to 1972 prices as follows:

\[ \frac{Y_{\text{current prices}, t}}{Y_{1972 \text{ prices}, t}} = \frac{1}{1972 \text{ price deflator}, t} \times 100 \]

Table 4 illustrates an example of the adjustment of the variable in different series of prices to the same series.

The gross fixed capital formation data from 1962 to 1978 are disaggregated into two main groups, agricultural investment and nonagricultural investment at current prices. Investment for sub-industries in the nonagricultural group is available only from 1970 to 1978. Thus, it is necessary to derive data during 1962 to 1969 for sub-industries. The derivation can be done as follows:

1. The proportion of gross fixed capital formation for each sub-industry group to gross fixed capital formation in nonagriculture for 1970 to 1978 investment data are computed.

2. A regression is run with these proportions regressed on time and then are extrapolated to 1962.

3. The extrapolated proportions are then multiplied by the actual gross fixed capital formation in nonagriculture for the 1962 to 1969 period to get sub-industry investment data.

Depreciation data for each industry including agriculture are obtained by multiplying the proportion of gross fixed capital formation for each industry to total gross fixed capital formation by capital consumption allowance, or
Table 4.1. Example of the adjustment of current price variable to 1972 price variable

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<td>68,427</td>
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<td>68,427</td>
<td>56090</td>
<td>56958</td>
<td>63515</td>
<td>66062</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CCA industry i = \( \frac{\text{gross fixed capital formation industry } i}{\text{total gross fixed capital formation}} \) \times \text{CCA}

In order to obtain net fixed capital formation (NINV), the capital consumption allowance in each industry (CCA\(_i\)) is subtracted from gross fixed capital formation in each industry (GINV\(_i\)), or

\[ \text{NINV}_i = \text{GINV}_i - \text{CCA}_i \]

Since the data of net fixed capital formation for each crop are not available, they can be derived by multiplying the proportion of planted...
area of each crop to total planted area by net fixed capital formation in agriculture (AGNINV), or

\[ \text{net fixed capital formation for crop } i = \frac{\text{planted area for crop } i}{\text{total planted area}} \times \text{AGNINV} \]

Actual data on population are available only from census as of 1960 and 1970. The data from 1961 to 1969 and 1971 to 1978 can be derived by using the exponential equation,

\[ Y = b e^{mt} \]

\[ \ln Y = \ln b + mt \]

- \( Y \) = number of population in year \( t \)
- \( b \) = constant term
- \( m \) = growth rate of population
- \( t \) = year

Fitting two points of available population on time \( t \) and interpolated for 1961 to 1969 and 1971 to 1978.

The Estimated Model

The model consists of 91 equations which are constructed specifically as linear in parameters and nonlinear in the variables in some equations. It contains 68 behavioral equations and 23 identities. The behavioral equations consist of 11 groups of equations.

The behavioral equations are as following:

1. Private personal consumption equations : 7
2. Government expenditure equations : 3
3. Investment equations : 7
4. Import equations : 5
The results of estimating the model as hypothesized are now presented. The symbols and discussion of the equations follow the equations. The figures in parentheses are t-statistics. D. W. denotes the Durbin-Watson statistic. The equations in the model are estimated by the two stage principal components method. The principal components are used to estimate the first stage regressions. The second stage is to regress the endogenous variables on the estimated value of the explanatory endogenous variable are obtained from the first stage and the other predetermined variables in the equation. The model contains 89 endogenous variables and 107 predetermined variables.

**Equations of the Model**

**Private personal consumption equations (1963-1978)**

\[
\frac{FBT_t}{N_t} = 43.451 + 0.054 \frac{PDY_t}{N_t} + 0.883 \frac{FBT_{t-1}}{N_{t-1}}
\]  

\[
(3.930) (1.422) (7.740)
\]

\[
R^2 = 0.997 \quad D.W. = 1.946 \quad F(2, 13) = 2,458.18
\]
\[
\frac{RFLHHO}{N_t} = 22.226 + 0.012 \frac{PDY}{N_t} + 0.133 \frac{RFLHHO}{N_t-1} \quad (IV-2)
\]
\[
(1.473) (1.770) (5.978)
\]
\[R^2 = 0.984 \quad D.W. = 1.401 \quad F(2, 13) = 410.80\]

\[
\frac{COPE}{N_t} = -21.757 + 0.031 \frac{GDP}{N_t} + 0.598 \frac{COPE}{N_t-1} \quad (IV-3)
\]
\[
(-1.714) (2.547) (3.387)
\]
\[R^2 = 0.990 \quad D.W. = 1.819 \quad F(2, 13) = 664.01\]

\[
\frac{FFHHE}{N_t} = 160.807 + 0.016 \frac{PDY}{N_t} - 122.523 \frac{FFHHE}{P_t} \quad (IV-4)
\]
\[
(2.289) (2.822) (-2.041)
\]
\[R^2 = 0.620 \quad D.W. = 1.680 \quad F(2, 13) = 10.62\]

\[
\frac{SERV}{N_t} = -26.366 + 0.031 \frac{PDY}{N_t} + 0.636 \frac{SERV}{N_t-1} \quad (IV-5)
\]
\[
(-1.092) (1.999) (3.095)
\]
\[R^2 = 0.922 \quad D.W. = 1.395 \quad F(2, 13) = 77.14\]

\[
\frac{TC}{N_t} = 102.859 + 0.068 \frac{PDY}{N_t} - 116.085 \frac{TC}{P_t} \quad (IV-6)
\]
\[
(0.372) (16.600) (-0.801)
\]
\[R^2 = 0.957 \quad D.W. = 1.870 \quad F(2, 13) = 144.20\]

\[
\frac{RE}{N_t} = 21.652 + 0.050 \frac{GDP}{N_t} + 0.237 \frac{RE}{N_t-1} - 51.161 \frac{PRE}{P_t} \quad (IV-7)
\]
\[
(0.649) (3.004) (1.023) (-3.094)
\]
\[R^2 = 0.996 \quad D.W. = 2.109 \quad F(3, 12) = 1,153.73\]
Government consumption equations (1963-1978)

\[
GADJP_t = -1,417.86 + 0.330 \text{GREV}_t + 0.570 \text{GADJP}_{t-1} \quad (IV-8)
\]
\[(-2.114) \quad (2.422) \quad (2.418)\]
\[R^2 = 0.980 \quad \text{D.W.} = 1.412 \quad F(2, 13) = 324.10\]

\[
GSERV_t = -1,134.63 + 0.151 \text{GREV}_t + 0.590 \text{GSERV}_{t-1} \quad (IV-9)
\]
\[(-2.729) \quad (2.679) \quad (2.928)\]
\[R^2 = 0.982 \quad \text{D.W.} = 2.759 \quad F(2, 13) = 360.76\]

\[
GTC_t = -56.398 + 0.031 \text{GREV}_{t-1} + 0.303 \text{GTC}_{t-1} \quad (IV-10)
\]
\[(-0.250) \quad (1.800) \quad (1.114)\]
\[R^2 = 0.629 \quad \text{D.W.} = 1.520 \quad F(2, 13) = 11.03\]

Investment equations (1963-1978)

\[
AGINV_t = -589.443 + 0.293 \text{AGINV}_{t-1} + 0.045 \text{AGOUT}_t \quad (IV-11)
\]
\[(-0.628) \quad (0.876) \quad (1.202)\]
\[R^2 = 0.684 \quad \text{D.W.} = 2.160 \quad F(2, 13) = 14.06\]

\[
MANINV_t = 1,143.993 + 0.498 \text{MANINV}_{t-1} + 0.259 (\text{MGDP}_t - \text{MGDP}_{t-1}) (IV-12)
\]
\[(2.070) \quad (2.926) \quad (1.093)\]
\[+ 0.673 (\text{MGDP}_{t-1} - \text{MGDP}_{t-2}) \]
\[(2.919)\]
\[R^2 = 0.914 \quad \text{D.W.} = 2.114 \quad F(3, 12) = 42.79\]

\[
CONSINV_t = 354.958 + 0.392 \text{CONSINV}_{t-1} + 0.093 \text{CONSOUT}_t \quad (IV-13)
\]
\[(1.784) \quad (1.983) \quad (2.463)\]
\[R^2 = 0.809 \quad \text{D.W.} = 2.485 \quad F(2, 13) = 27.51\]
\[
TCINV_t = -59.682 + 0.544 \text{TCINV}_{t-1} + 0.318 \text{TCOUT}_t \quad (\text{IV-14})
\]
\[
\begin{align*}
R^2 &= 0.958 \\
\text{D.W.} &= 2.065 \\
F(2, 13) &= 150.26
\end{align*}
\]

\[
WRTINV_t = 717.124 + 0.405 \text{WRTINV}_{t-1} + 0.062 \text{WRTOUT}_t \quad (\text{IV-15})
\]
\[
\begin{align*}
R^2 &= 0.849 \\
\text{D.W.} &= 2.096 \\
F(2, 13) &= 36.43
\end{align*}
\]

\[
SERVINV_t = 1,478.97 + 0.289 \text{SERVINV}_{t-1} + 0.024 (\text{GDP}_t - \text{GDP}_{t-1}) \quad (\text{IV-16})
\]
\[
\begin{align*}
R^2 &= 0.678 \\
\text{D.W.} &= 2.853 \\
F(3, 12) &= 8.44
\end{align*}
\]

\[
OTHINV_t = -1,095.71 + 0.898 \text{OTHINV}_{t-1} + 1.807 (\text{OTHOUT}_t - \text{OUTHOUT}_{t-1}) \quad (\text{IV-17})
\]
\[
\begin{align*}
R^2 &= 0.943 \\
\text{D.W.} &= 1.949 \\
F(2, 13) &= 108.30
\end{align*}
\]

**Import equations (1963-1978)**

\[
\text{IMPl}_t = 12,974.85 + 0.018 \text{PDY}_t - 10,069.5 \frac{\text{M1P}_t}{\text{PGDP}_t} \quad (\text{IV-18})
\]
\[
\begin{align*}
R^2 &= 0.837 \\
\text{D.W.} &= 1.691 \\
F(2, 13) &= 35.45
\end{align*}
\]

\[
\text{IMP2}_t = 9,109.127 + 7,888.982 \text{IP}_t - 8,202.2 \frac{\text{M2P}_t}{\text{PGDP}_t} \quad (\text{IV-19})
\]
\[
\begin{align*}
u_t &= 0.354 u_{t-1} \\
R^2 &= 0.917 \\
F(2, 13) &= 71.81
\end{align*}
\]
\[ \text{IMP}_3^t = -373.916 + 0.028 \text{PDY}_t - 304.630 \frac{\text{M3P}_t}{\text{PGDP}_t} \]  
\[ (-1.844) \quad (11.318) \quad (-2.597) \]  
\[ R^2 = 0.952 \quad \text{D.W.} = 1.677 \quad F(2, 13) = 128.09 \]  

\[ \text{IMP}_4^t = 13,818.32 + 0.299 \text{TINY}_t - 15,828.2 \frac{\text{M4P}_t}{\text{PGDP}_t} \]  
\[ (8.616) \quad (9.409) \quad (-6.541) \]  
\[ R^2 = 0.872 \quad \text{D.W.} = 1.563 \quad F(2, 13) = 44.43 \]  

\[ \text{IMPSERV}_t = 1,520.732 + 0.366 \text{SERGDP}_t - 2,799.31 \frac{\text{MTP}_t}{\text{PGDP}_t} \]  
\[ (2.819) \quad (19.482) \quad (-4.803) \]  
\[ R^2 = 0.972 \quad \text{D.W.} = 2.285 \quad F(2, 13) = 222.49 \]  

**Export equations**  

\[ \text{XRICE} = -4,348.85 + 0.326 \text{RICE}_{t-1} + 0.267 \text{XRICE}_{t-1} \]  
\[ (-1.772) \quad (2.454) \quad (1.353) \]  
\[ + 1,481.694 \quad \text{D}_2 \]  
\[ (2.611) \]  
\[ R^2 = 0.546 \quad \text{D.W.} = 1.595 \quad F(2, 13) = 4.80 \]  

\[ \text{XRUB}_t = 291.209 + 0.011 \frac{\text{WIMPRUB}_t}{\text{ER}_t} + 0.528 \text{XRUB}_{t-1} \]  
\[ (1.631) \quad (2.299) \quad (2.306) \]  
\[ R^2 = 0.914 \quad \text{D.W.} = 1.621 \quad F(2, 13) = 69.00 \]  

\[ \text{XMZE}_t = 565.830 + 165.145 \text{PXMXE}_t + 0.575 \text{MZE}_{t-1} \]  
\[ (2.554) \quad (0.851) \quad (3.998) \]  
\[ R^2 = 0.758 \quad \text{D.W.} = 2.852 \quad F(2, 13) = 20.39 \]
\[ XTAP_t = 9.753 + 1.129 \; TAP_t \quad \text{(IV-26)} \]
\[ \begin{align*}
R^2 & = 0.981 \quad \text{D.W.} = 2.360 \quad F(1, 14) = 725.35 \\
\end{align*} \]

\[ XSG_t = -758.981 + 1.180 \; SG_{t-1} + 0.185 \; XSG_{t-1} \quad \text{(IV-27)} \]
\[ \begin{align*}
(-3.950) \quad (6.974) \quad (1.487) \\
R^2 & = 0.943 \quad \text{D.W.} = 1.764 \quad F(2, 13) = 107.02 \\
\end{align*} \]

\[ \ln(XKN_t) = -10.958 + 1.441 \; \ln(\frac{WIMPKN_t}{ER_t}) + 0.672 \; \ln(PXKN_t) \quad \text{(IV-28)} \]
\[ \begin{align*}
(-3.672) \quad (4.125) \quad (1.599) \\
R^2 & = 0.887 \quad \text{D.W.} = 1.922 \quad F(4, 11) = 21.65 \\
\end{align*} \]

\[ XSERV_t = -1.168.08 + 0.337 \; SERGDP_t + 0.275 \; XSERV_{t-1} \quad \text{(IV-29)} \]
\[ \begin{align*}
(1.686) \quad (5.739) \quad (2.681) \\
R^2 & = 0.949 \quad \text{D.W.} = 2.629 \quad F(3, 12) = 74.08 \\
\end{align*} \]

\[ XOTH_t = -2,352.65 + 0.023 \; GDP_t + 0.977 \; XOTH_{t-1} \quad \text{(IV-30)} \]
\[ \begin{align*}
(-1.571) \quad (0.988) \quad (2.889) \\
R^2 & = 0.940 \quad \text{D.W.} = 1.697 \quad F(2, 13) = 101.70 \\
\end{align*} \]

**Net private capital movement equation (1963-1978)**

\[ PFK_t = -867.664 + 114.430 \; (CBINT_t - UINT_t) + 0.117 \; TX_t \cdot XTP_t \quad \text{(IV-31)} \]
\[ \begin{align*}
(-0.846) \quad (0.446) \quad (7.769) \\
R^2 & = 0.823 \quad \text{D.W.} = 2.732 \quad F(2, 13) = 30.27 \\
\end{align*} \]
Output equations (1963-1978)

\[
RICE_t = -67,101.4 + 0.404 \, RICE_{t-1} + 8,673.53 \, RICELAB_t + 1.559 \, RRICE_t
\]
\[
(-4.589) \quad (2.564) \quad (5.132) \quad (1.566)
\]
\[R^2 = 0.787 \quad D.W. = 1.471 \quad F(3, 12) = 14.76\]

\[
RUB_t = 78.188 + 0.294 \, ATRUB_t - 0.089 \, RRUB_t
\]
\[
(0.380) \quad (14.083) \quad (-1.286)
\]
\[R^2 = 0.942 \quad D.W. = 1.227 \quad F(2, 13) = 105.34\]

\[
MZE_t = -129.361 + 0.338 \, AMZE_t
\]
\[
(-0.508) \quad (8.103)
\]
\[R^2 = 0.824 \quad D.W. = 2.108 \quad F(1, 14) = 31.59\]

\[
TAP_t = 294.451 + 3.689 \, ETAPNINV_t
\]
\[
(2.904) \quad (22.370)
\]
\[R^2 = 0.973 \quad D.W. = 2.172 \quad F(1, 14) = 500.41\]

\[
OTHAG_t = 15,884.03 + 5.595 \, SOTHAGINV_t
\]
\[
(45.397) \quad (41.063)
\]
\[R^2 = 0.992 \quad D.W. = 1.897 \quad F(1, 14) = 1,686.18\]

\[
MGDP_t = 7,424.978 + 0.589 \, EMANNINV_t
\]
\[
(9.174) \quad (30.544)
\]
\[u_t = 0.534 \, u_{t-1}
\]
\[
(2.526)
\]
\[R^2 = 0.985 \quad F(1, 14) = 919.33\]
CONSOUT_t = 205.519 + 0.888 CONSOUT_{t-1} + 6,038.053 CONSLAB_t
\hspace{1cm} (0.246) (5.289) \hspace{1cm} (1.675)
R^2 = 0.903 \hspace{1cm} D.W. = 0.419 \hspace{1cm} F(2, 13) = 60.55

TCOUT_t = 4,803.256 + 0.171 TCNINV_t
\hspace{1cm} (14.764) (22.006)
\hspace{1cm} u_t = 0.521 u_{t-1}
\hspace{1cm} (2.443)
R^2 = 0.972 \hspace{1cm} F(1, 14) = 486.00

WRTOUT_t = 12,301.38 + 0.692 WRTNINV_t
\hspace{1cm} (46.734) (67.553)
R^2 = 0.997 \hspace{1cm} D.W. = 2.016 \hspace{1cm} F(1, 14) = 4,563.41

SERGDP_t = -3,992.330 + 15,473.537 SERLAB_t
\hspace{1cm} (-6.762) (34.598)
\hspace{1cm} u_t = 0.302 u_{t-1}
\hspace{1cm} (1.268)
R^2 = 0.988 \hspace{1cm} F(1, 14) = 1,152.67

OTHOUT_t = 118.301 + 1.089 OTHOUT_{t-1}
\hspace{1cm} (0.294) (54.284)
R^2 = 0.995 \hspace{1cm} D.W. = 1.191 \hspace{1cm} F(1, 14) = 2,946.71

Compensation of employee equations (1967-1978)

COMPAG_t = -8,979.43 + 0.192 AGOUT_t + 374.092 AGLAB_t
\hspace{1cm} (-0.681) (2.012) (0.281)
R^2 = 0.945 \hspace{1cm} D.W. = 1.219 \hspace{1cm} F(2, 9) = 76.71
\[
\text{COMPMC}_t = 3,386.599 + 17,219.51 \text{ CONSLAB}_t + 0.340 \text{ CONSOUT}_{t-1} \quad (IV-44)
\]
\[
(2.834) \quad (5.880) \quad (1.955)
\]
\[
R^2 = 0.902 \quad \text{D.W.} = 1.326 \quad F(2, 9) = 0.902
\]
\[
\text{COMPTC}_t = 716.825 + 0.189 \text{ TCOUT}_t \quad (IV-45)
\]
\[
(4.111) \quad (13.102)
\]
\[
R^2 = 0.945 \quad \text{D.W.} = 2.038 \quad F(1, 10) = 171.67
\]
\[
\text{COMPWRT}_t = -3,386.45 + 0.235 \text{ WRTOUT}_t \quad (IV-46)
\]
\[
(-4.164) \quad (9.329)
\]
\[
R^2 = 0.897 \quad \text{D.W.} = 1.182 \quad F(1, 10) = 87.50
\]
\[
\text{COMPSEV}_t = 1,582.909 + 0.438 \text{ SERGDP}_t \quad (IV-47)
\]
\[
(1.998) \quad (10.058)
\]
\[
R^2 = 0.910 \quad \text{D.W.} = 1.281 \quad F(1, 10) = 101.16
\]
\[
\text{COMPOTH}_t = 1,912.851 + 0.361 \text{ OTHOUT}_t \quad (IV-48)
\]
\[
(3.203) \quad (14.878)
\]
\[
R^2 = 0.957 \quad \text{D.W.} = 1.742 \quad F(1, 10) = 221.35
\]

**Income from unincorporated enterprises equations (1967-1978)**

\[
\text{FY}_t = -7,857.05 + 1.352 \text{ OTHAG}_t \quad (IV-49)
\]
\[
(-2.032) \quad (11.110)
\]
\[
R^2 = 0.925 \quad \text{D.W.} = 1.588 \quad F(1, 10) = 123.43
\]
\[
\text{YUE}_t = 4,354.486 + 0.265 \text{ GDP}_t - 11,008.7 \text{ RNAGLAB}_t \quad (IV-50)
\]
\[
(0.085) \quad (2.509) \quad (-0.034)
\]
\[
R^2 = 0.981 \quad \text{D.W.} = 1.622 \quad F(2, 9) = 232.02
\]
\[ FR_t = -1,530.692 + 0.143 \ AGOUT_t \]  
\[ (-1.505) \ (7.963) \]  
\[ u_t = 0.493 \ u_{t-1} \]  
\[ (1.965) \]  
\[ R^2 = 0.864 \ F(1, 10) = 63.53 \]  
\[ \text{INTDIV}_t = 549.749 + 111.646 \ \text{INTTB}_t + 0.063 \ \text{STDPCB}_t \]  
\[ (0.813) \ (0.942) \ (19.141) \]  
\[ R^2 = 0.981 \ D.W. = 1.394 \ F(2, 9) = 230.90 \]  

**Tax equations (1963-1978)**

\[ DTAX_t = -2.022.349 + 0.038 \ PI_t \]  
\[ (-5.448) \ (14.098) \]  
\[ u_t = 0.402 \ u_{t-1} \]  
\[ (1.757) \]  
\[ R^2 = 0.934 \ F(1, 14) = 198.12 \]  
\[ \text{IMPTAX}_t = 1,625.824 + 0.114 \ \text{TIMP}_t \]  
\[ (3.846) \ (9.669) \]  
\[ u_t = 0.342 \ u_{t-1} \]  
\[ (1.454) \]  
\[ R^2 = 0.870 \ F(1, 14) = 93.62 \]  
\[ \text{XTAX}_t = 622.510 + 0.047 \ \text{XRICE}_t + 0.997 \ \text{PR}_t \]  
\[ (3.102) \ (0.966) \ (14.382) \]  
\[ u_t = 0.553 \ u_{t-1} \]  
\[ (2.656) \]  
\[ R^2 = 0.942 \ F(2, 13) = 105.57 \]
\[ \text{BUSTAX}_t = -629.544 + 0.031 \text{GDP}_t \]  
\[ (-4.845) (39.785) \]  
\[ R^2 = 0.992 \quad \text{D.W.} = 1.803 \quad F(1, 14) = 1,582.82 \]

\[ \text{OIDTAX}_t = -1,153.63 + 0.043 \text{GDP}_t \]  
\[ (-5.841) (36.338) \]  
\[ R^2 = 0.990 \quad \text{D.W.} = 2.338 \quad F(1, 14) = 1,320.48 \]

**Monetary sector (1963-1978)**

\[ \text{CHP}_t = 3,138.676 + 0.064 \text{GDP}_t \cdot \text{PGDP}_t \]  
\[ (5.402) (26.569) \]  
\[ u_t = 0.359 u_{t-1} \]  
\[ (1.538) \]  
\[ R^2 = 0.981 \quad F(1, 14) = 722.84 \]

\[ \text{DDPCB}_t = 3,929.994 + 0.035 \text{GDP}_t \cdot \text{PGDP}_t - 197.017 \text{CBINT}_t \]  
\[ (3.777) (22.435) \quad (-1.630) \]  
\[ u_t = 0.346 u_{t-1} \]  
\[ (1.476) \]  
\[ R^2 = 0.979 \quad F(2, 13) = 303.02 \]

\[ \text{STDPCB}_t = -18.926.197 + 0.307 \text{GDP}_t \cdot \text{PGDP}_t \]  
\[ (-8.537) \quad (33.412) \]  
\[ u_t = 0.388 u_{t-1} \]  
\[ (1.683) \]  
\[ R^2 = 0.988 \quad F(1, 14) = 1,152.67 \]
\[ \text{STDPGB}_t = -265.168 + 0.034 \text{GDP}_t \cdot \text{PGDP}_t - \frac{0.628}{19.794} \]
\[ u_t = 0.459 u_{t-1} \]
\[ R^2 = 0.965 \quad F(1, 14) = 386.00 \]

\[ \text{GSCB}_t = -11,337.0 - 0.143 \text{LDCB}_t + 3.264 \text{DDPCB}_t - \frac{-4.899}{-2.806} \left( \frac{6.126}{-2.806} \right) \]
\[ u_t = 0.325 u_{t-1} \]
\[ R^2 = 0.971 \quad D.W. = 2.340 \quad F(2, 13) = 217.99 \]

\[ \text{GSGB}_t = -135.638 + 1.155 \text{STDPGB}_t + 119.850 \text{INTTB}_t - \frac{0.148}{21.293} \left( \frac{0.678}{21.293} \right) \]
\[ u_t = 0.550 u_{t-1} \]
\[ R^2 = 0.589 \quad F(2, 13) = 9.32 \]

\[ \text{LDCB}_t = -53,561.583 + 2.704 \text{TINV}_t - \frac{-3.568}{7.746} \]
\[ u_t = 0.489 u_{t-1} \]
\[ R^2 = 0.811 \quad F(1, 14) = 60.07 \]

\[ \text{BFCB}_t = -10,523.928 + 2,734.399 \text{CBINT}_t - 1,138.835 \text{JINT}_t - \frac{-1.724}{4.097} \left( \frac{-2.785}{-2.785} \right) \]
\[ u_t = 0.550 u_{t-1} \]
\[ R^2 = 0.589 \quad F(2, 13) = 9.32 \]
Price equations (1967-1978)

\[ P_t = 0.029 + 0.984 \text{PGDP}_t \]
\[ (1.562) (62.144) \]
\[ R^2 = 0.996 \quad \text{D.W.} = 1.949 \quad F(1, 14) = 3,861.84 \]

\[ \text{PGDP}_t = 0.705 + 0.000004 + 0.074 \text{M3P}_t \]
\[ (26.600) (4.587) \]
\[ R^2 = 0.969 \quad \text{D.W.} = 1.591 \quad F(2, 13) = 203.54 \]

\[ \text{IP}_t = 0.092 + 0.931 \text{PGDP}_t \]
\[ (2.189) (25.895) \]
\[ R^2 = 0.980 \quad \text{D.W.} = 2.426 \quad F(1, 14) = 670.56 \]

Identities

\[
\begin{align*}
\text{TPCE}_t &= \frac{\text{FBT}_t}{N_t} + \frac{\text{COPE}_t}{N_t} + \frac{\text{RFLHHO}_t}{N_t} + \frac{\text{FFHHE}_t}{N_t} + \frac{\text{SERV}_t}{N_t} + \frac{\text{TC}_t}{N_t} + \frac{\text{RE}_t}{N_t} \\
\text{TGCE}_t &= \frac{\text{GADJP}_t}{N_t} + \frac{\text{GTC}_t}{N_t} + \frac{\text{GSERV}_t}{N_t} \\
\text{TINV}_t &= \frac{\text{AGINV}_t}{N_t} + \frac{\text{NAGINV}_t}{N_t} + \frac{\text{DINV}_t}{N_t} \\
\text{NAGINV}_t &= \frac{\text{MANINV}_t}{N_t} + \frac{\text{CONINV}_t}{N_t} + \frac{\text{TCINV}_t}{N_t} + \frac{\text{SERVINv}_t}{N_t} + \frac{\text{WRTINV}_t}{N_t} + \frac{\text{OTHINV}_t}{N_t} \\
\text{TIMP}_t &= \frac{\text{IMPl}_t}{N_t} + \frac{\text{IMP2}_t}{N_t} + \frac{\text{IMP3}_t}{N_t} + \frac{\text{IMP4}_t}{N_t} + \frac{\text{IMP5}_t}{N_t} + \frac{\text{IMPSERV}_t}{N_t} \\
\text{TX}_t &= \frac{\text{XRICE}_t}{N_t} + \frac{\text{XRUB}_t}{N_t} + \frac{\text{XMZE}_t}{N_t} + \frac{\text{XTAP}_t}{N_t} + \frac{\text{XSG}_t}{N_t} + \frac{\text{XKN}_t}{N_t} + \frac{\text{XSERV}_t}{N_t} + \frac{\text{XOTH}_t}{N_t}
\end{align*}
\]
\[ AGOUT_t = RICE_t + RUB_t + MZE_t + TAP_t + OTHAG_t \]  
\[ NAGOUT_t = MGDP_t + CONSOUT_t + TCOUT_t + WRTOUT_t + SERGDP_t + OTHOUT_t \]  
\[ GDP_t = AGOUT_t + NAGOUT_t \]  
\[ GDP_t = TPCE_t + TGCE_t + TX_t - TIMP_t + TINV_t + SD_t \]  
\[ COMP_t = COMPAG_t + COMPMC_t + COMPTC_t + COMPWRT_t + COMPSERV_t + COMPOTH_t \]  
\[ TYUE_t = FY_t + YUE_t \]  
\[ YPROP_t = INTDIV_t + FR_t + OTHR_t \]  
\[ PI_t = COMP_t + TYUE_t + YPROP_t + TRANIN_t \]  
\[ TAX_t = DTAX_t + IDTAX_t \]  
\[ IDTAX_t = IMPTAX_t + XTAX_t + BUSTAX_t + OIDTAX_t \]  
\[ NY_t = COMP_t + TYUE_t + YPROP_t + CORPSAV_t + DTICORP_t + GGY_t - INTPD_t - INTCD_t \]  
\[ PDY_t = NY_t - DTHH_t - TRANOUT_t + TRANIN_t - DTICORP_t \]  
\[ TFK_t = PFK_t + PORTINV_t + GFK_t \]
\[ BOP_t = TX_t + XTP_t - TIMP_t - MTP_t + UT_t + TFK_t + ERR_t \]  
(IV-88)

\[ M_t = CHP_t + DDPBOT_t + DDPGB_t + STDPCB_t + STDPGB_t + SB_t \]  
(IV-89)

\[ M_t = FABOT_t + FADCB_t - BFCB_t + GSCB_t + LDGB_t + LDGB_t + GSBG_t \]  
+ CCBOT_t + FIACB_t - DOOB_t - STDOCB_t - ODCB_t - BOCB_t

\[ \text{GREV}_t = \text{TAX} + \text{MREV} \]  
(IV-91)

**List of variables**

1. AGINV = Gross Fixed Capital Formation in Agriculture
2. AGLAB\* = Number of Workers in Agriculture (100,000s of workers)
3. AGOUT = Total Output in Agriculture
4. AMZE\* = Planted Area for Maize (1,000 rai)
5. ATRUB\* = Tapping Area for Rubber (1,000 rai)
6. BFCB = Commercial Bank Borrowing from Abroad (mb.)
7. BOCB\* = Commercial Bank Borrowing from Banks in Thailand (mb.)
8. BOP = Balance of Payment (mb.)
9. BUSTAX = Business Taxes
10. CABOT\* = Capital Accounts and Other Liabilities of the BOT (mb.)
11. CACB\* = Capital Accounts and Other Liabilities of CB (mb.)
12. CAGB\* = Capital Accounts and Other Liabilities of GSB (mb.)
13. CBINT\* = Commercial Banks "Call Money" Interest Rate (% per annum)
14. CCBBOT* = Claim on Commercial Bank at BOT (mb.)
15. CHG* = Currency in Hand of Government (mb.)
16. CHP = Currency in Hand of Public (mb.)
17. COINS* = Total Coins (mb.)
18. COMP = Compensations of Employees
19. COMPAG = Compensations of Agricultural Workers
20. COMPMC = Compensations of Manufacturing and Construction Workers
21. COMPOTH = Compensations of Other Employees
22. COMPSERV = Compensations of Service Workers
23. COMPTC = Compensations of Transportation and Communication Workers
24. COMPWRT = Compensation of Wholesale and Retail Trade Workers
25. CONSLAB* = Number of Workers in Construction (100,000s of workers)
26. CONSOUT = Total Output in Construction
27. COPE = Consumption of Clothing and Other Personal Effects
28. CORPSAV* = Saving of Corporations and Government Enterprises
29. D1* = Dummy Variable, 1966-1972 = 1; Otherwise = 0
30. D2* = Dummy Variable, 1973-1975 = 0; Otherwise = 1
31. DDOBOT* = Other Demand Deposits at BOT (mb.)
32. DDOCB* = Other Demand Deposits at CB (mb.)
33. DDPBOT* = Private Demand Deposits at BOT (mb.)
34. DDPCB = Private Demand Deposits at CB (mb.)
35. DDPGB* = Private Demand Deposits at GSB (mb.)
36. DINV* = Change in Inventories
37. DTCORP* = Direct Taxes on Corporations
40. DTHH* = Direct Taxes on Households
41. ER* = Exchange Rates ($/Baht)
42. ERR* = Error in BOP (mb.)
43. FABOT* = Foreign Assets at BOT (mb.)
44. FADCB* = Foreign Currency on Hand and Balances at Banks in CB (mb.)
45. FBT = Consumption of Food, Beverages, and Tobacco
46. FIACB* = Commercial Bank Fixed and Other Assets (mb.)
47. FFHHE = Consumption on Furniture, Furnishings, and Household Equipment
48. FR = Farm Rent
49. FY = Farm Income
50. GADJP = Government Expenditures on Administration, Defense, Justice, and Police
51. GDP = Gross Domestic Product
52. GFK* = Government International Capital Movement (mb.)
53. GGY* = General Government Income from Property and Entrepreneurship
54. GREV = Government Revenue
55. GSBOT = Claims on Central Government at BOT
56. GSCB = Commercial Bank Investment on Government Securities
57. CSERV = Government Expenditures on Services
58. GSGB* = Claims on Government at Government Saving Bank
59. GTC = Government Expenditures on Transportation and Communication
60. IDTAX = Indirect Taxes
61. IMP1 = Imports of Consumer Goods
62. IMP2 = Imports of Intermediate Products and Raw Materials
63. IMP3 = Imports of Fuel and Lubricants
64. IMP4 = Imports of Capital Goods

65. IMP5* = Total Merchandise Imports in BOP - (IMP1 + IMP2 + IMP3 + IMP4)

66. IMPSERV = Imports of Services

67. IMPTAX = Import Taxes

68. INTCD* = Interest on Consumer Debt

69. INTDIV = Interest Income and Dividends

70. INTPD* = Interest on Public Debt

71. INTTB* = Interest Rate on Treasury Bills (percent per annum)

72. IP = Index of Industrial Production or GDP Price Deflator for Nonagricultural Sector

73. JINT* = "Call Money" Interest Rate in Japan (percent per annum)

74. KN* = Output of Kenaf

75. LDCB = Commercial Bank Loans, Overdrafts, and Discounts (mb.)

76. LDGB* = Loans and Overdrafts of GSB (mb.)

77. M = Money Supply (mb.)

78. MANINV = Gross Fixed Capital Formation in Manufacturing

79. MANNINV = Net Fixed Capital Formation in Manufacturing

80. MGDP = Manufacturing Output

81. MLP* = Price Deflator for IMP1

82. M2P* = Price Deflator for IMP2

83. M3P* = Price Deflator for IMP3

84. M4P* = Price Deflator for IMP4

85. MREV = The Government Revenue from Miscellaneous

86. MTP* = Total Import Price Deflator

87. MZE = Output of Maize
88. N* = Number of Population (100,000s of workers)
89. NAGINV = Gross Fixed Capital Formation on Nonagriculture
90. NAGOUT = Total Output in Nonagriculture
91. NY = National Income
92. OABOT* = Other Assets of BOT (mb.)
93. OAGB* = Other Assets of GSB (mb.)
94. ODCB* = Other Demand Liabilities of CB (mb.)
95. OIDTAX = Other Indirect Taxes
96. OTHAG = Output of Agricultural Products, Other Than Crops
97. OTHAGINV = Net Fixed Capital Formation in Agriculture, Other Than Crops
98. OTHINV = Gross Fixed Capital Formation in Other
99. OTHOUT = Output of Other Products
100. OTHR* = Other Rent
101. P = Price Deflator for All Consumption
102. PDY = Personal Disposable Income
103. PFFHHE* = Price Deflator for FFHHE
104. PFK = Net Private Capital Movement (mb.)
105. PGDP = GDP Price Deflator
106. PI = Personal Income
107. PORTINV* = Portfolio Investment (mb.)
108. PR* = Rice Premium Per Unit
109. PRE* = Price Deflator for RE
110. PTC* = Price Deflator for TC
111. PXKN* = Export Price Deflator for Kenaf
112. PXMZ* = Export Price Deflator for Maize
113. RE = Consumption Expenditures on Recreation and Entertainment
114. RFLHHO = Consumption Expenditures on Rent, Light, and Household Operation
115. RICE = Output of Rice
116. RICELAB* = Number of Workers in Rice Production (100,000s of Workers)
117. RNAGLAB* = Ratio of Nonagricultural Labor to Total Labor Force
118. RRICE = Rain Fall in Rice Production Area (mm.)
119. RRUB* = Rain Fall in Rubber Production Area (mm.)
120. RUB = Output of Rubber
121. SB* = Saving Bonds and Premium Saving Bonds at GSB (mb.)
122. SD* = Statistical Discrepancy
123. SERGDP = Output of Services
124. SERLAB* = Number of Workers in Services (100,000s of workers)
125. SERV = Consumption Expenditures on Services
126. SERVINV = Gross Fixed Capital Formation on Services
127. SG = Output of Sugar
128. STDOCB* = Other Saving and Time Deposits at CB (mb.)
129. STDPCB = Private Saving and Time Deposits at CB (mb.)
130. STDPGP = Private Saving and Demand Deposits at GSB (mb.)
131. TAP = Output of Tapioca
132. TAPNINV = Net Fixed Capital Formation on Tapioca
133. TAX = Total Taxes
134. TC = Consumption Expenditures of Transportation and Communication
135. TCINV = Gross Fixed Capital Formation on Transportation and Communication
136. TCNINV = Net Fixed Capital Formation on Transportation and Communication
137. TCOUT = Output of Transportation and Communication
138. TFK = Total Net Foreign Capital Movement (mb.)
139. TGCE = Total Government Consumption Expenditures
140. TIMP = Total Imports
141. TINV = Total Gross Fixed Capital Formation
142. TPCE = Total Personal Consumption Expenditures
143. TRANIN* = Net Transfers to Household from Government and the Rest of the World
144. TRANOUT* = Net Transfers from Household to Government and the Rest of the World
145. TX = Total Exports
146. TYUE = Total Income for Unincorporated Enterprises
147. UINT = Eurodollar Interest Rate in London (percent per annum)
148. UT = Unrequited Transfers
149. WIMPKN* = World Imports of Kenaf (millions of U.S. dollars)
150. WIMPRUM* = World Imports of Rubber (millions of U.S. dollars)
151. WRTINV = Gross Fixed Capital Formation in Wholesale and Retail Trade
152. WRTNINV = Net Fixed Capital Formation in Wholesale and Retail Trade
153. WRTOUT = Output of Wholesale and Retail Trade
154. XKN = Exports of Kenaf
155. XMZE = Exports of Maize
156. XOTH = Exports of Other Goods
Discussion of the Empirical Results of the Model

Private consumption expenditure equations (TPCE)

The specification of the private consumption equations follows the Friedman "permanent income" consumption hypothesis. Consumption for a particular commodity group is a function of income and the lagged value of consumption which reflects the permanent income effect. However, a relative price variable was also included with an anticipated negative sign. The ratio of the price deflator of each category in private consumption expenditure to the price deflator for all consumption was used as the
relative price variable. The equations in this sector are specified on a per capita basis to introduce the effect of population into the model and also to obtain a better explanation of the welfare of the people in the economy. If consumption increases but the population increases faster, per capita consumption tends to decrease.

The private consumption expenditure sector is disaggregated into seven categories as follows:

1. Food, beverage, and tobacco (FBT)
2. Clothing and other personal effects (COPE)
3. Rent, fuel, light, and household operation (RFLHHO)
4. Furniture, furnishings, and household equipment (FFHHE)
5. Services (SERV)
6. Transportation and communication (TC)
7. Recreation and entertainment (RE)

As mentioned before, the specification of each equation has per capita consumption as a function of income, the lagged value of consumption, and relative prices. However, the results of some equations were not satisfactory. Some coefficients were statistically insignificant or did not have proper signs. These variables have been left out when the ordinary least square (OLS) is applied.

The final estimated equation is shown in equations IV-1 through IV-7. The results of the estimation of the coefficients in each commodity group are reasonable and have good fits except for some coefficients in equations IV-6 and IV-7, which are insignificant. Those coefficients correspond to the variables $\frac{PTC_t}{P_t}$ and $\frac{RE_{t-1}}{N_{t-1}}$, respectively. These variables were not
dropped from the equations because when the OLS was applied with sample period 1960 to 1979, they were significant in terms of t-statistics. As 2SPC are applied, the number of observations in the sample period is reduced in order to make the available data consistent for all variables in the model. The sample period then runs from 1963 to 1978. As the number of observations is decreased, low t-ratios for those coefficients may result. In equation IV-4, the $R^2$ is fairly low, only 0.620, but the t-statistic of each coefficient is satisfactory. However, all estimated coefficients in this sector have the expected sign.

**Government consumption expenditure equations (TGCE)**

Many macroeconometric models have treated government consumption expenditure as an exogenous variable. Here it is specified to be determined endogenously. Government consumption expenditure is observed to be closely related to the government revenue. Its trend responds to the growth of the population and the growth of the economy. Government consumption expenditure is hypothesized to be a function of government revenues and lagged value of government consumption, and it is disaggregated into three categories, as follows:

1. General administration, Defense and Justice, and Police (GADJP)
2. Transport and communication (GTC)
3. Education and research, Health services, Special welfare services, and Other services (GSERV)

The results of the estimation of coefficients are statistically satisfactory and have good fit with high $R^2$, except for equation IV-10. The $R^2$
of this equation is only 0.629. However, the t-ratio of each coefficient is statistically significant.

**Gross fixed capital formation equations (TINV)**

The specification of the investment equations, made to be simple as possible, follows the accelerator principle, where gross fixed capital formation is hypothesized to be a function of output, or the past change of output, and the lagged value of the endogenous variable. The gross fixed capital formation equation is disaggregated into two main categories with the second main category further divided into six groups. They are shown as follows:

1. Gross fixed capital formation in agriculture (AGINV)
2. Gross fixed capital formation in nonagriculture (NAGINV)
   a. Gross fixed capital formation in manufacturing (MANINV)
   b. Gross fixed capital formation in construction (CONSINV)
   c. Gross fixed capital formation in transportation and communication (TCINV)
   d. Gross fixed capital formation in wholesale and retail (WRTINV)
   e. Gross fixed capital formation in services (SERINV)
   f. Gross fixed capital formation in other (OTHINV)

The results of the estimated equations are statistically satisfactory with generally good $R^2$'s, except for equations IV-11 and IV-16. The $R^2$'s of these equations are only 0.684 and 0.678, respectively. However, the estimated coefficients have the expected signs.
The import equations

The specification of the import equation is based on the theory of demand. Import goods are hypothesized to be a function of relative prices and income, but some have their own characteristics, such as imports of intermediate products and raw materials (IMP2) and imports of capital goods (IMP4). Therefore, an alternative specification is considered. IMP2 is hypothesized to be a function of income, the change in inventories, the industrial production index, and relative prices. The price deflator of nonagricultural output is used as a proxy for the industrial production index. Changes in inventories and income have been dropped from the equation because they do not yield the proper sign. The final specification has IMP2 as a function of the industrial production index and relative price. For the import of capital goods (IMP4) equation, it is considered as an investment function and follows the Prachowny specification, discussed above. It is hypothesized to be a function of total investment and the price ratio.

Imports are classified into six categories:

1. Imports of consumer goods (IMPl)
2. Imports of intermediate product and raw material (IMP2)
3. Imports of fuel and lubricants (IMP3)
4. Imports of capital goods (IMP4)
5. Imports of services (IMPSERV)
6. Other imports (IMP5)

The results of the estimation of the coefficients are satisfactory both in terms of t-ratios and R²'s. For IMP2 equation, the low Durbin-Watson statistic shows autocorrelation. Generalized least squares is used
to correct autocorrelation. The autocorrelation coefficient ($\hat{\rho}$) for this equation is 0.354, with a t-ratio of 1.513.

The export equations (TX)

The first attempt at export specification is based on the theory of demand. However, it was found that the theory of demand is not a good approach for Thai exports.

For Thailand, Ammar Siamwalla (1975) suggests that many Thai export commodities take only small shares in the total world market. Therefore, the major problem concerning exports is not lack of foreign demand but deficiency of supply. Thus, the specification of Thai export is based on supply rather than demand.

Stephenson and Itharattana (1977) suggest that a single equation of exports of an economy is a reduced form equation which reflects a series of equilibrium positions over time. It is difficult to specify the export equation as demand or supply. However, it is not impossible. The single equation approach will show a negative or a positive price effect which indicates demand or supply relationship. The 1977 report also shows the relationship between export and output and lagged value of exports which indicates a trend of export. Therefore, the specification of Thai export of various commodities will follow Stephenson and Itharattana and include Siamwalla's suggestion, i.e., a supply relationship will be observed.

\[ X_t = f(PX_t, Y_t, X_{t-1}) \]

where
- $X_t$ = output
- $X_{t-1}$ = export in period $t-1$
Exports are disaggregated into
1. Export of rice (XRICE)
2. Export of rubber (XRUB)
3. Export of maize (XMZE)
4. Export of tapioca (XTAP)
5. Export of sugar (XSG)
6. Export of kenaf (XKN)
7. Export of services (XSERV)
8. Export of other (XOTH)

In specifying that rice export equation, a dummy variable is added due to a shortage in rice supply from 1973 to 1975. The results of the estimation of coefficients in this equation are not particularly satisfactory. The $R^2$ is quite low, but as OLS is applied, the $R^2$ is equal to 0.775 for the sample period 1960 to 1978. When using 2SPC, $R^2$ is only 0.546. At the same time, the t-statistic of each coefficient is lower. This might be due to a reduction in the sample period. The export of maize equation is similar. When using 2SPC, the $R^2$ is fairly low, only 0.758. When OLS is applied to the sample period from 1960 to 1978, $R^2$ is 0.805. This pattern is the same as that for the export of rice equation and might be explained in the same way. In the specification of service export equation, a dummy variable is added due to the effect of the Vietnam War during 1966 to 1972. The results of coefficient estimation in the other equations besides rice export and maize export are statistically satisfactory. All coefficients have the expected signs.
The net private capital movement equation (PPK)

The specification of the net private capital movement equation follows the hypothesis of interest arbitrage. An attempt was also made to relate trade credit to the total value of exports. Therefore, the specification is hypothesized as a function of total exports in current prices and the difference between the domestic and the international interest rate. In specifying this equation, dummy variable is also added due to an increase in oil price since 1974. It caused direct investment, loans, and credits to both government and private enterprises to increase. When applying OLS, it was found that the coefficient estimation did not yield statistical significance. Thus, it was dropped from the equation.

The result of estimation is statistically satisfactory. $R^2$ is 0.823, which is fairly high, but the t-ratio for the difference of domestic and foreign interest is nonsignificant. It shows that the Thai net private capital movement probably depends upon the exports rather than the interest rate.

The output equations

The specification of output equations, in general, is based on the production function, i.e., output is a function of capital and labor. In Thailand, it is difficult to collect data on capital stock. Therefore, the sum of net investment is used for capital stock (as shown in Chapter III). For agricultural output, weather conditions such as the amount of rainfall in the cultivation areas and planted areas are considered as factors which determine the output of production. Output is disaggregated into:
I. Agricultural output (AGOUT)
(1) Rice (RICE)
(2) Rubber (RUB)
(3) Maize (MZE)
(4) Tapioca (TAP)
(5) Other agricultural output (OTHAG)

II. Nonagricultural output (NAGOUT)
(1) Manufacturing (MGDP)
(2) Construction (CONSOUT)
(3) Transportation and Communication (TCOUT)
(4) Wholesale and Retail Trade (WRTOUT)
(5) Services (SERGDP)
(6) Other nonagricultural output (OTHNAG)

The results of the estimation of the coefficients in this sector yield satisfactory. Even the $R^2$ for RICE equation is fairly low, only 0.787, but it is not very bad. Some equations in this sector have difficulties with low Durbin-Watson statistics such as RICE, MGDP, CONSOUT, TCOUT, SERGDP, and OTHOUT. In the RICE, CONSOUT, and OTHOUT, there are lagged endogenous variables. Therefore, Durbin-Watson statistics are not good for showing autocorrelation. For MGDP, TCOUT, and SERGDP equations, the low D-W statistics show autocorrelation. Generalized least squares is thus used to correct the autocorrelation. The autocorrelation coefficient ($\hat{\rho}$) for the MGDP equation is 0.534, with a t-ratio of 2.526, while $\hat{\rho}$ for TCOUT and SERGDP are 0.521 and 0.302 with t-ratio of 2.443 and 1.268, respectively. After generalized least squares is applied, the results of the estimation of coefficient remain satisfactory.
Income distribution equations (1967-1978)

Distribution of the national income, which appears in the national income accounts, is disaggregated into wages and salaries among various industries, incomes of unincorporated businesses, rental income, interest, and dividend income. The specification of wages and salaries among industries is based on the assumption of profit maximization by producers. Any change in output will affect employment and also wages and salaries. Some industries such as manufacturing, construction, transportation and communication may be affected by credit availability.

In the final specifications for compensation of employees in manufacturing and construction (COMPMC), loans and overdrafts from commercial banks (LDCB) are dropped from the equation because they yield insignificant results. Therefore, the COMPMC is specified as a function of labor employed in construction and construction output in the last year. The results of the estimation of the coefficient are statistically satisfactory with good $R^2$. The t-ratio of each coefficient is also statistically significant.

In the transportation and communication equation, LDCB and labor employed are also dropped due to improper signs and statistical insignificance. The results of the estimation of the coefficients yield a high $R^2$, 0.945. The t-ratio of the coefficient is highly significant.

The final result of the estimation of the coefficients is statistically satisfactory.
Income from unincorporated enterprises equations (1967-1978)

Income from unincorporated enterprise consists of farm income and the income of other unincorporated groups such as doctor, lawyers, taxi drivers, barbers, and others. Factors that affect farm income would include output and the number of laborers in the agricultural sector. In final specification, the number of laborers employed in agriculture was dropped because it does not yield a proper sign. This may be caused by correlation between labor employed and output. An attempt was made to specify income of other unincorporated business as a function of gross output and labor employed. It was found that GDP and RNAGLAB yield the best explanation of other unincorporated business income.

Rental income includes earnings received from housing rental, land for agriculture, and rent from various industries. The major source of rental income comes from agriculture. Therefore, farm rent (FR) is treated as an endogenous variable. Other rent is treated as exogenous. Farm rent is specified to be determined by cultivated area and agricultural output. Cultivated area was dropped from the equation because it yielded a nonsignificant coefficient perhaps due to the correlation between output and cultivated area. The estimation of this equation also gives a low Durbin-Watson statistic. The D-W statistic is equal to 0.861. Therefore, generalized least squares was applied to correct for autocorrelation. The correlation coefficient (̂p) was 0.493 with a t-ratio of 1.965.

Interest income is determined in the financial sector. Interest paid by banks to households is a major source of income in this group. Therefore, interest income is specified to be explained by interest rates in the financial sector and the amount of money deposited in banks.
The estimation of coefficients in the income distribution equations uses time series data available from 1967 to 1978. It is different from the other sectors of the model, which used samples from 1963 to 1978. Data for the earlier years, 1963 to 1966, were not available for the income distribution equations.

Tax functions

Taxation is the major source of government revenue. It is divided into direct taxes (DTAX) and indirect taxes (IDTAX). Direct taxes are assumed to depend on income before taxes, i.e., personal income (PI). Indirect taxes are disaggregated into import duties (IMPTAX), export duties (XTAX), business taxes (BUSTAX), and other indirect taxes (OIDTAX).

The import duties function is specified as a function of the value of import goods. Government revenue from export duties mainly comes from the rice premium. Therefore, export duties are specified to be a function of the value of rice exports (XRICE) and the rice premium rate (PR). Business taxes and other indirect taxes are assumed to depend on the level of income.

\[
\begin{align*}
\text{DTAX} &= f(\text{PI}) \\
\text{IMPTAX} &= f(\text{TIMP}) \\
\text{XTAX} &= f(\text{XRICE PR}) \\
\text{BUSTAX} &= f(\text{GDP}) \\
\text{OIDTAX} &= f(\text{GDP})
\end{align*}
\]

The results of the direct tax, import tax, and export tax equations show that there is autocorrelation. They yield low Durbin-Watson
statistics, 0.860, 1.071, and 0.664, respectively. Generalized least squares was then applied. The other equations are statistically satisfactory.

Monetary sector equations

The money supply usually is treated as an exogenous variable which is controlled by the financial authorities. Here, money supply is treated as an endogenous variable. Any change in commercial bank investment on government securities (GSCB), government saving investment on government securities (GSCB), loans, overdrafts, and discounts of commercial bank to private sector (LDCB), and borrowing from abroad of commercial banks (BFCB) will change the money supply.

The specification of the function starts with the balance sheet identity of the Bank of Thailand, commercial banks, and government saving bank.

Bank of Thailand balance sheet identity

\[(1) \quad \text{FABOT} + \text{GSBOT} + \text{CCBBOT} + \text{OABOT} = \text{NCBOT} + \text{DDPBOT} + \text{DDOBOT} + \text{CABOT}\]

**Assets**
- \(\text{FABOT}\) = Foreign assets at BOT
- \(\text{GSBOT}\) = Claims on the central government at BOT
- \(\text{CCBBOT}\) = Claim on commercial banks at BOT
- \(\text{OABOT}\) = Other assets of BOT

**Liabilities**
- \(\text{NCBOT}\) = Notes in circulation
- \(\text{DDPBOT}\) = Private demand deposits at BOT
DDOBOT = Other demand deposits at BOI
CABOT = Capital accounts and other liabilities

**Commercial bank balance sheet identity**

(2) \[ FADCB + CHCB + GSCB + LDCB + FIACB = DDPCB + DDOCB + STDPCB + STDOCB + ODCB + BOCB + BFCB + CACB \]

**Assets**

FADCB = Foreign currency on hand and in balances at banks
CHCB = Cash in hands of commercial banks
GSCB = Commercial bank investments in government securities
LDCB = Commercial bank loans, overdrafts, and discounts
FIACB = Commercial bank fixed and other assets

**Liabilities**

DDPCB = Private demand deposits at commercial bank
DDOCB = Other demand deposits at commercial bank
STDPCB = Private saving and time deposits at commercial bank
STDOCB = Other saving and time deposits at commercial bank
ODCB = Other demand liabilities
BOCB = Commercial bank borrowing from banks in Thailand
BFCB = Commercial bank borrowing from abroad
CACB = Capital accounts and other liabilities

**Government saving bank balance sheet identity**

(3) \[ CHGB + LDGB + GSCB + OAGB = DDPGB + STDPGB + SB + CAGB \]

**Assets**

CHGB = Notes and coins in the hands of the government saving bank
LDGB = Loans, overdrafts of the government saving bank
GSGB = Claims on government at government saving bank
OAGB = Other assets of government saving bank

Liabilities
DDPGB = Private demand deposits at the government saving bank
STDPCB = Private saving and demand deposits at the government saving bank
SB = Saving bonds and premium saving bonds
CAGB = Capital accounts and other liabilities of government saving bank

(4) NCBOT = CHP + CHCB + CHGB + CHG - COINP - COINCB - COING
       = CHP + CHCB + CHGB + CHG - COINS
COINS = COINP + COINCB + COING

where
CHP = Currency in the hands of the public
CHCB = Currency in the hands of commercial banks
CHGB = Currency and coins in the hand of the government saving bank
CHG = Currency in the hands of government
COINP = Coins in the hands of the public
COINCB= Coins in the hands of commercial banks
COING = Coins in the hands of government
COINS = Total coins

Substitute (4) in (1)
FABOT + GSBOT + CCBBOT + OABOT = CHP + CHCB + CHGB + CHG - COINS
+ DDPBOT + DDOBOT + CABOT
(5) \[ \text{CHP + DDPBOT} = \text{FABOT + GSBOT + } \text{CCBBOT + OABOT - CHCB - CHGB - CHG} \]
\[ + \text{COINS - DDOBOT - CABOT} \]

From (2)
\[ (6) \text{DDPCB + STDPCB} = \text{FADCB + CHCB + GSCB + LDCB + FIACB - DDOCB} \]
\[ - \text{STDOCB - ODCB - BOCB - BFCB - CACB} \]

From (3)
\[ (7) \text{DDPGB + STDPGB + SB} = \text{CHGB + LDGB + GSGB + OAGB - CAGB} \]
\[ (5) + (6) + (7) \]

Left hand side = CHP + DDPBOT + DDPCB + DDPGB + STDPCB + STDPGB + SB

Right hand side = FABOT + GSBOT + CCBBOT + OABOT - CHG + COINS - DDOBOT
\[ - \text{CABOT + FADCB + GSCB + LDCB + FIACB - DDOCB - STDOCB} \]
\[ - \text{ODCB - BOCB - BFCB - CACB + LDGB + GSGB + OAGB - CAGB} \]

The first specification will be
\[ (1) \text{CHP} = f_1(Y, r, \frac{\Delta P}{P}) \]
\[ (2) \text{DDPCB} = f_2(Y, r, \frac{\Delta P}{P}, \frac{Y_{na}}{Y}, \frac{Y_a}{Y}) \]
\[ (3) \text{STDPCB} = f_3(Y, r, \frac{\Delta P}{P}, \frac{Y_{na}}{Y}, \frac{Y_a}{Y}) \]
\[ (4) \text{STDPGB} = f_4(Y, r, \frac{\Delta P}{P}, \frac{Y_{na}}{Y}, \frac{Y_a}{Y}) \]
\[ (5) \text{GSCB} = f_5(LDCB, DDPCB, r) \]
\[ (6) \text{LDCB} = f_6(TINV, r, \frac{\Delta P}{P}) \]
\[ (7) \text{GSGB} = f_7(LDGB, STDPGB, r) \]
\[ (8) \text{BFCB} = f_8(r, r_f) \]

where \( Y \) = income
\[ Y_{na} \] = income from agriculture
The demand for currency (CHP) is hypothesized to be a function of current income, the interest rate, and the rate of inflation. The interest rate represents the rate of return in holding other financial assets, and the inflation rate represents the opportunity costs of holding cash rather than goods. Statistical tests show insignificance of the two effects. Thus, the interest rate and the rate of inflation have been left out of the demand for currency equation. The result of coefficient estimation shows high significance in the relationship between demand for currency and current income.

The demand for demand deposits and time and saving deposits is specified as the demand for currency. Here changes in income in nonagricultural and agricultural sectors were added to be investigated. They represent a proxy for income distribution. Because statistical tests do not show significant relationship among the variables, they were dropped from the equations. The final specification of demand deposits of commercial is as a function of current income and the interest rate. The interest rate shows a statistically insignificant relationship, but as a whole it improves $R^2$ in the equation. The demand for time and saving deposits in both commercial banks and government saving banks shows a highly significant relationship with current income.

Claims on government at commercial banks (GSCB) and at the government saving banks (GSGB) are specified to be functions of the amount of bank deposits, the rate of returns, and the amount of other investments, i.e.,

\[
\begin{align*}
Y_{na} &= \text{income from nonagriculture} \\
r &= \text{domestic interest rate} \\
r_f &= \text{foreign interest rate}
\end{align*}
\]
loans and overdrafts. Because the interest rate shows an insignificant relationship to GSCB, it was dropped out. Therefore, GSCB is specified to be a function of LDCB and DDPCB. LDGB is insignificant in GSGB and was left out of the equation. The specification of LDGB then is a function of STDPGB and the interest rate.

LDCB is hypothesized to be a function of total investment, the interest rate, and the rate of inflation. Because only total investment shows statistical significance, the others were dropped.

Commercial bank borrowing from abroad (BFCB) is specified to be a function of the domestic interest rate and the foreign interest rate. The results of coefficients are statistically satisfactory and have the expected signs.

Price determination

An approach to specify a general price level equation may follow the quantity theory of money. The equation for the quantity of money can be defined as

\[ PY = MV \]

where

- \( P \) = implicit national income (price index)
- \( Y \) = real national income
- \( M \) = nominal quantity of money
- \( V \) = income velocity of circulation

Rewritten the quantity of money equation

\[ P = \frac{MV}{Y} \]

Assuming that \( V \) is fixed, and taking logarithm both sides of the equation,
\[ \ln P = \ln M - \ln Y + \ln V \]

Therefore, the specification of a general price equation will be

\[ P = f(M, Y) \]

The estimated coefficients have the expected signs, but the estimated coefficient corresponding to GDP does not yield a statistically significant result. This may be due to the correlation between \( M \) and GDP. It has been found that \( M3P \) (the import price index of fuel and lubricants) has a strong effect on the domestic price level. Thus, \( M3P \) was considered and showed a significant effect.

The specification of the price deflator for all consumption (\( P \)) equations and the GDP price deflator for the nonagricultural sector (\( IP \)) equation follow the Evans and Klein standard hypothesis. It is assumed that the change in prices in any given period is proportional to the difference between the equilibrium sectoral price, which depends on the general price level, and last period actual price.

Symbolically,

\[ \Delta P = \delta(P^e - P_{t-1}) \]

and

\[ P^e = f(P_{GDP}) \]

where

- \( P \) = sectoral price
- \( P^e \) = equilibrium sectoral price
- \( PGDP \) = general price level
- \( \delta \) = speed of adjustment

The equation can be rewritten as

\[ P_t - P_{t-1} = \delta(P^e - P_{t-1}) \]

\[ P_t = \delta P^e + (1-\delta)P_{t-1} \]
Substitute for $P^e$ by $f(PGDP)$

$$P^t = \delta \cdot f(PGDP) + (1-\delta) P_{t-1}$$

The $P^t$ and $IP^t$ equations are specified as functions of PGDP and the last period price in each sector. In the $P^t$ equation, $P_{t-1}$ has been dropped due to having an incorrect sign. The final specification of the $P^t$ equation will be as a function of PGDP alone. In the $IP^t$ equation, $IP_{t-1}$ has also been dropped because it gives an incorrect sign and statistical insignificant. The final specification of the $IP^t$ equation will be as a function of PGDP alone.

The result of the coefficient estimation is statistically satisfactory. It is shown that the price index for all consumption responds to general price level more than the GDP price index for the nonagricultural sector.
CHAPTER V. SIMULATION OF THE MACROECONOMETRIC MODEL

Model Simulation Method

After a model is constructed, it is necessary for researchers to test the model's performance. The model illustrates the relationship among economic variables which are hypothesized from economic theory. Testing the model is done by testing its predictive performance. Simulation is a testing technique of the predictive ability of a model. The method of simulation depends upon the structural model constructed. If the structural equations are linear in both parameters and variables, reduced form simulation can be used. If the structural equations are nonlinear in either the variables, parameters or both, the Gauss-Seidel simulation algorithm can be used. The Thai macroeconometric model described in Chapter IV is linear in parameters, but some equations are nonlinear in variables. Therefore, only the Gauss-Seidel algorithm will be discussed.

The Gauss-Seidel method is an iterative technique. It does not require the inversion of matrices and derivatives. When the equations of the model are written in the following form,

\[
Y_1 = f_1(Y_2, Y_3, \ldots, Y_G, X_1, X_2, \ldots, X_K)
\]

\[
Y_2 = f_2(Y_1, Y_3, \ldots, Y_G, X_1, X_2, \ldots, X_K)
\]

\[
\vdots
\]

\[
Y_G = f_G(Y_1, Y_2, Y_3, \ldots, Y_{G-1}, X_1, X_2, \ldots, X_K)
\]

\[
Y^0 = (Y_1^0, Y_2^0, \ldots, Y_G^0)
\]

The first round of \(Y_s\) \((Y^1)\) can be computed as
The first round can then be used to generate a second round \((Y^2)\) as

\[
Y^1_1 = f_1(Y^0_2, Y^0_3, \ldots, Y^0_G, X_1, X_2, \ldots, X_K) \\
Y^1_2 = f_2(Y^1_1, Y^0_3, \ldots, Y^0_G, X_1, X_2, \ldots, X_K) \\
\vdots \\
Y^1_G = f_G(Y^1_1, Y^1_2, \ldots, Y^1_{G-1}, X_1, X_2, \ldots, X_K)
\]

The iteration is repeated and stops when

\[
\frac{Y^K_i - Y^{K-1}_i}{Y^{K-1}_i} \leq \delta \text{ for all } i
\]

where \(\delta\) is a small positive number.

The Gauss-Seidel method will sometimes not converge, depending on the order of the equations. The procedure suggested is to arrange the equations so that the matrix of endogenous variables is as triangular as possible.

Error Measures

A model should be tested for the accuracy of its predictive performance. The success of the prediction can be checked by comparing the actual values of each variable in the sample period with the predicted values of that variable. This method, called ex post prediction, uses the historical value of observed variables.
The statistics which can be used to measure the accuracy of the predictions of the model are as follows:

1. **Mean Absolute Error (MAE)**

   \[
   MAE = \frac{1}{T} \sum_{t=1}^{T} |\hat{Y}_t - Y_t|
   \]

2. **Mean Absolute Percentage Error (MAPE)**

   \[
   MAPE = \frac{1}{T} \sum_{t=1}^{T} \left( \frac{|\hat{Y}_t - Y_t|}{Y_t} \right)
   \]

3. **Root Mean Square Error (RMSE)**

   \[
   RMSE = \frac{1}{T} \sqrt{\sum_{t=1}^{T} (\hat{Y}_t - Y_t)^2}
   \]

4. **Root Mean Squared Percentage Error (RMSPE)**

   \[
   RMSPE = \sqrt{\frac{1}{T} \sum_{t=1}^{T} \left( \frac{\hat{Y}_t - Y_t}{Y_t} \right)^2}
   \]

5. **Correlation coefficient (CC)**

   \[
   CC = \frac{\sum_{t=1}^{T} (\hat{Y}_t - \bar{Y}_t)(Y_t - \bar{Y})}{\sqrt{\sum_{t=1}^{T} (\hat{Y}_t - \bar{Y}_t)^2(\bar{Y}_t - \bar{Y})^2}}
   \]

6. **Theil U-statistic (U)**

   \[
   U = \frac{\sum_{t=1}^{T} (\hat{Y}_t - Y_t)^2}{\sqrt{\sum_{t=1}^{T} \hat{Y}_t^2} \sqrt{\sum_{t=1}^{T} Y_t^2}}
   \]

where \(\hat{Y}_t\) = predicted value of \(Y\) at time \(t\)

\(Y_t\) = actual value of \(Y\) at time \(t\)

\(T\) = the numbers of sample periods
Results of Simulations

The model performance test used in this study is the ex post test, meaning that it is an examination over the sample period. Because of the limitation of data available in some variables, the sample period will be reduced to the 1967 to 1978 period. The simulation is fully dynamic in the sense that the model generates its own lagged endogenous variables. It is assumed that all exogenous variables are known and constant. The results of the simulations are summarized in the Appendix, which are illustrated by both figures and graphs. The only statistic presented is RMSPE because the SAS (ETS) computer package is used for the simulation. It provides this statistic.

The overall results of simulation are fairly satisfactory over the sample period. However, there is some variation in the results. Some equations perform better than others, as will be discussed in more detail.

In the private consumption sector, the difference between the predicted and actual values of the total private consumption is RMSPE 0.070. It shows reasonably good performance of the equation. The worst performance in this sector is consumption expenditures on rent, light, and household operation (RFLHHO), with an 0.736 RMSPE. It can be said that the majority of the equations in this sector predict reasonably well.

The equations in the government expenditure sector perform well. The equations can predict the total government expenditure quite accurately. The total government expenditure has an 0.072 RMSPE. The poorest fit in this sector is the government expenditures on transportation and communication, with an 0.224 RMSPE.
In the investment or gross fixed capital formation sector, the equations have fair predictive performance. The error measurements are comparatively high. RMSPE range from 0.090 to 0.319. It is not surprising considering that data were lacking in this sector initially. The equation for investment of other has a large error, at 0.319 RMSPE. During the period 1971 to 1978, the equation gives overprediction, but underprediction in 1969 and 1970. The investment of construction also has a large error, at 0.165 RMSPE. The reason for the large error in this equation may be the effect of a big prediction error in the construction output which is a variable in this variable. As the construction output equation performs poor, the error is transferred to this equation as well. However, the prediction error of the total investment equation has a 0.097 RMSPE which is not very high.

In the import sector, most equations show results similar to what was found in the investment sector. RMSPEs range from 0.072 to 0.208. The best performance in this sector is the import of fuel and lubricants equation, worth only an 0.072 RMSPE. The worst predictive performance was in the import of intermediate products and raw materials. It shows low predictive power with high RMSPE. However, total imports show reasonably good prediction performance, at 0.090 RMSPE.

The equations in the export sector show variation in predictive power. RMSPEs range from 0.086 in exports of rubber to 2.469 in exports of sugar. Prediction of maize exports was also poor. It might be due to low predictive power in the maize equation which is transmitted to this equation. Lagged maize output is a variable in this equation, thus, as the maize equation does not perform well, it contributes to the poor prediction in
the maize export equation as well. However, the total export prediction is reasonably good, showing a 0.088 RMSPE.

The net private capital movement equation shows relatively low predictive power. The estimated equation has large error, 0.504 RMSPE. This equation performs badly in the 1971 and 1973 years. In 1971, there was a decrease in net private capital movements followed by an increase in 1972. In 1973, it dropped again and then increased tremendously in 1974. The fluctuation of data can be explained by the fact that direct investment, loans, and credits to both government and private enterprises decreased in 1971. In 1973, private enterprise repayments were greater than drawings, which caused PFK to decrease. In 1974, direct investment and loans and credits to private enterprises doubled, and also loans and credits to government enterprises increased by threefold. They caused PFK to increase in 1974.

The equations in the output sector do reasonably well in performance. The equations of agricultural and nonagricultural output have satisfactory predictive power, with 0.027 and 0.032 RMSPE, respectively. The worst predictive performance in this sector falls into the output of construction, where the error measure is very high (0.304 RMSPE). However, the majority of the equations perform well.

In the compensation of employee sector, the results of simulation show good predictive performance, but there are variations in the power of prediction. The aggregate compensation of employee has a relative low error, only 0.044 RMSPE. In the disaggregated equations, RMSPEs range from 0.046 to 0.149, which is satisfactory, except COMPWRT equation. It has a large error, at 0.149 RMSPE. However, the performance is not very bad.
Income from unincorporated enterprises equations perform well. They have good fit, with error measurements of only 0.051 and 0.030 RMSPE in the income from property (YPROP) and total income for unincorporated enterprises (TYUE), respectively. The disaggregated equations also perform fairly well, with error measurements ranging from 0.035 to 0.112 RMSPE. The farm rent equation predicts poorly (0.112 RMSPE). However, this performance is not bad.

The majority of the tax equations shows relatively good predictive power. The exception is in the export taxes equation, which has a very poor predictive performance. The actual data fluctuate considerably, possibly because of political situations and weather conditions. However, as a whole, the total tax equation has a relatively low error of prediction, only 0.088 RMSPE.

In the monetary sector, the money supply equation has a fair performance. The error measurement shows 0.112 RMSPE, which is a little high. The other equations perform reasonably well except for the commercial bank loans, overdrafts and discounts (LDCB) and commercial bank borrowing from abroad (BFCB) equations. The LDCB equation is high during 1969 to 1976 and low from 1977 to 1978. It has a high error of 0.333 RMSPE. The BFCB equation also has a high error (0.676 RMSPE). It has very poor fit during 1969 to 1971 and 1976 to 1978.

All price equations have good fit and show relatively high predictive power. The PGDP equation has 0.068 RMSPE, while P and IP equations have 0.054 and 0.058 RMSPE, respectively.

The last group of variables in simulations is income defined in various ways, i.e., GDP, PDY, NY, and PI. The incomes are all predicted
with small errors, 0.020 RMSPE, 0.020 RMSPE, 0.016 RMSPE, and 0.016 RMSPE, respectively.
CHAPTER VI. SUMMARY AND CONCLUSION

Thailand is experiencing many problems which generally occur in most developing countries, i.e., low capacity income, a high population growth rate, unequal income distribution, and low productivity of labor. Development planning has been used as a means to accelerate economic progress. Agricultural planning has also been used to solve problems in the agricultural sector. A linear programming technique for planning in the agricultural sector was developed initially. Later it was felt that macroeconometric model should be linked to the linear programming model in order to obtain a complete view of Thai agriculture and economy. Thus, the Thai macroeconometric model was constructed in 1974 at the Office of Agricultural Economics, the Ministry of Agriculture and Cooperatives, Thailand.

The model was built by using only OLS because there were some difficulties with available computer programs and available data, which led to estimators which did not have the property of consistency. Therefore, an attempt was made in this study to reconstruct and expand the earlier Thai macroeconometric model. The objective of modeling is to investigate the interaction between the nonagricultural sector and agricultural sector and attempts to disaggregate in more detail where possible. Rather than using OLS, a more sophisticated estimation procedure was applied, i.e., two-stage principal component.

The estimated model consists of 91 equations which contain 68 behavioral equations and 23 identities. The model contains 89 endogenous variables and 107 predetermined variables. The estimation of the model was done by the method of two-stage principal component (2SPC). The
disaggregation of the model was attempted as the data permitted. Short-time series data from 1963 to 1978 were used in the estimation of parameters in all sectors except in the compensation of employee equation where the data used ranges from 1967 to 1978. The model simulation uses the Gauss-Seidel algorithm procedure because the estimated model is linear in parameters but nonlinear in variables in some equations. The simulation is fully dynamic. The model generates its own lagged endogenous variables, and it is assumed that all exogenous variables are known and constant. The results of the estimated model and dynamic simulation were discussed in Chapters IV and V.

There were some difficulties in construction, both in terms of theoretical and empirical attempts. Sometimes it is difficult to apply model construction techniques formulated in developed countries such as the U.S. to developing countries like Thailand, because the countries have quite different economic structures. Most developing countries also have problems of availability of disaggregated time series data. Thus, a researcher who builds the models should be aware of these weaknesses.

The model is constructed to provide useful information to policymakers. It is hoped that this objective has been achieved. However, there remain weaknesses in the model. The model is estimated by using short time series data. Therefore, the parameters estimated are subject to these data weaknesses. There also may be specification errors. To be more effective, the model should be revised. Time series data could be expanded and improved in quality.

Despite its limitations, the model may be used to make ex ante forecasts. In order to make such forecasts useful, the policymaker should be
aware of what policy will be used. The model can show the effect of different policies, and the policymaker may select the best one for his purpose.

The weakest parts of the model are the investment sector, income distribution sector, and the balance of payment equation. The investment and income distribution sectors have limited disaggregated time series. It is expected that hopefully reliable disaggregated data will become available in these sectors. The balance of payment equation has low prediction power. It is hoped that this weakness can be reduced in the future, perhaps by using another form of specification.
BIBLIOGRAPHY


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daughter, Rathakarn, for being patient and understanding when I had to leave Thailand in pursuit of my education.
The actual and dynamic simulated values of selected endogenous variables are shown in the following tables and graphs. The solid lines in each graph represent the actual values of endogenous variable where the dotted lines represent the dynamic simulated values. RMSPE is represented root mean square percentage errors.
### TPCE

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RMSPE = 0.070

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RMSPE = 0.072
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RMSPE = 0.184

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RMSPE = 0.020
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RMSPE = 0.051

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**TAX**

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RMSPE = 0.045
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RMSPE = 0.044

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RMSPE = 0.112

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RMSPE = 0.054

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