STRUCTURAL ADJUSTMENT TO EXCHANGE RATE POLICY IN A GENERAL EQUILIBRIUM FRAMEWORK: THE CASE OF INDONESIA

By

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CHAPTER I

INTRODUCTION

Problem Situation

Indonesia is a member of the Organization of Petroleum Exporting Countries (OPEC). Exports of crude oil constituted about 74.8 percent of total exports in 1975. Exports of agricultural commodities ranked second in value for the same year accounting for about 20 percent of total export earnings. Of non-oil exports, the agricultural commodities' share was 79 percent. During the 1975 - 1979 period, the average annual growth of net agricultural exports (agricultural exports minus agricultural imports) was 29 percent but decreased to 11 percent annually in the 1980 -1983 period.

Traditionally, rubber has been the most important agricultural export from Indonesia followed by wood and forest products, palm oil, tea, coffee, tobacco, and cocoa. Some less important agricultural exports are shrimp, spices, rattan, and fish. In 1986, rubber export value was US$ 713 million which is slightly smaller than the 1984 export value of US$ 952 million. In the same year, palm oil export value was US$ 140 million, substantially higher than the tea and coffee export values of US$ 99 million and US$ 82 million, respectively. In 1984 Indonesia ranked fourth in value of agricultural commodities supplied to the U.S. after Brazil, Canada, and Mexico.

Exports generate needed foreign exchange, particularly in developing countries where economic development often depends on trade as the essential mechanism for real capital formation. Imported capital goods and the modern technologies they embody constitute a crucial input into their development processes.

Following the collapse of oil prices in 1982, the growth of foreign exchange earnings depended heavily on non-oil exports. An immediate consequence was the importance of agricultural exports. The exports averaged 74 percent of non-oil exports starting from the first oil shock in 1973 - 1974 (Glassburner, 1985). Moreover, low cost labor, suitable soil and climate, and government policies strongly influenced comparative and competitive advantage of agricultural exports.

For years, Indonesia enjoyed excess foreign exchange earnings, primarily because of the sixfold increase in oil prices during the 1971 - 1978 period. However, the abundant foreign exchange earnings did not last long. First, the price of oil declined sharply in 1982. Second, the period of increased revenue provided a great incentive to spend on the part of the private and public sectors. While the bulk of the revenues were generated from external sources, expenditures were mainly on domestic goods and services (Kincaid, 1084). The increased expenditures by both the private and public sectors were not balanced by expansion of domestic productive capacity. Consequently, prices and imports increased. This increase in the domestic price level relative to the world price level appreciated the Indonesian currency leading to a deterioration in the competitiveness of non-oil exports. As prices of domestically produced import competing goods rose faster than their world price counterparts, production of these goods was sluggish.

To alleviate this problem, that is, to promote non-oil exports and restrain imports, on November 15, 1978, a major devaluation called "KENOP 15" was undertaken. The rupiah was devalued from Rp. 415.00 to Rp. 625.00 per US dollar (a 33 percent depreciation of the rupiah in terms of the dollar). For a time, Indonesia was able to maintain its competitiveness in the world market and reduce inflation to the international level. However, as expenditures continued to outgrow domestic productive capacity, by 1981 the relative price of domestic to foreign goods had returned to the level existing prior to the 1978 devaluation. In response to the balance of trade deficit, the government of Indonesia announced another major devaluation, this time the rupiah was depreciated by 28 percent. Recently, the government undertook another devaluation from Rp. 1200.00 to Rp. 1600.00 per US dollar (a 25 percent rupiah depreciation).

Traditionally, it is believed that changes in relative prices, such as real exchange rates, will affect the balance of trade. A higher real exchange rate decreases the cost to foreign consumers of Indonesian products and improves agricultural competitiveness. Conversely, a lower real exchange rate tends to raise the cost to foreign consumers of Indonesian products. Consequently, this hampers the competitiveness of agricultural products. This argument has inspired many developing countries to pursue a policy of devaluation, i.e., a decrease in the value of a currency in terms of other currencies, and thus alleviate accute foreign exchange shortages. Despite the alleged unsuccessful results as reported by Krueger (1978), this policy is still very popular and often relied on in developing countries.

The impact of the 1978 devaluation was reported by Kincaid (1984). Earnings from non-oil exports increased substantially, by more than 75 percent during the 1977 - 1979 period. Export volume increased by 35 percent. The increase in non-traditional exports was more than threefold. Imports, which increased at a rate of 22 percent annually during the 1976 - 1978 period, slowed to a 12 percent growth rate in 1979.

Nainggolan (1987) conducted a study on the macroeconomic impacts of Indonesian agricultural exports. The relationships between macroeconomic policies and agricultural exports through exchange rates, interest rates, and inflation were investigated. Simulation experiments were carried out to measure the impacts of a money supply shock and a foreign income shock. He concluded that the real exchange rate significantly affected agricultural exports.

The conclusion that the real exchange rate significantly affects agricultural exports is not sufficient though to understanding the substantial adjustments occurring in most developing countries. Reallocation of resources toward sectors where there is scope for import substitution and/or export expansion almost certainly occurs. New equilibrium in relative prices emerge as well as changes in the distribution of income and employment. In the Indonesian case, most agricultural exports are non-food agricultural products. As the non-food agricultural exports increase resource use such as land, labor, and capital increases thus driving up prices of those resources. This in turn will increase the cost of production in the food sectors and thus leading to increased food prices.

A study of such complex linkages between sectors, households, factors of production, and rest of the world in a partial equilibrium framework is not sufficient. An applied general equilibrium approach based on disaggregated social accounts is required. It is true that applied general equilibrium models based on social accounts are structural and can not be used easily to make unconditional projections or forecasts. However, a major advantage of the applied general equilibrium models is that the mechanisms driving them are clearer and easier to grasp because their structure is rooted in theory (Dervis et al., 1985).

The importance of linkages through the exchange rate and money supply in a general equilibrium formulation was also suggested by Suprapto (1988). He studied the impact of reduced fertelizer input subsidies in rice production on the economy of Indonesia. An applied general equilibrium model was developed to capture the relationships between the economic sectors, households, factors of production, and the rest of the world. Six policy experiments were conducted in conjunction with reducted fertelizer subsidy. His model however was without the linkages of exchange rate policies.

The earlier input-output analyses could captured only very simple general equilibrium relationships. With the aid of a Social Accounting Matrix (SAM), more complete linkages in the economy are captured. For instance, Adelman and Robinson (1986) used a general equilibrium framework with a Social Accounting Matrix (SAM) to analyze U.S. agricultural policy. A SAM is a modification of the input-output table where the full circular flow of money and goods in the economy is described. It incorporates the flows from producing sectors to factors of production (value added) and then on to entities such as households and government and finally back to the demand for goods. Nevertheless, their model ignored issues of resource allocation, productivity, and factor utilization. Because they used fixed coeficients, it ignores substitution possibilities in consumption, production, imports, and exports triggered by changes in relative prices. Moreover, the model does not capture the behaviour of economic agents in response to shifts in price signals, the tool generally used by government to influence the economy. A Computable General Equilibrium (CGE) model with a SAM as its basis includes price-responsive supply and demand behaviour and generates relative prices in addition to quantities and all nominal accounts.

Traditional CGE models have been used to analyze growth, structural change, and trade related problems in developing countries. For example, Dervis et al. (1985) have reviewed a wide selection of CGE models to developing countries. CGE models with applications to developed countries are surveyed by Scarf and Shoven (1984).

There are a number of existing models that focus on issues of international trade. Taylor and Black (1974) study the general equilibrium results of resouce pulls under trade liberalization in Chile. Dervis (1978) applied a CGE model to study the foreign exchange gap, economic growth, and industrial development in Turkey. Feltenstein (1983) used a CGE model for Argentina to study the effects on prices of trade restrictions and adjustments of the exchange rate. Ali (1984) used a CGE model for Pakistan to test the hypothesis that a significant improvement in employment can be secured by replacing the conventional policy of import substitution with a policy of promoting exportable industries which are intensive in the use of labor such as agriculture.

Few studies have been conducted based on a computable general equilibrium model of the Indonesia economy. In particular, studies that focus on trade related problems are nonexistent. Gupta (1977) developed a CGE model for Indonesia to study income distribution, employment, and growth. Several alternative development strategies were studied with respect to the trade-off between equity and growth in the long run. Suprapto (1988) studied the impact of fertelizer input subsidy reduction on the economy of Indonesia. It is based on mathematical optimization where linearization was introduced as a way of approximation. However, it belongs to the same class of computable general equilibrium models.

Objectives of the Study

The general objective of the study is to develop a computable general equilibrium model for Indonesia that facilitates analysis and evaluation of the impact of exchange rate policies on the agricultural sector and the distribution of income. Specifically the objectives are :

(1) To develop a social accounting matrix (SAM) for Indonesia identifying nine production sectors with agriculture disaggregated to six sectors, i.e., food crops, non-food crops, livestock, forestry, fisheries, and food processing.

(2) To formulate a Computable General Equilibrium model of Indonesia based on economic theory and the SAM developed above.

(3) To evaluate the general equilibrium results of alternative exchange rate policies on variables affecting social and rural welfare such as commodity prices, rates of return to resources, and distribution of household income.

The objectives of this study, when completed, should be useful to planners and policy makers, while at the same time enriching the literature on the application of CGE models to trade problems in Indonesia.

Overview of Research Procedure

To investigate the impact of devaluation on the economy, particularly on the agricultural sector, a computable general equilibrium model based on economic theory will be constructed. Special treatement of trade will be introduced to accomodate devaluation policy. The model is in terms of a set of mathematical equations in accordance to microeconomic theory. Further, the model is calibrated to the base year social accounting matrix of Indonesia (assumed to be in equilibrium) to assure that any changes in endogenous variables after the devaluation are relative to the base year values of the social accounting matrix. The social accounting matrix which was constructed by the Central Bureau of Statistics of Indonesia will be further aggregated to accomodate the study. Different simulation experiments will be performed by altering the value of the exchange rate and solving for the new equilibrium.

Outline of the Thesis

The remainder of this thesis is divided into six chapters. Previous works in relation to the study will be presented in the literature review, chapter II. The Indonesia economy based on the social accounting matrix will be presented in chapter III. Theoretical development of the computable general equilibrium of Indonesia is presented in chapter IV. Data and programming will be discussed in chapter V. Chapter VI reports the results and the simulation experiments. Finally, the summary and conclusions of the study will be presented in chapter VII.

CHAPTER II

REVIEW OF LITERATURE

The proper macroeconomic environment has long been recognized as an important factor for a sustainable growth in developing countries. The 1970 oil price increases coupled with debt burden have further convinced development economists of this assertion, as many developing countries were unable to adjust to the high prices and shortages in foreign exchange due to the oil price crisis. Many countries faced the hardship of high cost of adjustment while at the same time meeting debt service and other governmental responsibility. Many simply could not afford to continue economic reforms and at the same time fulfill loan commitments. It is in response to these situations that the World Bank developed the instrument of structural adjustment loans. Structural adjustment refers to administering broad changes in economic policy with the intent of reorienting the economy towards equilibrium and placing it upon a path of sustainable growth. Economic growth per se usually is not an immediate priority, but it is assumed that the reforms will lay the basis for better growth prospects in the medium and/or long term (Norton, 1987).

Michalopoulos (1987) defines structural adjusment lending based on the World Bank operation manual as non-project lending to support programs of policy and institutional change necessary to modify the structure of an economy so that it can maintain both its growth rate and the viability of its balance of payments in the medium term. He further explained the two types of lending activities, that is an economy-wide structural adjustment loan (SAL), and a specific sectoral adjustment loan (SEL). The former might involve policy measures such as currency devaluation, money supply contraction, or government expenditure reduction, while the latter might focus on policies such as changes in tariff rates, reduction in selected input subsidies, or elimination of specific administered prices.

Indonesia was the recipient of such a World Bank loan. But the purpose of this study is not to evaluate the specific policy measures related to the World Bank loan but rather to analyze the broad impacts of such policies on the agricultural sector in terms of distribution of income, prices, and employment. As Norton (1987) states, the analysis of economic adjustments to changing macroeconomic conditions has been practiced for a long time even though it has not been called by the name of structural adjustment. Because the specific research interest here is to study the impact of exchange rate policy on the agricultural sector, this chapter first reviews relationships between exchange rates and the agricultural sector and then follows with an exposition of general equilibrium modeling which is now widely used to study distributional impacts of policy. The effects of exchange rate policy on international trade in an open economy are also discussed.

Exchange Rate Defined

The exchange rate is defined here as the number by which world prices (say U.S. dollars) must be multiplied to obtain local prices (say Indonesian rupiahs) net of taxes. For instance, it is the amount of rupiahs needed to purchase one U. S. dollar. The IMF defines the exchange rate as the inverse of the proceeding or the amount of dollars needed per rupiah. There are several different types of exchange rate : nominal exchange rate or simple exchange rate, effective exchange rate, real exchange rate, and a price-level-deflated exchange rate. The following definitions are adopted from Dervis et. al. (1985). The nominal or simple exchange rate is the actual parity (current value) that translates dollars into the local currency.

The effective exchange rate literature refers to the price of foreign currency inclusive of all taxes imposed on its purchase. Thus, for imports, the effective exchange rate equals the nominal exchange rate multiplied by one plus the rate of import duties.

The real exchange rate measures the relative price of a basket of tradables to a basket of non-tradables. A real devaluation means that tradables have become relatively more expensive, whereas a nominal devaluation simply means that the exchange rate has increased. A nominal devaluation will imply a smaller, equal, or greater real devaluation, depending on the home goods price levels. If the price of the home goods falls then nominal devaluation implies greater real devaluation. On the other hand, if the price of home goods increases, nominal exchange rate devaluation implies lower real devaluation. If the price of home goods remains constant, then nominal devaluation implies equivalent real devaluation.

A price-level-deflated exchange rate refers to the exchange rate deflated by a price index with some arbitrary base measuring domestic inflation. The purchasing-power-parity (PPP) price-level-deflated (PLD) exchange rate is the exchange rate deflated by a constant measuring the excess of domestic inflation over world inflation. Thus an increase in the local price level relative to the world price level will result in overvaluation of the local currency, that is, a lower PPP-PLD exchange rate. For an identical choice of weights, changes in real exchange rate are equivalent to changes in the PPP-PLD exchange rate.

Theory of Exchange Rate Determination

An equilibrium exchange rate of a country is viewed as the market clearing exchange rate which equilibrates the demand for and supply of foreign exchange. This is pictured in Figure 1, where S_F and D_F denote the supply and demand of foreign exchange respectively.

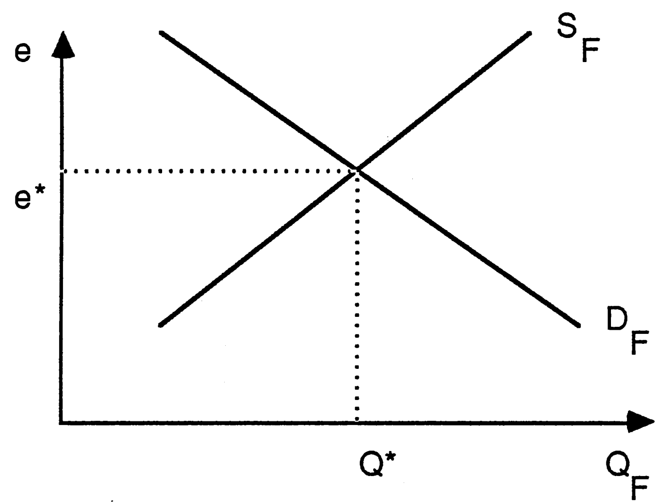

Figure 1. The Indonesia Foreign Exchange Market

At point e*, the equilibrium level of the exchange rate, the quantity of foreign exchange demanded equals the quantity supplied. At a level of exchange rate above e*, the quantity of foreign exchange demanded is less than the quantity supplied, a surplus in balance of payments occurs, and the domestic currency is depreciated or undervalued. When the quantity of foreign exchange supplied is less than the quantity demanded, the balance of payments is in deficit and the exchange rate is overvalued. Parameters involved in the determination of the exchange rate equilibrium include the current account and the capital account. The driving factors behind the current account include national income, price levels, tastes and preferences, resources endowments, and production functions. The capital account, is affected by propensity to save and invest, liquidity preferences, and money supply. When any of the parameters change, the equilibrium position of the balance of payments changes.

Theoretically, there are at least six approaches to exchange rate determination. Each approach is based on the importance of one or more parameters described earlier. Discussion begins with the monetary approach.

The Monetary Approach

The monetary approach, associated with Johnson (1976) and Mundel (1968), emphasizes the importance of monetary policy in directly affecting the balance of payments and exchange rate, and indirectly affecting the interest rate, international capital flows, and finally the balance of payments and exchange rate. Thus, the relationship between changes in the stock of money supply, the balance of payments, and the exchange rate is the focus in this approach. Dornbusch (1976), however, emphasizes the indirect relationship between changes in the stock of money supply and the interest rate. A change in a country's interest rate relative to that of other countries, affects international capital flows, which in turn, alters the country's balance of payments position and equilibrium exchange rate level. He further theorized that capital movements are determined not only by interest differentials between home and foreign countries, but also by the expected interest differentials.

An open market sale of bonds by the monetary authority leads to a reduction in bank reserves and upward pressure on the home interest rate. The higher interest rate, in turn, increases demand for home country's bonds, and decreases demand for foreign country's bonds. The result is a net capital inflow, that is an improvement in the balance of payments of the home country, leading to appreciation of the home country's currency.

Partial Elasticity Approach

This approach, developed by Robinson (1973), has been widely used to measure the effects of a change in the exchange rate on the prices, quantities, and values of imports and exports. The focus is on the trade balance, the difference between the total value of exports of goods and services and the total value of imports of goods and services. The demand and supply of foreign exchange depends on elasticity of the import and export supply of commodities. Yeager (1976) derived a formula that determines the percent change in total export value, υ, as a result of a one percent devaluation:

$$\upsilon = [\lambda_h(\eta_f + 1)]/[\lambda_h + \eta_f]$$

and the percent change in total import value, δ, as a result of a one percent devaluation :

$$\delta = [\eta_h(\lambda_f + 1)]/[\lambda_f + \eta_h]$$

where λ_h = aggregate export supply elasticity of the home country,
λ_f = aggregate export supply elasticity of the foreign country,
η_h = aggregate import demand elasticity of the home country, and
η_f = aggregate import demand elasticity of the foreign country.

The net percentage change in the trade balance as a result of a one percent devaluation is equal to $\delta - \upsilon$. The result implies that the necessary condition for improvement in trade balance is that $\delta - \upsilon$ be negative.

In summary, the partial elasticity approach emphasizes the importance of international commodity trade flows. The price elasticities of domestic demand

and supply and import demand and export supply in each country are fundamental in determining international commodity trade, trade balance position, and the exchange rate. The emphasize is on the current account.

Keynesian Multiplier approach

The Keynesian multiplier approach (Harberger, 1950) assumes that there are unemployed resources with rigidity in prices and wages. A two-country, two-good (importable and exportable) is assumed. The export good is produced at constant real input prices.

The model suggests similar results on the impacts of exchange rate devaluation as the partial elasticity approach. However, the latter was improved by making domestic demand for imports and home goods a function of the relative price of goods and income, thus, the income effect was incorporated.

In summary, the Keynesian multiplier approach emphasizes, in addition to the elasticities condition, the importance of real income in affecting the exchange rate.

Income Absorption Approach

In this approach (Alexander, 1952), the current account balance is defined to be the difference between the total value of domestic production of goods and services and the total absorption of expenditures on goods and services. A deficit is defined as an excess of expenditures over income. To correct a current account deficit, a country should either increase income or reduce expenditure or both.

The change in the absorption of goods and services associated with devaluation consists of the change in absorption induced by the change in real income that results from devaluation, and the direct change in absorption due to devaluation. Therefore, the effect of devaluation on the current account balance depends on the effect on income and the direct effect on absorption. The impact of devaluation on income depends on the availability and mobility of resources that can be shifted to the production of exportable goods and the terms of trade effect.

In summary, the income absorption approach emphasizes not only the importance of the level of real income, but also the level of expenditures. If devaluation results in an increase in the level of real income but also induces a higher level of real expenditures, then this will cause the exchange rate to deteriorate further.

Keynesian Policy Approach

This approach is a modification of the income absorption approach (Meade, 1951; and Mundel, 1968). The assumption is that for a devaluation to improve the current account balance, the use of exchange rate changes as a policy instrument must be combined with other policy measures, such as monetary restriction, tight fiscal policy, higher taxes, or direct control on prices and trade. The advantage of the Keynesian policy approach over the income absorption approach is its assertion that if a country is confronted with an inflationary situation, an output-increasing policy or an expenditure-reducing policy is necessary to improve the current account balance position, rather than to rely on further inflation of prices induced by devaluation to have a deflationary effect on the current account.

To correct current account deficit, the approach suggests that devaluation will not only decrease the consumption of domestic non-traded and imported goods, but also increase the value of exports.

In summary, the Keynesian policy approach emphasizes the importance of monetary and fiscal measures to affect the level of real income and real expenditure. It suggests there is no guarantee that a devaluation will result in a greater increase in real income than in real expenditure unless some monetary and fiscal or direct control measures are taken.

Purchasing-power-parity (PPP) Approach

The approach suggests that the percentage change in the exchange rate should approximately equal the change in the ratio of relative price indexes of the home and foreign countries (Cassel, 1918). The simple PPP view of exchange rate determination is expressed as

$$\hat{e} = \hat{p}_f - \hat{p},$$

where $\hat{e}$ denotes percentage change in exchange rate, $\hat{p}_f$ denotes percentage change in the rate of inflation in foreign countries, and $\hat{p}$ denotes the percentage change in domestic rate of inflation.

This simple PPP approach was revised later by Dornbusch (1976) by incorporating the monetary equilibrium condition and the quantity theory of money (Bilson, 1975). With this modification, both prices and the exchange rate are determined endogenously by the stock demand and supply of money. Further, changes in the monetary and/or fiscal policies or other macro variables such as real income and interest rate, can be reflected in the stock supply and demand for money, and finally reflected in the exchange rate changes.

In summary, PPP approach emphasizes the direction of exchange rate movement in relation to the rates of inflation in the home and foreign countries. A higher rate of inflation in the home country than in the foreign country implies that the level of exchange rate of the home country currency is overvalued. On the other hand, a lower rate of inflation in the home country relative to the foreign country implies that the currency of the home country is undervalued.

Devaluation and Foreign Exchange Earnings

It was argued in the previous section that exchange rate determination depends on many micro and macro economic variables. It also suggested that the impact of exchange rate change on the balance of payments depends on a miriad of factors. A devaluation of the home country currency may increase the aggregate value of exports and/or decrease the aggregate value of imports leading to increases in foreign exchange earnings which further improve the trade account balance.

Economic theory suggests that increasing the price of foreign exchange, and thus the price of tradeable goods relative to domestic goods, will shift resouces toward the production of tradeable goods and increase the supply of exportables and import substitutes. At the same time, consumers will substitute home goods (nontradeable) for traded goods and reduce domestic demand for imports. However, the aftermath of the devaluation depends on many factors. Krueger (1978) argued that appropriate macroeconomic policy has to accompany the increase in price of foreign exchange. Expansionary monetary and fiscal policy could result in domestic inflation higher than world inflation, leading to predevaluation prices of tradeables relative to nontradeables.

The nature of the exchange control system also affects the observed consequences of devaluation. Changes in quantitative restrictions, taxes, and subsidies that accompany an exchange rate change will influence its outcome. Likewise, the implications of the licencing system, and the way it operates during the predevaluation period, can have strong effects on the aftermath of devaluation. When the value of import licences is increased at the time of devaluation, it is quite possible that imports will actually increase.

Balance of payments position improvement will cause the domestic monetary base to increase. Consequently the interest rate may decline. As the rate of interest falls, the demand for real money balances increases, resulting in an excess demand for real money balances, resulting in further declines in real expenditures. Lower interest rate may cause net capital outflows and worsening of the balance of payments position. This adjustment process continues untill a new equilibrium is established.

In summary, the choice of policy measures to accompany a devaluation and predevaluation policies that prevail after the devaluation at least partially determines the effect of the devaluation on the level of economic activity and foreign exchange earnings.

Exchange Rate Policy and the Agricultural Sector

Traditionally agricultural economists paid little attention to the effects of macroeconomic variables on the agricultural sector until the seminal work by Schuh (1974) highlighted the importance of the exchange rate on U.S. agriculture. The United States, a country with perhaps the most technologically advanced agriculture in the world, had to subsidize its agricultural exports to dispose them outside commercial channels. The common explanation to this phenomenon is that the U.S. has overvalued its agricultural resources through price support programs and land retirement schemes. Effects of the price support and land retirement programs are high land values and high labor costs (common to developed countries) and were suspected to be the cause for the inability of U.S. agricultural products to compete in the world markets. In addition, it is believed that trade barriers by other countries against U.S. exports justified the use of export subsidies and other devices to maintain the U.S. position in the world markets.

Schuh believed instead that overvaluation of the U.S. dollar throughout the 1950's and the 1960's culminated in large agricultural surpluses contributing to the first devaluation in 1971. Overvaluation of U.S. dollar resulted in an under-valuation of agricultural resources in relation to their world opportunity cost. Given the small country assumption for the U.S. with respect to the world markets, the perfectly elastic world demand would shift downward leading to a decline in domestic prices for farm products. With lower prices, domestic supply should decrease as resources are transfered out of the agricultural sector. However, he further argued that the stress caused by this under-valuation forced a more rapid rate of technical change than would otherwise have been obtained, because of sizable investments in basic and applied research. In other words, the supply curve shifted to the right, such that exports increased even at the lower domestic prices.

Based on this interpretation, his explanation of the effect of the price support program was to cushion the effect of the over-valuation. He further argued that even though relative farm prices continued to decline through the 1950's and the 1960's it was at a slower rate than would have been in the absence of the program. In summary, he argued that the over-valuation of the dollar was a factor overlooked in contributing to the U.S. farm problem. It is still questionable, however, whether the under-valuation of the agricultural resources relative to world opportunity costs was really the major factor forcing a more rapid rate of technical change in U.S. agriculture and thus leading to increases in production.

Kost (1976) attempted to explain the effects of an exchange rate change on agricultural trade in general. His analysis is theoretical in nature where he assumed a two country world with competitive systems existing in both countries. A single homogenous commodity with a downward-sloping demand and upward-sloping supply functions for each country was also assumed. He further classified two kinds of devaluation, i.e., devaluation by the exporting country and a devaluation by the importing country. A devaluation by the exporting country is simply a change in the scaling of the vertical axis of the importing country's price-quantity space. For instance, a 50 percent devaluation by the exporting country reduces the scale of the price axis of the importing country by half leading to a rotation of its supply function to the left resulting in a new equilibrium of price and quantity. Similarly, a devaluation by the importing country would result in a rotation of the supply and demand functions, but this time for the exporting country.

Based on the described analytical framework, he came to the conclusion that the impact of devaluation both by importer and exporter depends on the elasticities, namely on the slopes of the demand and supply functions, and the magnitude of the exchange rate changes. As the export supply curve becomes more elastic, the quantity traded will increase and the price rise will decrease for any given shift in the import demand curve. The export supply elasticity depends on the domestic supply elasticity, the elasticity of demand in the exporting country, and the relative importance of the export sector. The effect on imports of a change in exchange rate is similar. However, this time it depends on the elasticity of the import demand curve. The more elastic the import demand curve, the larger the quantity effect and the smaller the price effect. The import demand elasticity is a function of the domestic supply elasticity, the demand elasticity, and the relative importance of the import sector.

Assuming that the elasticity of both demand and supply for U.S. agricultural products are relatively small, particularly in the short run, it is likely that a devaluation would generate relatively larger changes in prices than in quantities compared to industrial goods which Kost contends have more elastic demand and supply response. In summary, he concluded that a devaluation would be relatively inflationary within the agricultural sector. By the same token, in the industrial sector, a devaluation would cause a relatively larger quantity impact. As to the contribution of a devaluation on the balance of trade, it is asserted that for a large net exporter of agricultural products, there would be some improvement in the balance of trade. However, it might be relatively small compared to the rest of the economy.

The above theoretical framework by Kost is appealing as to the role of elasticity in analyzing the impact of a devaluation. However, there is very little room for cross price effects between tradable and non-tradable goods, between agricultural products and other goods, and the changes in relative prices involved in deriving excess demand functions. The analysis is limited to the assumption that a product is either imported or exported. Chambers and Just (1979) argued that all relative prices and income must be incorporated in the excess demand and excess supply equations. Prices, exchange rate, and income were included as shifters in their excess demand functions while all prices and exchange rate were treated as excess supply shifters. Their econometric studies imply that there is no reason to expect the price or the quantity change to be less in percentage terms than the change in the exchange rate.

Chambers and Just (1981) studied the effect of exchange rates on U.S. agriculture based on an econometric dynamic analysis. Their basic presumption is that since agricultural production occurs only once a year, the exchange rate will have important dynamic effects on both domestic disappearance and inventory accumulation. Their econometric model consists of fifteen equations and explains disappearance, inventories, and exports for the three agricultural commodities of corn, wheat, and soybeans. Complete cross price effects were also incorporated in the model. Simulation of a 10 percent depreciation of the exchange rate, which was approximately equal to the devaluation President Nixon announced in 1971, resulted in increases in corn exports by 90 million bushels, wheat exports by 34 million bushels, and soybeans exports by 8 million bushels. At the same time, however, to compensate for the dramatic increase in exports in the short run, a substantial decrease occured in inventories. The sharp upward pressure on overall demand, which was not met immediately by a corresponding increase in supply, lead to a dramatic increase in price and to an increase in production in later periods. In the long run, however, as inflationary tendencies take over, the system tends to cycle toward a steady-state solution and the effects start to wear off. The long run response to a 10 percent devaluation is an increase in exports of 15 percent for wheat, 35 percent for corn, and 7 percent for soybeans.

Another important result of this analysis is that only the wheat price has an inelastic response in the long run, while both corn and soybean prices appear to be elastic. For instance, their result shows that a 10 percent devaluation increased the price of wheat by 7.9 percent. In the short run, however, the impacts on domestic prices are all quite elastic. Thus the analysis suggests that significant income, welfare, and allocation effects could materialize as a result of such a devaluation.

In the absence of devaluation or revaluation an implicit devaluation or revaluation could occur in an economy because of changes in relative prices of tradeable and non-tradeable goods or relative domestic prices of imports and exports versus prices of domestically produced goods. Given a fixed nominal exchange rate, a relatively higher (lower) domestic price level to the price level of the rest of the world, results in an over-valuation (devaluation) of the domestic currency. Kincaid (1984) studied the impact of relative prices on the non-oil trade account in Indonesia. The oil boom of 1971 was believed to have an inflationary impact on the economy of Indonesia between the period of 1971 to 1978 leading to an over-valuation of the rupiah. On November 15, 1978 the rupiah, which had been fixed against the U.S. dollar since 1971, was devalued by 31 percent. After the devaluation and coupled with tight fiscal and monetary policies, a stable link between the rupiah and the dollar was restored. However, with the additional oil revenue brought about by the second round of oil price increases, the relative price of domestic goods to foreign goods began to rise. By 1981, the rupiah was again over-valued and back to the rate prior to the 1978 devaluation in real terms. Exports began to stagnate and import volume increased rapidly.

To capture the economic situation between the period of 1971 to 1981, Kincaid constructed equations representing import demand and export supply. Because Indonesian imports are small relative to the world market, the foreign price of imports were assumed to be exogenous. Demand for real imports are a function of the domestic income, the relative price of foreign to domestic goods, and the excess supply of liquidity. To account for the importer's behavior when they are off their long run demand curve, a partial adjustment to the quantity imported was introduced. All imports are aggregated into one good in real terms. On the export side the small country assumption is also imposed. Export supply is specified as a function of the relative price of exports (in domestic currency) to its domestic consumer price index, and the ability of exporters to supply the foreign market represented by the real gross domestic product as a proxy. To accomadate lags in supply response, a partial adjustment mechanism was incorporated to the model.

Empirical results indicate that the relative price significantly affects the demand for real imports both in the short run and the long run albeit the magnitudes of -0.20 for the short run and -0.31 for the long run were relatively small. The supply-price elasticity was moderate in the short run at 0.61 while the long run was about 6.0. A high long run supply-price elasticity is as expected knowing that non-oil exports are relatively small, i.e., there is plenty of room to expand domestic productive capacity.

Two simulation experiments in real imports were conducted. The first assumed that the structure of relative prices prevailing prior to the depreciation continued unchanged for the rest of the simulation period, i.e., no real devaluation occurred. The result was that the actual price developments kept import volumes below the level simulated by no real devaluation until 1981 when the import volume would have been equal. The second assumed that the more favorable relative prices created after the devaluation continued. The result showed that import volume would grown much slower and would have been 20 percent lower than the actual volume in 1981. The same two experiments were applied to export supply. Reduced exports under the first experiment would have resulted in a reduction in international reserves by about US$ 0.8 billion in 1981. Results of the second experiment however, indicated an increase in international reserves by US$ 0.9 billion dollars above the actual level. In summary, Kincaid concluded that the non-oil trade account was strongly influenced by the relationship of domestic prices to domestic currency prices of exports and imports.

Nainggolan (1987) conducted a study on the macroeconomic impacts on Indonesian agricultural exports. Three major agricultural commodities were considered, i.e., rubber, coffee, and palm oil. Exporters were assumed to be price takers in the world market. Reduced form equations representing export supply and import demand for each commodity were estimated. Each system was a function of GNP, real prices of the corresponding commodity, lagged real exchange rate, a dummy variable to capture the seasonal variability between quarters, and a time trend to measure technological change. Real exchange rate was defined to be the nominal exchange rate multiplied by the ratio between the domestic consumer price index and the consumer price index of the trading partner country, equivalent to the PPP-PLD defined earlier. The nominal exchange rate was defined to be the number by which the domestic price must be multiplied to obtain the trading partner's currency price. This definition is the opposite to the definition adopted in this study.

His empirical results show that the real exchange rate had impact on the export of rubber after two to six quarters. A 10 percent depreciation of the real exchange rate increased rubber exports by 2.0 percent. Palm oil exports also took about six quarters to respond to changes in the real exchange rate. A 10 percent depreciation of the real exchange rate resulted in a 13.1 percent increase in palm oil exports, a substantially larger impact than for rubber exports. The evidence suggested however, that coffee exports were not significantly affected by the real exchange rate.

Several common characteristics of the foregoing analyses are in order. Econometric modeling was generally used in the analyses. Basic questions mostly pertained to impacts of exchange rates (real or nominal) on the agricultural sector, particularly on agricultural exports. None attempted to answer questions on the distributional impacts of exchange rate policy. For example, who gains and who losses due to such policies. Does the poorer rural segment of the population suffer the most ? How is the distribution of employment altered by such actions. The lack of studies on the distributional impacts of exchange rate policies is not surprising. Incorporating different labor categories and different socioeconomic groups requires extensive modeling and data. For example, modeling an economy with nine production sectors (commodities), eight different socioeconomic groups or institutions, and five different factors (four labor categories and one capital category) would necessitate estimation of more than 200 equations. The study by Chambers and Just (1981) discussed the welfare and income impacts of exchange rate policy through changes in relative prices. Nevertheless, they did not explicitly incorporate distributional impacts of their analysis.

There are several studies, however, that emphasize the distributional impacts of exchange rate policies on the economy, particularly on the agricultural sector. A study by Norton (1987) is possibly one of the most extensive analysis of the impacts of exchange rate policies on the agricultural sector. In discussing possible impacts of over-valuation on the agricultural sector, researchers tend to emphasize the reduced agricultural supply brought about by distorted prices. Norton argues, however, that the more important consequence is the price effect on producer's incomes. He hypothesized that an over-valued exchange rate of x percent results in producer's income being lowerd by more than x percent. He further states that via multiplier effects the reduction in income will be transmitted to other sectors of the economy, leading to a reduction in internal demand for agricultural products.

A real devaluation implies an increase in the prices of tradables relative to non-tradables. Norton argues that, on average, agricultural products are more highly tradable than are products from the rest of the economy. Therefore, a devaluation should improve agriculture's internal terms of trade. Further, he contends that import substitutions for food will tend to occur as a result of the increase in prices of imports relative to the prices of domestic substitutes brought about by the devaluation. For example, in Mexico, the dollar value of food imports fell by 10.5 percent per year after 1981, while it had increased by 28.8 percent per year from 1973 to 1981. Norton pointed out that the growth rate of real output in agriculture accelerated during the years 1981 to 1984 and real GDP grew more rapidly in agriculture than in the non-agricultural sector.

Such results depend on the presence of other monetary and fiscal policies. For instance, if monetary and fiscal restraint either raises the cost of agricultural inputs (by eliminating subsidies) or reduces their availability, then the supply curve will shift to the left leading to lower agricultural output and employment. If import quotas had existed prior to the adjustment situation then a devaluation-cum-trade liberalization package would lead to greater volumes of imports and lower agricultural incomes. If there is rationing of foreign exchange instead of devaluation, then the net effect on agricultural prices, employment, and output will depend on how the scarce foreign exchange is allocated among sectors. But because of a greater reduction in demand, agricultural output will necessarily be lower than in the devaluation case. At the same time, agricultural prices will not be lower than in the case of devaluation.

The discussion by Norton (1987) is very much analytical. As previously mentioned, an attempt to model the distributional and sectoral impact of such structural adjusment policies requires comprehensive time series data that many developing countries do not have. However, modeling based on the accounts in a social accounting matrix (SAM) has been widely used. For instance, Norton and Hazell (1985) developed a SAM-based model to evaluate the economic impact of food aid in Bangladesh. The SAM was disaggregated within the agricultural sector and hence treated in more detail than the industrial sectors. The SAM was then expanded by specifying behavioral relationships to make it of the form of the general equilibrium family of models. It was linearized so that it is suitable to be implemented using a linear programming algorithm.

They proposed two reasons for using the general equilibrium framework. First, given changes in government expenditure policies, such as food aid, the impact goes beyond just the agricultural sector, that is, it affects other sectors in the economy as well. Second, the general equilibrium model captures the linked reactions of prices and income throughout the economy.

Theoretical justification of the model is found in Norton and Scandizzo (1981) where it is proven mathematically that such an approach to general equilibrium analysis will generate a competitive solution. The "net social surplus," that is the sum of the value of final consumption sales less factor income, is maximized subject to a set of constraints including production and factor use, factor incomes, household income formation, consumer budget identities, demand functions, savings and investment, resources, trade and balance of payments, public finance, and pricing. Because the value of final consumption sales is non-linear, a grid linearization was introduced. In the production sectors, the constant return to scale Leontief production technology was adopted. The demand functions constraints is to ensure that the utility maximazing behavior of the household is implicitly captured by the model, which is basically enforced by the Euler theorem property and the homogeneity condition of the demand function. To ensure that the profit maximizing behavior of the firm is incorporated in the model, marginal cost pricing was introduced, reflected by the pricing constraints. The rest of the constraints were introduced to maintain consistency in the balances according to the SAM.

The Bangladesh model includes seven household categories and eight commodity specifications which imply that there are fifteen endogenous product prices and factor prices involved. The households are : rural landless laborers, small farms, large farms, rural informal service workers, rural formal service workers, urban informal service workers, and urban formal service workers.

The commodities are : grains, export crops, other agriculture, fish, rural services, manufacturing, urban informal services, and urban formal services. However, to make the model neither underdetermined nor overdetermined, namely to close the model, two of these endogenous prices were set equal to unity, that is the price of manufacturing output and the factor price of urban formal services. In essence, the closing of the model is to make the model square, that is with n equations and n unknowns which is common practice in general equilibrium modeling.

Several experiments were conducted with the model. The first was to simulate the effect of an 87.5 percent reduction in food aid to Bangladesh (or a 20 percent cut in total foreign aid). The result was an increase in food prices, where the grain price increased relatively little. The price of tradable goods rose relatively more than the price of non-tradable goods (referred to as a change in the "real exchange rate").

Total output and household incomes declined. For example, total gross output declined by 0.81 percent and aggregate income by 2.2 percent. All service workers experienced a 6.6 decline in income. Urban households experienced a 7.5 percent decline. Grain production increased because of the rise in the price of grain and farm income rose slightly. The landless, however, experienced a decline in real income because a large part of their income was derived from work in the service sectors. It was concluded that the urban sectors and the service sectors benefited more than the farming sector from an increase in food aid. There were other experiments conducted in the study. What is important however, is that given the availability of the SAM for Bangladesh, several different comparative static analyses (numerically) were conducted using data and parameters from a base year SAM.

A different approach to SAM-based general equilibrium modeling was introduced by Dervis et. al., (1985) in their study of the Turkey economy. Their model was without linearization. A set of equations based on microeconomic theory to clear the market was specified. Another set of equations that cleared the labor market was defined. On the production side, six highly aggregated sectors were set up derived from a set of 19 disaggregated sectors. The sectors are : agriculture, consumer goods, intermediate goods, capital goods, construction and infrastucture, and services. Households were aggregated into one representative household. Two categories of labor were specified, i.e., agricultural labor which is fixed in supply, and urban labor which is also assumed fixed in supply. Urban labor was further classified into two categories, i.e., skilled and unskilled.

For each good a household demand function was specified. The household was assumed to maximize a simplified Stone-Geary utility function subject to disposable income and resulted in a linear expenditure system (LES). Firms facing constant elasticity of substitution technology were assumed to maximize profit. The results are a supply function for each commodity and a derived demand for each labor category. Households were assumed to own the factors of production (labor and capital) and supply them to the production sectors which in turn generate income. Government generates income from taxes where part was spent on consumer goods and part was saved for investment. Capital stocks in each sector were assumed fixed at least during the period modeled. Hence, total savings by households, capitalists, and government were translated into investment demand by sector of origin only for accounting purposes.

One of the unique characteristics of the model was the treatement of trade. Imports were assumed to be imperfect substitutes for domestic goods and governed by a CES function. This immaginary good, called a composite good (composed of imports and domestic production), is the one that was consumed. Buyers were assumed to minimize their cost of consuming the composite good resulting in a demand specification for domestically produced goods and imports. The entire set of n equations were solved for the n endogenous variables.

The purpose of the study was to simulate and compare the macroeconomic impacts and the structural impacts of three different adjustment mechanisms to a foreign exchange crisis in Turkey. The adjustment mechanisms were: devaluation, premium rationing of foreign exchange, and fixed price rationing of foreign exchange. A 50 percent decline in net foreign resources were introduced into the model. To study the first adjustment mechanism, the exchange rate was left to adjust freely, that is the exchange rate was endogenously determined by the model. To study the second and the third adjustment mechanisms, exchange rate was fixed at the base year value, while both premium and fixed price rationing schemes were introduced into the model.

The following are several basic macroeconomic results. There was a 21.5 percent devaluation when a low trade elasticity was assumed compared to a much smaller 8.7 percent devaluation when a high trade elasticity was assumed. Because the values of the high set of elasitcities were about three times the values of the low set, the exchange rate adjustment responds nonlinearly to changes in the values of these parameters, i.e., if the response were linear, the extent of devaluation would reduce to about 7.1 percent instead of the observed 8.7 percent. The same impacts on export and import prices with a high and a low trade elasticity were also observed. User price of imports reduced from 21.5 percent with a low elasticity to 8.7 percent with a high trade elasticity, while dollar price of exports changed with low trade elasticity by -17.4 percent and by -6.6 percent with a high trade elasticity.

Under premium rationing of foreign exchange the user price of imports rose by 71.6 and 32 percent, respectively, which are three and four times greater than the rise in import prices that occurred with devaluation. This observation reflects the fact that the entire burden of adjustment had shifted to the import side. In the case of fixed price rationing, the user cost was kept constant by forcing users off their demand curves. The necessary reduction in the volume of imports was reached by an adjustment in relative domestic prices, leading to a substantial reallocation of resources.

Structural impacts of alternative adjustment mechanisms were also reported. Adjustment by devaluation raised the relative price of close import sustitutes and exportables at the expense of import complements and less tradable sectors. For example, intermediate goods with the highest ratio of imports to domestic goods of 26.5 percent, and consumer goods with the highest ratio of exports to total output of 10.9 percent experienced the largest increases in domestic prices. The agricultural sector and capital goods and construction experienced declines in domestic prices and net prices, leading to declines in output. In summary, devaluation draws resouces toward the consumer and intermediate good sectors and away from the rest of the economy.

With the foregoing discussion, it appears that more comprehensive linkages in the economy coupled with consistency in relationships in the comparative static analyses can be captured by general equilibrium modeling. Given the availability of a SAM for a developing country, general equilibrium modeling is a useful tool in development planning. In the following section, a general picture and theoretical exposition to general equilibrium modeling is presented.

General Equilibrium Models

The general equilibrium model of an economy has a long history. It is the result of nearly two hundred years of conceptual and intellectual work by various economists. Presumably its origin can be traced back to Adam Smith when he laid down the foundation of the capitalistic economy. However, the theoretical foundation and the functioning of the general equilibrium model became more clearly understood later in the nineteenth century through the work of Leon Walras and culminating in the well known Walras theorem, stating that the value of the excess demand is equal to zero. This is equivalent to saying that of n excess demand equations only n-1 are independent and, therefore, only relative prices matter. One price, or any linear combination of prices, can be choosen as a numeraire to which all prices are relative. In a general equilibrium framework, consumers are assumed to maximize utility subject to their income. Firms are assumed to maximize profit using available technology. The solution to these maximization problems is the general equilibrium solution.

Attempts toward bridging the gap between theory and application trace back to the early input-output and linear programming models pioneered by Leontief and others. Although traditional input-output type analysis does not contain a market clearing mechanism through price incentives, it has laid the foundation for modern applied general equilibrium modeling (all aplications of general equilibrium theory will be referred to as applied general equilibrium (APE) models). The very heart of the input-output accounts is the interindustry (or intersectoral) flows of products from each producing sector to each purchasing sector measured for a particular time period (usually a year) in monetary terms. Purchasers who are exogenous to the production sectors are further defined. The demands of these exogenous units are generally referred to as final demands (Miller and Blair, 1985). These flows are usually presented in a tabular form which basically represents a picture of an economy at a point in time.

There are two markets in the economy implicitly or explicitly captured by an input-output table, namely, product markets and factor markets. There are economic institutions or "actors" that are also represented. For instance, producers are institutions who produce products (representing the product markets) and buy inputs (representing the factor markets). Households are another type of institution that provide inputs (labor) to the production sectors and buy products. The last component of the table is the intermediate or interindustry flows account. Schematically this circular flow is presented in Figure 2.

A social accounting matrix (SAM) is a further advancement to input-output accounts. Issues such as income distribution and structural adjustment require analysis that goes beyond the sectoral production accounts to include income and expenditure flows that are part of a SAM (Robinson, 1988). The complete circular flow in an economy as pictured in Figure 2 is explicitly represented by a SAM where a series of accounts balance the incomings and outgoings (King, 1985).

Models that complete the circular flows of an economy (Figure2) and incorporate income effects and price incentives are in the class of applied general equilibrium models. Hazell and Norton (1986) list four elements of any general equilibrium model (GEM) : (1) a specification of technology and producer behavior including resource limitations; (2) commodity balances to

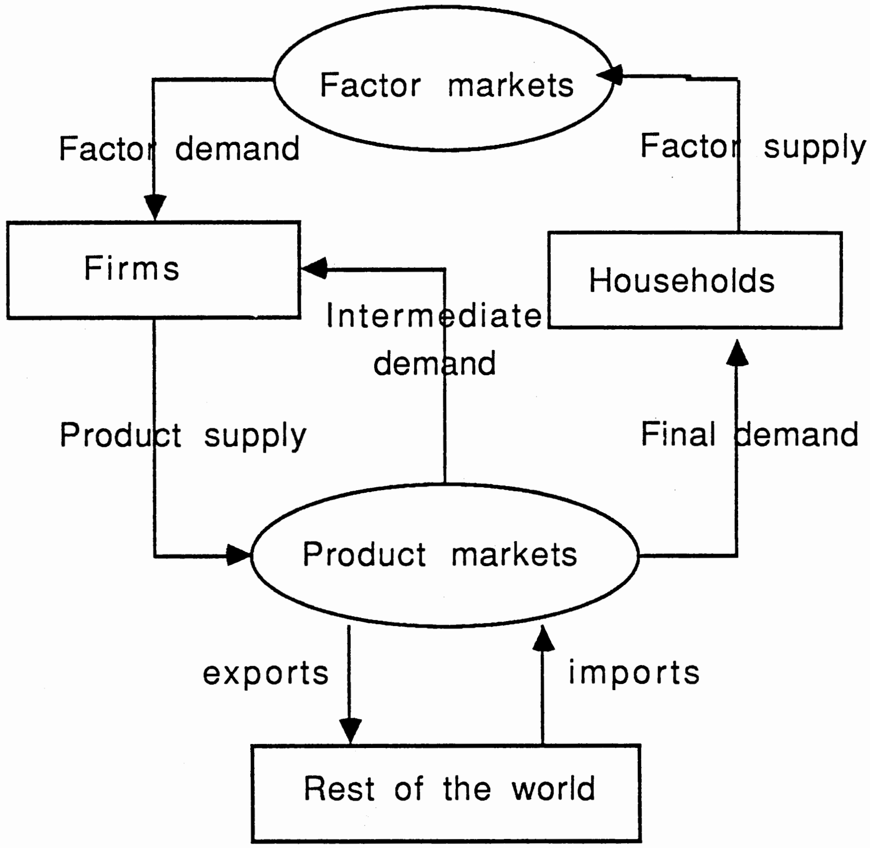

Figure 2. Circular flow account represented by input-output

provide for market clearing; (3) a description of how income is formed and distributed, and (4) specification of consumer demand behavior. Dervis et. al. (1985) refer to the same class of models as Computable General Equilibrium (CGE) models. In the same spirit of defining a GEM as given by Hazell and Norton, Adelman and Robinson (1987) list the workings of a CGE : (1) specifying the various actors in the economy (for example, firms, households, govenment, and the rest of the world); (2) describing their motivation and behavior (utility maximizing for consumers and profit maximzing for firms); (3) specifying the institutional structure, including the nature of market interactions (competitive market for goods and factors); and (4) solving for the equilibrium values of all endogenous variables.

Once the model is developed, it simulates the workings of an economy and solves for a set of prices (wages, product prices, exchange rate) that clear all markets (labor, commodities, and foreign exchange). The model or the simulator is usually in the form of a set of mathematical equations. The set of equations explains the household behavior, firm behavior, and the rest of the world behavior along with rules for clearing factor and product markets.

Household Behavior

The common practice is to assume that households maximize utility subject to income. Let the bundle of goods (or sectors) available be denoted by the vector $\mathbf{q}^d$ which is a member of the set of all possible bundles $\mathbf{Q}^d$, i.e., $\mathbf{q}^d = (q_1, q_2, \ldots, q_n)$, assuming there are n sectors (commodities) in the economy. Let the prices of goods be denoted by the vector $\mathbf{p}$, i.e., $\mathbf{p} = (p_1, p_2, \ldots, p_n)$. Let income be denoted by y. The household is assumed to have preferences for all possible bundles $\mathbf{Q}^d$ represented by the utility function $U(\mathbf{q}^d)$. The household behavior can then be stated in the following maximization problem :

$$\max U(\mathbf{q}^d) \qquad (2\text{-}1)$$

$$\text{subject to } \mathbf{pq}^d = y \text{ and } \mathbf{q}^d \text{ in } \mathbf{Q}^d .$$

The solution to the maximization of (2-1) is the usual set of n demand equations, one for each good. In CGE modeling, a well known managable form of the utility function is usually choosen. If there are h households in the economy, then there will be hxn systems of equations representing the households.

Households are also endowed with labor. The labor is supplied to the labor markets to generate income for each household. In CGE modeling, a fixed supply of labor is generally assumed. However, this does not rule out the possibility of modeling nonfixed labor supply, that is labor supply becomes a function of wages.

Firm Behavior

Firms are assumed to posses technological ability to produce products using different combinations of inputs, represented by a production function. Let q^s denote the product of a particular sector. Let the vector **x** denote a bundle of inputs or factors with the corresponding vector of prices **r**, i.e., $\mathbf{x} = (x_1, x_2, \ldots, x_k)$ and $\mathbf{r} = (r_1, r_2, \ldots, r_k)$. Let technology be represented by the function f, i.e., $q^s = f(\mathbf{x})$. Given the usual concavity assumption of a production function, the maximizing behavior of the firm can be summarized in the following maximization problem :

$$\max \Pi = pf(\mathbf{x}) - \mathbf{rx} \tag{2-2}$$

for each production sector. Π denotes profit and p denotes the price of output $f(\mathbf{x})$. Solution to this maximization problem is the usual derived demand functions for factors, **x**, while the supply function is obtained by substituting this solution back into the production function. There will be k factor demand equations, by each production sector and n supply equations, one for each sector. Therefore there will be kxn equations that determine the behavior of firms (or all production sectors).

Market Clearing

To close the model, commodity balances are specified to provide market clearing. This is satisfied by setting excess demands in both labor (factor) markets and product markets equal to zero. By substitution, all equations can be collected into n excess demand equations, one for each product.

One major assumption of the above analysis is that of a closed economy. Furthermore, saving by households and hence investments are omitted in the specification. In the next section treatment of the savings-investments identity is discussed followed by the treatment of trade as the assumption of a closed economy is lifted.

Saving and Investment

Capital stocks are assumed fixed at least during the period being modeled. Total savings by households is used for investment, however, investment will not be available for production until the next period. Investment by sector of destination is a function of total saving. Let **i** denote vector of investment by sector of destination. Therefore in general form, investment by sector of destination can be written as follows :

$$\mathbf{i} = \mathbf{i}\,(TS) \qquad (2\text{-}3)$$

where TS denotes total saving. Knowing investment by sector of destination, demand for investment goods by sector of origin can be specified as,

$$\mathbf{z} = \mathbf{z}\,(\,\mathbf{i}\,) \qquad (2\text{-}4)$$

where **z** is the the vector of investment demand by sector of origin. Equations (2-3) and (2-4) are vector functions of n elements (n sectors). With this new investment demand incorporated into the model, total demand for products is now equal to consumer demand plus intermediate demand plus investment demand.

Treatment of Trade

With a closed economy there is no need to consider imports, exports, and capital flows in the model. However, in an open economy these factors are incorporated in the model. In terms of Figure 2, this is equivalent to modeling the lower component of the picture (the rest of the world). There are several ways to model imports. The extreme formulations are to assume infinite or zero elasticities of substitution between imports and domestic goods. The former, which is the same as assuming perfect substitutability between domestic and imported goods, implies the "law of one price." The definition of elasticity of substitution is the percentage change in the ratio of imported to domestic goods by a one percent change in their relative prices. This also implies that a given product has the same price whether it is imported or produced domestically. Another important implication of this assumption is that a product is either exported or imported but never both. This assumption appears to be unrealistic particularly when sectors are fairly aggregated.

The second exteme alternative formulation, i.e., zero elasticity of substitution, implies imports become perfect complements of domestic products and are frequently called non-competitive imports. This formulation is suitable when a sector heavily depends on imports and the imports depend on domestic production levels. This implies that changes in relative prices, such as exchange rates, do not affect the structure of the domestic economy. To alleviate this problem, Norton (1986) introduced an intercept term along with fixed marginal propensities to import so that the ratios of imports to domestic production change as the level of economic activity changes. In this case, changes in relative prices affect domestic structure of the economy, at least indirectly.

Reality is somewhere in between, i.e., the elasticity should be between zero and infinity. The following exposition is based on the work of Armington (1969). He introduced a theoretical framework that facilitates treatment of the demand for products distinguished by place of production. He began by assuming that the same kind of good produced in two different places was basically two different goods. Hence, French machinery and Japanese machinery are two different goods in the sense that they are not perfect substitutes and not perfect complements in demand. This is equivalent to saying that imported and domestically produced goods are imperfect substitutes. Hence, if there are nine sectors in the economy, there are eighteen products distinguished in the model, that is assuming imports are from only one "country", the rest of the world. Similarly, there is one export demand, i.e., to the rest of the world, for each product.

Let n denote the number of goods and $\mathbf{q}^d$ the bundle of goods available to each buyer. Then $\mathbf{q}$ is written as

$$\mathbf{q}^d = (q_{11}, q_{12}, q_{21}, q_{22}, \ldots q_{n1}, q_{n2}) \tag{2-5}$$

$$= (q_1, q_2, \ldots, q_n), \text{ where } q_i = (q_{i1}, q_{i2}) \text{ for } i = 1, 2, \ldots, n$$

(note, for the second index, 1 = domestic product, 2 = imported). Let $\mathbf{p}$ denote the vector of all prices but now with nx2 elements,

$$\mathbf{p} = (p_{11}, p_{12}, p_{21}, p_{22}, \ldots, p_{n1}, p_{n2}) \,. \tag{2-6}$$

Now the utility of each buyer is a function of the bundle of 2n goods instead of the previous bundle of n goods in the closed economy model. The result of the utility maximization is a set of demand equations for all 2n goods,

$$q_{ij} = q_{ij}(y, p_{11}, p_{12}, p_{21}, p_{22}, \ldots, p_{n1}, p_{n2}) \tag{2-7}$$

where $i = 1, 2, \ldots, n$; and $j = 1,2$ (domestic and imported).

Equation (2-7) states that the decision as to how much of a good i is to be fulfilled by imports and how much is to be fulfilled by domestic products depends on the same decisions as with other goods. This specification generally is too complex to handle in practical research, while the degree of dependence might not be that large. What is needed is to decide first the total amount of a particular good to consume, say chemicals (a composite good, composed of domestic production and imports), and then to decide the proportion supplied domestically and the proportion supplied from imports.

Given the following assumptions, the above two step decision can be done. First, is the assumption of independence. Buyer's preferences for different products of any kind (e.g., domestic chemicals, imported chemicals) are independent of their purchases of products of any other kind (e.g., domestic machinery, imported machinery). The next assumption is that each country's market share is not affected by changes in the size of the market as long as relative price in that market remains the same. The last assumption is that the elasticity of substitution between any two products of the same kind is constant.

The assumption of independence states that the utility function is of the following form :

$$U(\mathbf{q}^d) = U(q_{11}, q_{12}, q_{21}, q_{22}, \ldots, q_{n1}, q_{n2})$$
$$= U'(q_1, q_2, \ldots, q_n), \text{ where } q_i = \psi_i(q_{i1}, q_{i2}) \,. \qquad (2\text{-}8)$$

Notice the difference between equation (2-5), where there is no functional relationship between q_{i1} and q_{i2}, and equation (2-8) where q_i is governed by a function ψ_i. The last assumption ensures that p_i depends only on product prices, that is the function ψ_i is linear and homogenous. Now the demand for any composite good q_i is obtained by maximizing U' subject to $y = \mathbf{pq}^d$. Once the demand for good i is determined, the demand for imported and domestically produced goods q_{i1}, q_{i2}, is obtained by minimizing the cost of purchasing the volume of q_i. The solutions would be :

$$q_{ij} = q_{ij} \; (\; q_i, \; p_{ij}/p_{i1}, \; p_{ij}/p_{i2}) \qquad (2\text{-}9)$$

where i = 1,2, . . . , n ; and j = 1, 2. Equation (2-9) states that demand for imported goods is a function of the relative price between the imported and domestic product. Similarly, demand for the domestic product depends on the same relative price. The common practice is to choose y_i to be a constant elasticity of substitution (CES) function and complies with all the previously mentioned assumptions.

Treatment of export demand is similar to the above exposition by considering the rest of the world as the importing country. Finally, minor rearrangements are made to the clearing market conditions to accomodate the introduction of trade to the model.

Calibration

When a particular equational form is choosen for any of the previous formulations, some parameters remain undetermined. For example, if a Cobb-Douglass production function replaces the general production function f(**x**) in equation (2-2), shares and shift parameters of this production function need to be determined. The natural way to estimate these parameters is through econometric estimation. However, the number of observations required to do such an estimation is beyond the data of many developing countries. For example, two hundred or more equations with two hundred or more endogenous variables is not uncommon in CGE modeling with highly aggregated sectors. The more common procedure is to "calibrate" the model to a base year observation. Calibration means to specify the model in a way that reproduces the base year data as a model solution. Parameters such as elasticities are usually adopted from previous research. Often, information on parameters from previous studies is limited or not available. In this case, sensitivity analysis is commonly practiced. One advantage of calibration is that base year data can be considered as a "benchmark" equilibrium under existing policies to which new equilibrium under new policies can be compared.

If the base year data are to reflect equilibrium levels, demands must equal market supplies for all commodities and factors. Factor supply and demand is separately identified by actor in the economy. Each actor, in turn, has income and expenditures consistent with budget constraint. Mansur and Whaley (1984) list four sets of equilibrium conditions base year data must satisfy to be considered benchmark equilibrium :

1. Demands equal supplies for all commodities,
2. Non positive profits are made in all industries,
3. All domestic agents (including government) have demands that satisfy their budget constraints, and
4. The economy is in zero external sector balance.

The above conditions are satisfied by a SAM and therefore can be used as benchmark equilibrium. However, some adjustments may be needed to reflect the current situation since most available SAM's are dated five or even ten years back. Whether the SAM alone is sufficient to uniquely determine the parameters depends on the functional forms chosen. For example, all of the share parameters for a Cobb-Douglass production function are contained in the SAM. Because the model is required to generate the base year SAM as a solution, the first order conditions of profit maximization are used to obtain the shift parameters. CES functional forms, however, require exogenously determined elasticities of substitution. Once these parameters are known, the rest of the parameters can be computed from the SAM, again with the help of first order conditions.

Most SAMs are presented in monetary values. To separate prices and quantities in the account, the base year price is usually set equal to one and referred to as price normalization. Parameters unique to this study are presented in chapter V.

Solution Algorithm

Applications of general equilibrium theory were hindered by the absence of high speed computation facilities and to relatively slow advancements in numerical techniques needed to solve non-linear systems of equations. However, with high speed computation techniques, CGE modeling has become more feasible for researchers. The objective is to solve a system of equations that simulate the workings of the economy. For planners with available technological data, linear programming can be used to solve the system (Ginsburg and Waelbroech, 1984). Programming models can theoretically be constructed so that solutions generate general (competitive) equilibria. Norton and Scandizzo (1981) also show how linear programming can be used to generate the general competitive equilibrium solutions. Suprapto (1987) used the latter model without specifically having available technological data. Technological data were generated by first estimating production functions from the base year SAM and then by grid linearization obtaining the technology data.

Leaving the system of equations as is, i.e., without linearization, the problem becomes one of solving a set of excess demand equations equal to zero (by Walras law). In mathematical terms, this refers to finding the zeroes of the system of equations. There are several algorithms available to solve a system of non-linear equations numerically. Dervis et. al. (1985) listed some of them in Appendix B of their book. Three classes of algorithms are used : (1) algorithms based on the fixed-point theorem, (2) algorithms based on the tatonement process, and (3) algorithms that exploit the derivatives of the excess demand functions.

The tatonement process is simply to adjust the price in each sector whenever there is excess demand. If sectoral excess demand is positive, price is raised; if negative, price is lowered until all excess demands equal zero. Algorithms that exploit the derivatives of the excess demand functions are the Newton-Raphson method and steepest descent or steepest ascent method.

Condon et. al. (1987) argue that non-linear optimization packages such as MINOS can be used to solve a system of non-linear excess demand equations. In optimization, the constraints are usually either underdetermined or overdetermined, i.e., the number of equations in the constraints is either less than or greater than the number of endogenous variables. When the number of equations is exactly equal to the number of endogenous variables, the objective function simply does not matter. The optimization package will solve the constraints (n by n equations) and there is only one solution regardless of the form of the objective function chosen. They then use GAMS (General Algebraic Modeling System) which is an end-user software to call MINOS (MINOS has linear and non-linear solvers) to solve their system of equations.

CHAPTER III

THE INDONESIA ECONOMY: A SOCIAL ACCOUNTING MATRIX PRESENTATION

A social accounting matrix (SAM) is a "snapshot" of an economy at a given point in time. It pictures flows among the components of an economy, i.e., factors of production, institutions (households, government, and private companies), production sectors, and rest of the world. In 1980, the Central Bureau of Statistics (CBS) of Indonesia in cooperation with the Center for World Food Studies, Amsterdam, produced three different disaggregated SAMs of Indonesia. The first is disaggregated to a 37 x 37; the second is disaggregated to a 106 x 106; and the third is disaggregated to a 261 x 261. This study begins with the 106 x106 SAM and aggregates to a 44 x44.

A Social Accounting Matrix

There are many different ways to organize data and information. A social accounting matrix, commonly known as SAM has been used to organize data or information about the economic and social structure of a country for a particular year. Though most of the existing SAMs are at the country level, their use are not limited to that level. A SAM for a region, village, or river basin can also be constructed. Once a SAM is completed for a particular year, it reveals much about the structure of the economy.

To understand the workings of the economy, however, more than a SAM is needed. A model of the economy has to be constructed. Then the model can be used to study or to simulate the impact of a policy intervention or the effects of an external shock on the rest of the economy. To do the simulation, additional data are needed. For instance, some of the structural parameters of the model need to be estimated. The base year SAM provides some of the information needed to estimate these parameters. In addition, the base year period SAM provides a benchmark to which the results of a simulation can be compared.

Basically a SAM is a double entry bookeeping account presented in a single entry matrix form. It is a series of accounts where receipts and expenditures must balance and thus all flows in the economy are accounted for with no leakages. The SAM pictures the structure of the economy as a circular flow with demand leading to production, production leading to income, and in turn, income leading back to demand. The components of a SAM therefore include institutions (households, government, and private companies) who supply factors of production, and demand products. Factors of production, usually different categories of labor and capital, receive payment from producers for use of factors in the production sectors. Production sectors in turn produce commodities and sell products to institutions. The revenue from sales is used to pay for purchased inputs and as factor payments and thus eventually accrues to institutions. In a country with an open economic system, the rest of the world is considered to be one of the demanders of the goods produced domestically (exports) and thus there is a transfer of assets or money indirectly to domestic institutions. At the same time the rest of the world supplies foreign goods (imports) and capital and receives payments for these goods and interest for capital. Indirect tax and subsidies account is added to the matrix to capture government receipts and expenditures. The last component in the matrix is an account to capture the flow of total savings which in turn is used to finance investments.

Schematically a SAM for Indonesia in aggregate level is presented in Figure 3. The accounts in the SAM are grouped into six major categories: (1) factors of production; (2) institutions; (3) production sectors; (4) domestic commodities; (5) imports; and (6) balances. Each cell containing (T_{ij}) in Figure 3 represents a transaction subsystem between various accounts. For example, T_{13} is a subsystem containing the transaction between production sectors and factors of production. To produce total output of $T_{.3}$, production sectors must pay for factor cost of T_{13}. For the factors of production, these values are incomes, whereas for the production sectors, the values are expenditures. Row totals must equal column totals, that is, $T_{i.}$ must equal $T_{.i}$ for all i.

SAMs may have different accounts and aggregations. They may have different aggregations in the production sectors, or they may have different categories of factors of production and different groups of institutions. SAMs may distinguish between use of domestic commodities and imported commodities in the production sectors and consumptions. The 44 x 44, 1980 SAM of Indonesia distinguishes source of commodity (imports and domestically produced) as used by its production sectors and as consumed by its households. Nine production sectors and nine commodities are further specified: (1) Food crops, (2) Non-food crops, (3) Livestock, (4) Forestry, (5) Fisheries, (6) Food processing, (7) Mining, (8) Manufacturing, and (9) Construction and services (CONSTSERV). The first six sectors are exactly the same as in the 106 x106 SAM. Mining includes coal, minerals, oil, natural gas, and other mining. Manufacturing includes textiles, clothing and leather industries, paper and publishing industries, transportation equipment, metal products, chemical industries, fertelizer, ceramic and cement, basic metal

Expenditures ↓ / Receipts →	Factors of Production	Institution	Production Sectors	Domestic Commodities	Imports	Balances	Total
Factors of Production	T_{11}	T_{12}	T_{13}	T_{14}	T_{15}	T_{16}	$T_{1.}$
Institution	T_{21}	T_{22}	T_{23}	T_{24}	T_{25}	T_{26}	$T_{2.}$
Production Sectors	T_{31}	T_{32}	T_{33}	T_{34}	T_{35}	T_{36}	$T_{3.}$
Domestic Commodities	T_{41}	T_{42}	T_{43}	T_{44}	T_{45}	T_{46}	$T_{4.}$
Imports	T_{51}	T_{52}	T_{53}	T_{54}	T_{55}	T_{56}	$T_{5.}$
Balances	T_{61}	T_{62}	T_{63}	T_{64}	T_{65}	T_{66}	$T_{6.}$
Total	$T_{.1}$	$T_{.2}$	$T_{.3}$	$T_{.4}$	$T_{.5}$	$T_{.6}$	$T_{..}$

Figure 3. The Schematic Presentation of the Aggregated Indonesian SAM

industries, and other industries. CONSTSERV includes wood and wooden industries; construction and building; water, electricity, and gas; retailing and wholesaling; transportation and storage services; restaurants and hotels; land, air, and sea transportation; communications; banking, insurance, and real estate; corporate services; government and defense; education, health, and social services; film and entertainment; and personal, family, and other services. The complete 44 x 44, 1980 SAM of Indonesia is presented in Appendix A.

The following example clarifies the notion that a double entry account can be represented by a single entry account in the SAM. For instance, consider row 19 and column 19 in the SAM (Food Crops Production). This double entry account can be presented as follows (all figures in billion rupiah):

<u>Receipts (row 19)</u>		<u>Expenditures (column 19)</u>		
Total sales of domestic		Payment for factors :		
production	Rp 7710.86	a. Ag. laborers	Rp	3827.92
		b. Prod. workers	Rp	16.22
		c. Sales & sevices	Rp	7.88
		d. Prof. & management	Rp	5.73
		e. Capital	Rp	2201.01
		Payment for domestic commodities :		
		a. Food crops	Rp	1271.03
		b. Non-food crops	Rp	.46
		c. Livestock	Rp	24.79
		d. Forestry	Rp	2.63
		e. Manufacturing	Rp	237.21
		f. CONSTSERV	Rp	123.44
		Payment for imported commodities :		

		a. Food crops	Rp	1.79
		b. Manufacturing	Rp	54.05
Total	Rp 7710.86	Total	Rp	7710.86

Factors of Production

The five factors of production identified in the Indonesian SAM are : (1) Agricultural laborers, (2) Production workers, (3) Sales and services, (4) Professional and management, and (5) Capital. The latter includes capital owned by government, private entities, and foreign entities. Production sector payments to the factors of production are obtained from columns 14 to 22 and rows 1 to 5. About 71.5 percent of the Agricultural laborers' income was generated from Food crops, 14.2 percent from Non-food crops, 5.2 percent from Livestock, 3.8 percent from Forestry, and 5.3 percent from Fisheries (see Table I). Production workers receive income mainly from the last four sectors. For instance, about 69.4 percent comes from the CONSTSERV sector. However, among agriculturally related sectors, Food processing generates the highest income for Production workers, i.e., about 85.3 percent, followed by Forestry (5.4 percent), Non-food crops (5.1 percent), and Food crops (3.5 percent). Sales and services, and Professional and management labor categories are concentrated in the non-agricultural sectors. Mining and CONSTSERV are the most highly capital intensive sectors relative to the other sectors.

The base year data provide estimates of labor employed in each production sector. Because a person can be employed in two or more different sectors, employment is defined in terms of labor unit equivalents. For instance, if half of a person's working time is utilized in the Food crops sector and the other half is in Fisheries, then his labor unit equivalent is one-half for each

TABLE I

DISTRIBUTION OF FACTOR INCOME BY PRODUCTION SECTORS, 1980 (Percent)

Factor	Production sector									
	Food crops	Non-food crops	Live-stock	Fores-try	Fish-eries	Food proces-sing	Mining	Manu-factur-ing	CONSTSERV	Total
Agric. laborers	71.5	14.2	5.2	3.8	5.3	0.0	0.0	0.0	0.0	100.0
Prod. workers	0.4	0.5	0.1	0.5	0.0	8.6	4.2	16.3	69.4	100.0
Sales & services	0.1	0.4	0.1	0.2	0.0	0.8	1.5	2.1	94.7	100.0
Professional & management	0.2	0.3	0.1	0.1	0.0	0.3	1.9	4.6	92.5	100.0
Capital	7.3	5.2	3.0	3.9	1.7	3.4	40.3	8.1	27.2	100.1

sector. Distribution of labor equivalents by labor categories and production sectors is presented in Table II. About 48 percent of the labor force in 1980 was in the agricultural sectors (the first five sectors). If Food processing is included, agriculturally related sectors absorbed about 51 percent of the total labor force. About 47.5 percent of the labor force was Agricultural laborers, 23 percent was Production workers, 25.3 percent was Sales and services, while the rest (about 4.2 percent) was Professional and management. From this information, it appears that a large portion of the population was involved in agriculturally related activities.

Institutions

Eight institutions are identified in the SAM: (1) Agricultural laborers, (2) Agricultural operators, (3) Rural non-agricultural low income, (4) Rural non-agricultural high income, (5) Urban low income, (6) Urban high income, (7) Private companies, and (8) Government. The institutional classification of household categories is composed of different labor categories which are supplied to the production sectors. Rows 6 to 13, columns 1 to 5 provide the source of income for each institutional category from each factor of production. Private companies and Government do not have ownership of labor as indicated by empty cells in rows 12 and 13, columns 1 to 4 but do show ownership of capital as given in column 5. In addition, Government generates income from direct and indirect taxes (row 13 with columns 6 - 13 and 42 - 43). For instance, government revenue from direct taxes on capital was 123.4 billion rupiah in 1980 (row 13, column 5), whereas entries in the same row, columns 6 to 11 are government revenue from direct taxes on households. The figure in row 13 column 42, 402.24 billion rupiah, is Government revenue from indirect taxes minus subsidies. In the same year, there was about 22.32 billion rupiah

TABLE II

DISTRIBUTION OF LABOR EQUIVALENTS BY LABOR CATEGORY AND PRODUCTION SECTOR, 1980 (1000)

	Production Sector										
Labor	Food Crops	Non Food Crops	Livestock	Forestry	Fisheries	Food Processing	Mining	Manufacturing	CONSTSERV	Total	Percent
Ag. laborers	21747.7	2744.8	1111.3	452.3	823.9	.0	.0	.0	.0	26880.0	47.5
Prod. workers	77.5	93.7	5.2	70.3	6.0	1540.5	388.1	2644.0	8201.4	13026.7	23.0
Sales & services	35.0	65.0	9.1	23.9	9.6	99.2	40.4	217.9	13798.3	14298.4	25.3
Professional & management	14.7	11.6	1.4	2.7	.9	11.4	12.3	69.1	2232.4	2356.5	4.2
Total	21874.9	2915.1	1127.0	549.2	840.4	1651.1	440.8	2931.0	24232.1	56561.6	100.0
Percent	38.6	5.2	2.0	1.0	1.5	2.9	.8	5.2	42.8	100.0	

transfered from the rest of the world to the Government, in the form of grants and/or borrowings from other countries. Private companies generate most of their income from capital returns, i.e., about 17,546.85 billion rupiah in 1980, plus transfers from the rest of the world, government, and other companies (row 12 and columns 43, 13, and 12).

In addition to labor income, households receive income from other institutions (rows 6 to 11 and columns 6 to 13). For instance, Agricultural laborers might send money to relatives who study or work in the cities. This transfer amounted to 6.91 billion rupiah (row 10 column 6) for urban low-income households. Likewise, relatives of agricultural laborers who work in the cities might routinely send remittances to those who live in the villages. This amounts to 5.03 billion rupiah (row 6, column 10) for urban low-income households sending remittances to agricultural laborers. The last source of income for households is transfers from the rest of the world (rows 6 to 11, column 43) which could be transfers from expatriate workers and income from capital ownership (rows 6 to 11, column 5).

Distribution of income among the six household categories, full-time labor equivalent supplied by household category, and income per full-time labor equivalent are presented in Table III. Income per full-time labor equivalent of Urban high income households was more than twice the income of Urban low income households. Income of Rural non-agricultural high income households was 88 percent higher than the Rural non-agricultural low income households and 13 percent higher than Urban low income households. The lowest income among the household categories was the income of Agricultural laborers at about Rp. 291.24 thousand.

Households, Private companies, and Government use their income to pay taxes, purchase commodities, and save for future consumption. Private companies and Government also make interest payments to the rest of the world. In 1980 these interest payments were Rp. 145.03 billion for Private companies, and Rp. 724.28 billion for Government (row 43, columns 12 and 13). The proportion of household disposable income spent on commodities is provided in Table IV.

Agricultural laborers spent more of their disposable income on Food crops and Food processing products compared to the rest of the household groups. The proportion of disposable income spent on Food crops and Food processing decreases going from Agricultural laborers to Urban high income

TABLE III

DISTRIBUTION OF INCOME, SUPPLIED LABOR EQUIVALENT, AND INCOME PER LABOR EQUIVALENT BY HOUSEHOLDS, 1980

Household category	Income (billion Rp.)	Full-time labor equivalent (1000 persons)	Income per full-time labor equivalent (1000 Rp.)
Agricultural laborers	1622.98	5572.70	291.24
Agricultural operators	11277.20	23628.30	477.28
Rural non-agric. low income	5370.06	12757.80	420.92
Rural non-agric. high income	1970.91	2483.30	793.03
Urban low income	6337.41	9065.60	699.06
Urban high income	4593.73	3051.80	1505.25

households. For instance, Urban high households spent 4.3 percent of their income on Food crops and 19.3 percent on Food processing products compared to 31.3 percent and 38.2 percent, respectively, for Agricultural

TABLE IV

PROPORTION OF HOUSEHOLD AND GOVERNMENT DISPOSABLE INCOME SPENT ON COMMODITIES (Percent)

	Hosehold Groups						
Commodity	Agric. laborers	Agric. operators	Rural non-agric. low income	Rural non-agric. high income	Urban low income	Urban high income	Government
Food crops	31.3	24.5	18.1	12.9	10.2	4.3	0.0
Non-food crops	7.1	4.6	3.6	2.1	1.9	1.3	0.2
Livestocks	4.1	4.6	3.4	4.5	4.4	5.4	0.0
Forestry	2.6	1.5	.9	.5	.3	0.0	0.0
Fisheries	4.6	4.3	4.4	5.0	4.4	3.8	0.0
Food processing	38.2	27.7	28.0	26.8	21.1	19.3	0.0
Mining	0.4	0.3	0.2	0.2	0.2	0.2	0.0
Manufacturing	4.3	12.2	14.7	18.6	16.5	19.0	11.1
CONSTSERV	7.4	20.5	26.7	29.4	41.1	46.8	88.6

laborers. This result shows Engel's law at work. Households with higher incomes consume higher proportion of manufacturing and services goods. Only a small portion of household disposable income was spent on imports. However, there is tendency that the larger the disposable income percapita, the higher the proportion spent on imports. For example, Agricultural laborers spent about 1.7 percent of their income on imports, while Urban high income households spent about 9.2 percent. Agricultural operators spent about 4.6 percent, Rural non-agricultural low income about 6.1 percent, Rural non-agricultural high income about 8.2 percent, and Urban low income about 6.5 percent.

In 1980, Agricultural laborers saved Rp. 47.61 billion, about 2.9 percent of their gross income. Agricultural operators saved Rp. 1,271.98 billion or about 11.3 percent. Rural non-agricultural low income saved Rp. 499.64 billion or about 9.3 percent. Rural non-agricultural high income saved Rp. 284.47 billion or about 14.4 percent , Urban low income saved Rp. 711.36 billion or about 11.2 percent, and Urban high income saved Rp. 930.13 billion or about 20.2 percent. Of all institutions, Private companies saved the highest proportion of their income or 46.5 percent of Rp. 8,314.24 billion. The Government saved Rp. 3,113.02 billion or about 30.4 percent of total income. The percentage of income saved by institution is summarized in Table V.

Production Sectors

Nine production sectors are identified. In the process of production, they require intermediate and primary inputs. They also pay indirect taxes to the government. In the SAM, trade margins are separated from the production process but included in the final product (commodity). In our model, final

TABLE V

PERCENTAGE INCOME SAVED BY INSTITUTIONS

Institution	Percentage Income saved
Agricultural laborers	2.9
Agricultural operators	11.3
Rural non-agric. low income	9.3
Rural non-agric. high income	14.4
Urban low income	11.2
Urban high income	20.2
Private companies	46.5
Government	30.4

products are identified to be equivalent to the production sectors. Therefore, trade margins are treated as part of the CONSTSERV sector.

Payment to all factor inputs (labor and capital) by all production sectors is equivalent to gross domestic product (GDP) at factor costs and equalled Rp. 48,511.22 billion in 1980. This is also commonly referred to as value added. GDP distributed to each factor by each production sector is obtained as described in rows 1 to 5, columns 14 to 22 of the SAM.

Production sectors purchase intermediate inputs. Payment for these inputs are given in rows 23 to 40, columns 14 to 22. Intermediate inputs produced domestically are given in rows 23 to 31, while imported intermediate inputs are given in rows 32 to 40. By including trade margins in the CONSTSERV sector, information on the purchase of intermediate inputs is used to generate input-output coefficients as presented in Table VI.

Indirect taxes and subsidies are components of primary inputs. Indirect taxes are part of government revenue, whereas subsidies are part of government expenses transferred to producers. Negative data in this account indicate subsidies greater than indirect taxes. For instance, manufacturing was subsidized about Rp. 518.82 billion in 1980. These data are found in row 44 columns 23 to 31. Total output of each sector is presented in table VII.

TABLE VI

INPUT-OUTPUT COEFFICIENTS FOR THE INDONESIA ECONOMY, 1980

Sector	Food crops	Non-food crops	Live-stock	Fores-try	Fish-eries	Food proces-sing	Mining	Manu-factur-ing	CONSTSERV
Food crops	.14510	.00035	.00761	.0	.00039	.36904	.0	.00028	.00493
Non-food crops	.00005	.16563	.00501	.0	.0	.15277	.0	.01397	.00229
Livestock	.00283	.00126	.25461	.0	.00017	.00421	.0	.00267	.01021
Forestry	.00030	.00256	.00057	.01988	.00719	.00055	.00001	.00143	.02914
Fisheries	.0	.0	.00013	.0	.07129	.00606	.0	.0	.00294
Food processing	.0	.0	.04342	.0	.00690	.05500	.0	.00188	.01552
Mining	.0	.0	.00007	.0	.00315	.00138	.02918	.13179	.01757
Manufacturing	.03320	.04626	.00439	.02918	.03703	.02910	.03379	.32956	.16909
CONSTSERV	.12286	.21839	.15346	.33386	.35187	.14501	.07048	.30268	.11042

TABLE VII

TOTAL OUTPUT OF EACH SECTOR IN 1980 (BILLION RUPIAH)

Sector	Output
Food crops	8,772.14
Non-food crops	4,262.45
Livestock	2,243.99
Forestry	2,288.35
Fisheries	1,518.35
Food processing	7,389.87
Mining	4,352.04
Manufacturing	13,380.49
CONSTSERV	31,367.62
Total	75,575.30

Rest of the World

With aggregated sectors, it is expected that each commodity is exported and imported at the same time, which is the case for the 44x44 aggregated SAM. For instance, even the domestically oriented CONSTSERV sector exports about Rp. 702.77 billion, albeit this amounts to only about 2.2 percent of total sectoral output. Table VIII presents data on total sectoral imports, total sectoral exports, size of each sector relative to the size of the economy, and other information.

Table VIII also describes the trade orientation of the sectors in the economy. For instance, Mining has a high ratio of exports to sectoral output and contributes about 72 percent of total exports. The most agriculturally exportable sector is Non-food crops which contributed about 8.6 percent of total exports and had a ratio of exports to sector output about 0.32. If one is interested in exports relative to the size of the sector then Forestry is second behind Mining but before Non-food crops and Manufacturing. However, if the interest is in the role of exports in generating foreign exchange, then the ratio of sectoral exports to total exports is more relevant. In this case Manufacturing is second after Mining, followed by Non-food crops and Forestry.

Manufacturing is the most import dependent sector with a ratio of imported intermediate inputs to total intermediate inputs of about 0.48. Next is Mining followed by the Food processing sector. Sectors which are most import dependent also have the highest import shares of domestic demand. For instance, the Manufacturing import share is about 45.9 percent of its domestic goods and the Mining share is about 19.1 percent. Among the agriculturally related sectors, Food processing is the most import dependent sector with a ratio of imported intermediate inputs to total intermediate inputs of 9.2 percent, followed by Non-food crops, and Food crops with corresponding ratios of 0.67

TABLE VIII

STRUCTURE OF COMMODITY IMPORTS AND EXPORTS IN 1980

Sector	Total commodity imports (Rp. Billion)	Total commodity exports (Rp. Billion)	Sectoral shares of total output (%)	Ratio of import to domestic goods (%)	Ratio of imported intermediate inputs to total intermediate inputs (%)	Ratio of exports to sectoral output (%)	Ratio of sectoral export to total exports (%)
Food crops	174.72	36.00	10.25	1.97	3.15	.41	.22
Non-food crops	205.04	1,382.31	4.98	6.68	9.36	32.43	8.55
Livestocks	10.31	13.55	2.62	.46	.39	.60	.04
Forestry	1.48	1,028.39	2.67	.12	.13	44.94	6.36
Fisheries	1.30	132.94	1.77	.09	0.00	8.76	.82
Food processing	721.88	119.17	8.64	9.19	9.43	1.61	.74
Mining	711.17	11,333.01	16.17	19.13	25.03	78.96	70.12
Manufacturing	8,758.67	1,414.02	15.64	45.89	47.50	10.57	8.75
CONSTSERV	1,056.91	702.77	36.65	3.33	3.46	2.24	4.35
Total	11,641.48	16,162.16					

and 0.20. Higher import shares indicate potential for the sector to have import substitutes depending on the trade-substitution elasticity between imported and domestically produced goods.

Capital Account

In the 1980 SAM, total saving by each institution is described in the capital account (row 41, columns 6 to 13). Total saving in the economy was Rp. 15,172.45 billion. Total saving is balanced with total investment described in column 41. For instance, Rp. 1,073.20 billion worth of capital goods were purchased from the Manufacturing sector in 1980. Rp. 6,896.64 billion was purchased from the CONSTSERV sector, which costitutes the largest capital good purchases in the economy. The largest imported investment good was from the Manufacturing sector and equaled Rp. 2,712.74 billion. In the same year, about Rp. 3,278.04 billion was invested in other countries.

CHAPTER IV

THE COMPUTABLE GENERAL EQUILIBRIUM MODEL OF INDONESIA

The computable general equilibrium (CGE) model of Indonesia described in this chapter is based on the model developed by Dervis, de Melo and Robinson (1985). CGE models are built according to their particular purpose(s) to be served. The model developed here for Indonesia is to support the purposes of this study.

In general all CGE models attempt to simulate a market economy where quantities and prices for goods and factors adjust to achieve equality between supply and demand. A model is defined which represents the economy, usually in terms of a set of mathematical equations. Specification of the mathematical equations is usually based on economic theory and the assumed behavior of individual agents in the economy. For instance, producers are assumed to maximize profits and consumers are assumed to maximize utility. The model is then used to simulate the effects of a change in any exogenous variable or government policy and solve for the new equilibrium.

The new equilibrium is compared with the old equilibrium to measure the effects of the exogenous change. In CGE modeling, a SAM is usually assumed to represent equilibrium of the economy at a point in time and under a given structure of the economy. The equilibrium need not necessarily represent a competitive equilibrium. For example, the 1980 SAM for Indonesia is used as the benchmark equilibrium with built-in government policy interventions. The results of model simulations will be compared to this benchmark equilibrium.

Given that the CGE model represents the economy, one would expect that it should be able to reproduce the base year (benchmark) SAM. Indeed it should, given that a number of the parameters of the equations is generated from the SAM. This technique, sometimes called calibration of the model, is explained in this chapter.

In the Indonesian CGE model, each commodity group distinguished in the economy is associated with a production sector. There are nine commodity groups and nine production sectors in the economy (see chapter III for the current SAM). For every commodity group, one demand and one supply equation is specified. Discussion begins with commodity demand.

Commodity Demand

Total commodity demand is the summation of intermediate input demand, consumer demand, investment demand, and export demand. Commodity supply is the summation of domestic production and imports. Inventories adjust year-to-year carryovers and are ignored in this model. Because intermediate demand is treated as a factor in the production process, it is discussed in the next section on domestic commodity supply. Similarly, because imports are treated as a component of total commodity demand, they are discussed in this section. Discussion begins with consumer demand.

Consumer demand

Each institution or socioeconomic group in the economy is considered to represent one consumer and that consumer's bundle of goods results from maximizing utility. Each group can have a different demand schedule because of differences in preferences, tastes, and income. One of the characteristics of the general equilibrium model is that the model should be able to capture the cross-price effects in the demand for commodities. For this reason, a system of demand equations is specified for each socioeconomic group. There are alternative demand systems that can be considered. Because of its simplicity and its capability to support the study without loss of generality, the Stone-Geary linear expenditure system (LES) was chosen.

Consider the following Stone-Geary utility function:

$$U = \sum_i \beta_i \ \ln (C_i - \gamma_i) \qquad (4\text{-}1)$$

$(i = 1, \ldots, n)$

where β_i's are the budget shares that determine the allocation of supernumerary income (i.e., expenditure above the required for purchasing the necessary or committed quantities or "subsistence minima"), C_i's are the levels of consumption, and γ_i's are the subsistence minima. Let $DISP_k$ denote disposable income of household k (that is, after tax, after saving, and net of transfers to other households). Maximizing this utility subject to consumer disposable income gives consumer demand for each good i by each household k:

$$C_{ik} = \gamma_{ik} + (\beta_{ik}/P_i) * (DISP_k - \sum_j P_j\gamma_{jk}) \qquad (4\text{-}2)$$

where P_i is the price of good i (see Henderson and Quandt, 1980, pp. 37-39).

Multiplying equation (4-2) by Pi generates the following expenditure functions :

$$P_iC_{ik} = P_i\gamma_{ik} + \beta_{ik} * (DISP_k - \sum_j P_j\gamma_{jk}) \qquad (4\text{-}3)$$

which are linear in income and prices. Because of the lack of data, all of the parameters can not be estimated statistically. By taking the first derivative of expenditure with respect to income, multiplying by the inverse of the share parameter, the following equation results:

$$\beta_i = \alpha_i\varepsilon_i \qquad (4\text{-}4)$$

where ε_i is the expenditure elasticity for commodity i, and α_i is the average budget share. The subscript k denoting socioeconomic group is deleted to simplify the notation. Equation (4-4) shows that with the income or expenditure elasticity ε_i and the average budget share α_i, β_i can be computed. In this study, α_i is generated from the base year SAM and ε_i is adopted from previous studies. For consumer demand equation (4-2) to be completely specified, parameters γ_k have to be estimated. In the LES, the Frisch parameter (i.e., the elasticity of marginal utility of income with respect to income) for each socioeconomic group is equal to the ratio of total expenditure to supernumerary expenditure as stated in the following equation

$$\phi_k = DISP_k/(DISP_k - \sum_j P_j\gamma_{jk}) \qquad (4\text{-}5)$$

(see Frisch, 1959; Brown and Deaton, 1972). Substituting equation (4-5) into equation (4-2), and premultiplying by $P_i/DISP_k$ results in the following solution for γ_k :

$$\gamma_k = [DISP_k/P_i]\,[\alpha_i + (\beta_i/\phi_k)]. \tag{4-6}$$

When ϕ_k is known, consumer demand for each good i by each socioeconomic group k is completely specified in equation (4-2). Suprapto (1988) estimated the Frisch parameters for each socioeconomic group for Indonesia. These parameters are used for this study.

In summary, with income elasticities from other studies, average budget shares from the SAM, per capita disposable income for each socioeconomic group also from the SAM, then consumer demand is completely specified and is represented by equations (4-2), (4-4), and (4-6). The endogenous variables are:

C_{ik} = quantity of goods i consumed by socioeconomic group k

P_i = prices of goods i, and

$DISP_k$ = disposable income of socioeconomic group k.

To distinguish between the six household socioeconomic groups, the government and the private companies, we denote C_{ik} as quantity consumed by the households and C_{ig} as quantity consumed by the government. As noted from the SAM, private companies or enterprises do not consume commodities. Therefore consumer demand equations are specified only for households and government. Total consumer demand for good i is the sum of all demands over all socioeconomic groups and government given by:

$$C_i = C_{ig} + \sum_k C_{ik}. \tag{4-7}$$

<u>Investment Demand</u>

The government, private companies, and households decide how income is spent. Prior to any consumption decision made, these institutions decide on the proportion of their income to be saved. Let total saving be denoted by TS. Let Y_k, Y_g, and Y_e denote total income of households, government, and private companies, respectively. TS is equal to domestic plus foreign saving:

$$TS = \sum_k s_k Y_k + s_e Y_e + s_g Y_g + \bar{F} . ER \tag{4-8}$$

where s_k is the marginal propensity to save by households, s_e is the marginal propensity to save by private companies, s_g is the marginal propensity to save by the government, $\bar{F}$ is total foreign savings, and ER is the foreign exchange rate. To explain what happens to total savings withdrawn from the flow of funds, it is assumed that savings is spent on investment goods. It is also assumed that the amount of capital stock in each sector is fixed at the beginning of the period modeled. This implies that investment adds to capacity in future periods. Therefore, the specification of investment demand is only for accounting purposes.

Let $\bar{H}_i$ denote the share of investment going to sector i; ΔK_i denote the real investment in sector i, that is investment measured in physical equivalent unit; and I_i denote the price of capital. Then

$$\bar{H}_i = I_i\ (\Delta K_i/TS). \tag{4-9}$$

Since in this study $\bar{H}_i$ is given exogenously, real invesment is

$$\Delta K_i = \bar{H}_i\ (TS/I_i). \tag{4-10}$$

Because capital in each sector is a fixed-proportion composite commodity, the price of capital I_i, is the weighted average of its parts given by

$$I_i = \sum_j h_{ji}\ P_j \tag{4-11}$$

where h_{ji} are shares in the capital composition matrix and given exogenously. Equations (4-10) and (4-11) reveal that sectoral capital accumulation ΔK_i is determined in part by the price system. It remains to translate the sectoral pattern of capital accumulation into demands for investment goods by sector of origin. Let Z_i denote the total investment demand for good i. Then,

$$Z_i = \sum_j h_{ij}\ \Delta K_j. \tag{4-12}$$

Again, h_{ij} are the shares in the capital composition matrix, i.e., the proportion of capital stock in sector j originating in sector i.

Because h_{ij} and $\bar{H}_i$ are given exogenously, investment demand is completely specified by equations (4-8), (4-10), (4-11), and 4-12). Prices, Z_i, and total saving, TS, are the endogenous variables in these equations.

Import Demand

In the pure theory of international trade a good is either imported or exported, but never both. However, what is often observed in the real world is a two-way trade, even when commodities are classified in an extremely disaggregated form. This is certainly applicable to this study where the commodities are highly aggregated into nine sectors. The second problem with the pure theory of trade is the common assumption that domestically produced goods are perfect substitutes for those sold in the world markets. This perfect substitutability implies "the law of one price," i.e., that the domestic price of a traded good is equal to its world price. But empirical evidence shows that disparities in prices are often observed.

The reality is somewhere between perfect substitutes and perfect complements for traded goods. Or equivalently, for any given level of aggregation, foreign and domestic goods in a given standard industrial trade classification (SITC) are not identical. They may have different prices, and may be characterized by a degree of substitutability that varies across sectors. To resolve these problems, product differentiation by country of origin is introduced following the work by Armington (1969) which was first used in a partial equilibrium framework.

A composite good Q_i is defined for each tradeable where part of it is produced abroad (imports, M_i) and part of it is produced domestically (D_i). M_i and D_i are assumed to be imperfect substitutes and related to each other by the following constant elasticity of substitution (CES) function :

$$Q_i = B_i\left[\delta_i M_i^{-\rho_i} + (1 - \delta_i) D_i^{-\rho_i}\right]^{-1/\rho_i} \qquad (4\text{-}13)$$

where B_i, δ_i, and ρ_i are parameters. Consumers or buyers are assumed to behave rationally by minimizing their cost of consuming a specified amount of the composite good Q_i. The composite good Q_i can be produced using inputs M_i and D_i according to equation (4-13). Therefore, the demand for imports is the solution to the minimization of the following equation (i.e., the cost of consuming the composite good):

$$P_iQ_i = PD_i\, D_i + PM_i\, M_i \qquad (4\text{-}14)$$

subject to equation (4-13), given by

$$(M_i/D_i) = (PD_i/PM_i)^{\sigma_i}(\delta_i/(1 - \delta_i))^{\sigma_i} \qquad (4\text{-}15)$$

where $\sigma_i = 1/(1 + \rho_i)$ is the "trade substitution" elasticity and PD_i, and PM_i are prices of domestic and imported goods, respectively (see Henderson and Quandt, 1980, for the derivation of the above equations). Equation (4-15) reflects the responsiveness of domestic demand to changes in relative prices of imported goods which could be brought about by trade and exchange-rate policy or any exogenous event. The sensitivity of the response depends on the magnitude of σ_i. PM_i is linked to the world price by the following equation:

$$PM_i = \overline{PW}_i(1 + tm_i)ER \qquad (4\text{-}16)$$

where tm_i is import tariff and $\overline{PW}_i$ is the exogenously given world price and conforms to the price-taker assumption.

As with the previous equations, the value of all parameters need to be determined. σ_i generally will be supplied exogenously by adopting results from previous studies. Sometimes, a lower and upper bound of σ_i can be used. Results from previous research is used for the present study.

With the values for σ_i, the ρ_i are calculated from $\sigma_i = 1/(1 + \rho_i)$. The method of calibration is used to obtain values for the B_i and δ_i parameters (the calibration technique, its justification, its advantages and disadvantages are discussed in chapter II). Consider equation (4-15). If the values of M_i, D_i, PD_i, and PM_i are known, then the δ_i can be determined.

In the calibration method, these values are usually obtained from the base period SAM. Using information available in the base year SAM, equation (4-13) can be solved for B_i. Import demand is now completely specified by equations (4-13), (4-14), (4-15), and (4-16). Endogenous variables are the Q_i composite goods, M_i imported goods, D_i domestic goods, PD_i prices of domestic goods, and PM_i prices of imported goods.

Export Demand

The small-country assumption is consistent with a perfectly elastic import demand. Product differentiation is still generally compatible with the small-country assumption. But when a country is selling a differentiated product, the demand for exports produced in a particular country generally will be less than infinitely elastic. This implies that export prices are no longer fixed. This is particularly true for less developed countries like Indonesia. While Indonesia may not be able to affect the world market price with its exports, it may show a declining market share as its domestic prices increase.

Let PWE_i denote the world "dollar" price of exports, and let Λ_i denote an "aggregate" world price for a product in commodity group i which reflects a weighted average of production costs and trade policies in all countries. The above discussion leads us to the following general form for export demand:

$$E_i = E_i(\Lambda_i, PWE_i). \tag{4-17}$$

The fact that a country is small leads to the treatment of Λ_i as exogenously fixed. But PWE_i is endogenously determined by domestic costs, export incentives, and exchange rate policy. Hence, the "dollar" export price is:

$$PWE_i = PD_i/[(1 + te_i)ER] \tag{4-18}$$

where te_i is the rate of export subsidy.

Equation (4-18) shows that an increase in domestic production costs increases PD_i and leads to an increase in the dollar price of exports, PWE_i. An increase in export subsidy or a devaluation of the exchange rate ER, leads to a decrease in PWE_i. A further postulate is that a decrease in PWE_i with constant Λ_i, leads to an increase in the demand for exports from sector i. If the whole world behaves as a single country consuming products according to the rule of cost minimization subject to a generalized CES formulation that specifies composite world commodities, export demand is given by:

$$E_i = E_o(\Lambda_i/PWE_i)^{\eta_i} \tag{4-19}$$

where η_i is the price elasticity of export demand and E_o is a constant term reflecting total world demand for commodity group i and the country's market share when $\Lambda_i = PWE_i$.

The next step is to specify the parameters of equation (4-19), i.e., η_i, Eo, and Λ_i. Estimation of the second parameter E_o is straight forward by assuming total export of each commodity is equal to the base year SAM. Λ_i is estimated as the domestic price times (1 + export tax) and divided by the exchange rate, all for the base year SAM. The parameter η_i is adopted from previous studies. Given all these parameters, the export demand is now completely specified and represented by equations (4-18) and (4-19). There are three endogenous variables: (1) export demand for commodity i, E_i; (2) the world dollar price of exports, PWE_i; and (3) the domestic price of commodity i, PD_i.

Domestic Commodity Supply and Factor Demand

Domestic commodity supply and demand for factors are derived based on classical theory of the firm. A firm is defined as a technical unit in which commodities are produced. Owners or managers decide how much to produce. In the process of production, inputs (factors) are transformed into outputs subject to technical constraints specified by the production function. The difference between revenues from sales of the output and the cost of factors is profit. It is this profit that is maximized in the production decision. Discussion begins with the production function.

Production Function

Sectoral outputs are related to inputs according to the following two-level production function

$$X_i = f_i(A_i, K_i, L_i^a, V_i^a) \tag{4-20}$$

where X_i = sectoral output or domestically produced goods,

A_i = a shift parameter that dynamically reflects disembodied technical progress,

K_i = the stock of aggregate capital goods and is assumed fixed by sector,

L_i^a = an aggregation of labor inputs, and

V_i^a = an aggregation of intermediate inputs.

The parameter A_i is constant within a period and depends on the units in which outputs and inputs are measured. The sectoral capital stock K_i is assumed fixed within each period. A unit of sectoral capital stock is assumed to consist of proportions of different investment goods, with the proportion varying among sectors.

The production function is called two-level production function because one of the variables, i.e., labor is assumed to be an aggregation of different skill categories (see Chapter III) which follow a specific functional form. Let m denote the number of different skill categories, hence, in general form, aggregate labor is given by,

$$L_i^a = L_i^a(L_{i1}, \dots, L_{im}). \tag{4-21}$$

Given the level of aggregation in most CGE modeling, production functions are only a rough representation of the actual technical production process. However, if carefully chosen, the production function should not seriously distort representation of the underlying technology. The production function should be able to support the degree of substitutability between factors. Traditionally, CES or Cobb-Douglass type production functions are used in CGE modeling. In this study, the Cobb-Douglass production function is used and is represented as:

$$X_i = A_i \prod_s L_{is}^{\alpha_{is}} K_i^{\alpha_i^*} \tag{4-22}$$

where s = labor skill and $\alpha_i^* = 1 - \sum_s \alpha_{is}$.

Notice that A_i is a combination of the shift parameters contained in equations (4-20) and (4-21). Also, equation (4-22) has the Cobb-Douglass specification of (4-21). Because intermediate goods, V_i, are represented by fixed coeficients there is no need to incorporate them into equation (4-22). This is discussed in a later section.

For equation (4-22) to be completely specified, all parameters must be estimated. Again calibration technique is used but because this technique requires the results from first order conditions, it is treated in the next subsection.

Demand for Labor

Each sector in the economy is treated as one large firm facing perfectly competitive product markets. In the process of production the firm uses intermediate inputs where some are imported and some are produced domestically, i.e., intermediate inputs are composite goods. The aggregate wage rate paid by a sector varies because of different proportions of skills used. Notice that wages paid by each sector for a certain category of labor is not the same. It is assumed that the base year data reflects the constant wage proportionality, i.e., the proportion of the average wage earned by labor with skill category s who works in sector i remains constant. Let this be denoted by ω_{is}. Therefore, the aggregate sectoral profit functions can be written as,

$$\Pi_i = PD_i\, X_i - t_{ij}\, PD_i X_i - \sum_j P_j\, a_{ji}\, X_i - \sum_s \omega_{is} W_s\, L_{is}. \qquad (4\text{-}23)$$

Note that $a_{ji}X_i$ is the intermediate input X_j required in production of X_i. Using this information, the profit equation is rewritten as follows,

$$\Pi_i = PN_i\, X_i - \sum_s \omega_{is} W_s\, L_{is} \qquad (4\text{-}24)$$

where

$$PN_i = PD_i(1 - t_{ij}) - \sum_j P_j\, a_{ji} \qquad (4\text{-}25)$$

or the net price, PN_i, is the per unit value-added coeficient net of indirect tax t_{ij}. W_s is the wage rate for labor of type s, and a_{ij} are the input-output coeficients. The labor demands are derived demands which are the solutions to profit maximization given by,

$$PN_i\, (\partial X_i/\partial L_{is}) = \omega_{is} W_s \qquad (4\text{-}26)$$

or specifically,

$$PN_i\, (\alpha_{is}/L_{is})\, X_i = \omega_{is} W_s. \qquad (4\text{-}27)$$

Equation (4-27) implicitly defines the demand for labor of skill s by sector i. Notice that the supply of goods X_i is implicitly defined by both equations (4-22) and (4-27).

The base year SAM contains information on the value of X_i, L_{is}, K_i, W_s, ω_{is}, and PN_i. Substituting this information into equation (4-27) α_{is} is solved. Knowing α_{is}, together with other values from the SAM, equation (4-22) is solved for A_i. Therefore, supply functions for X_i, and demand functions for labor inputs L_{is} are completely specified.

Intermediate Demand

Intermediate input demand is determined assuming the Leontief input-output technology. This implies no need to specify a separate aggregate function to define intermediate demand. Since input-output coefficients are readily available from the SAM, intermediate demand for sector i is completely specified by,

$$V_i = \sum_j a_{ij} X_j \qquad (4\text{-}28)$$

where the a_{ij} are input-output coefficients.

Income Formation

In the derivation of comsumer demand, income is an argument in the function, but so far income formation has not been explained. Each household group in the SAM receives payment from factors used in production. The SAM also reveals that each household group receives transfer payments from other institutions and from abroad. It is reasonable to assume that, in general, transfer payments do not depend on prices and other endogenous variables. In other words, transfer payments are assumed to be exogenously determined. This implies that each of the six household groups own and supply the first four factors which generate income by using those factors in the production sectors. It is also assumed that households own shares of capital used in production processes, denoted by θ_k. The proportion of labor in category s originating from household group k is assumed to be constant and denoted by φ_{ks}. TR_k denotes total trasfers to household group k. Income formation for household group k is then given by,

$$Y_k = \theta_k \, RVA + TR_k + \sum_s \varphi_{ks} \sum_i \omega_{is} W_s L_{is} \qquad (4\text{-}29)$$

where Y_k (k = 1, 9) represents the total income received by group k, and RVA is the residual value added accruing to capital and is defined in the following equation. Other variables are as previously defined. Transfer payments are modeled by incorporating exogenous variables representing each transfer.

Private companies receive a large portion of the return accruing to capital i.e., residual value added, plus some transfers. Let these transfers be denoted by TR_e, and the private companies' share of residual value added be denoted by κ, then private companies' income is

$$Y_e = TR_e + \kappa * RVA \qquad (4\text{-}30)$$

where,

$$RVA = \sum_i (PN_i X_i - \sum_s \omega_{is} W_s L_{is}).$$

The rest of the variables are as previously defined.

Government revenue or income is through direct and indirect taxes and transfer payments. This is represented by,

$$Y_g = \sum_k td_k Y_k + tc\ RVA + tp\ Y_e$$

$$+ \sum_i tm_i PW_i M_i + \sum_i ti_i\ PD_i\ X_i + TR_g \qquad (4 - 31)$$

where td_k is the direct tax on household income, tc is the direct tax on residual value added, tp is the direct tax on private companies income, tm_i is the import tariff, ti_i is the indirect tax on domestic production, and TR_g represents transfers to the government.

Equilibrium of Markets and the Price Level

To complete the model, it remains to specify balance-of-payments equilibrium, labor market equilibrium, product market equilibrium, and the price level. Discussion begins with the balance-of-payments.

Balance-of-payments Equilibrium

Indonesia has an open economy. For an open economy model to be completely specified, the current and capital accounts are used to define the balance-of payments equilibrium. The equation is given by,

$$\sum_i \overline{PW}_i\ M_i - \sum_i PWE_i\ E_i - F = 0 \qquad (4\text{-}31)$$

where F is the endogenously determined value of net foreign resource flows, and the other variables are as previously defined. $\overline{PW}_i$ is obtained from the base SAM data. The other four variables are determined endogeously in the system.

Labor Market Equilibrium

Total labor demanded is equal to total labor supplied which is given exogenously for the static CGE model. Let $\bar{L}_s$ denote total labor supplied in skill s, then the following represents equilibrium in the labor markets:

$$\sum_i L_{is} - \bar{L}_s = 0 \tag{4-33}$$

Product Market Equilibrium

Market demand includes intermediate input demand, consumer demand, investment demand, import demand, and export demand. The first three are composite goods made up of domestically produced and imported goods. The composite goods are expressed as,

$$Q_i = V_i + C_i + Z_i. \tag{4-34}$$

Part of the composite goods are supplied domestically and part are supplied from abroad which is governed by equation (4-13). Therefore, equation (4-34) can be thought of as composite goods identity equation.

It also holds that part of the domestic output, X_i, is exported, i.e., export demand is for the domestically produced goods rather than for the composite goods. Hence total demand for domestically produced goods is equal to (D_i + E_i), which leads to the following equilibrium condition for domestically produced goods,

$$(D_i + E_i) - X_i = 0. \tag{4-35}$$

Equation (4-35) states that sectoral excess demands are equal to zero.

Results of the CGE model now have the same number of equations as the number of variables. But following Walras's law, the excess demand equations are not independent which is equivalent to saying that if vector of prices P is a solution to the model, then λP for any $\lambda > 0$ also is a solution. To avoid this non-uniqueness in the solution, price-normalization is introduced to close the system.

Price Level

Price-normalization is commonly employed to provide a "no-inflation" benchmark against which all price changes are measured as relative changes. The equation is given by,

$$\sum_{i} P_i \Omega_i = \bar{P} \qquad (4\text{-}36)$$

where $\bar{P}$ is the price-level, and Ω_i are the weights in the price index which is given exogenously for a base period.

To conclude the chapter, the complete set of equations together with the description of the endogenous and exogenous variables and the list of parameters are given in Tables IX, X, XI, XII.

TABLE IX

THE COMPLETE LIST OF EQUATIONS IN THE CGE MODEL OF THE INDONESIA ECONOMY

Description	Number of equations	Equation number
Consumer Demand		
$C_{ik} = \gamma_{ik} + (\beta_{ik}/P_i)(DISP_k - \sum_j P_j\gamma_{jk})$	9x6	(4-2)
$C_{ig} = \gamma_{ig} + (\beta_{ig}/P_i)(DISP_g - \sum_j P_j\gamma_{jg})$	9	
$C_i = C_{ig} + \sum_k C_{ik}$	9	(4-7)
Investment Demand		
$TS = \sum_k s_kY_k + s_eY_e + s_gY_g + F \,.\, ER$	1	(4-8)
$\Delta K_i = \bar{H}_i\,(TS/I_i)$	9	(4-10)
$I_i = \sum_j h_{ji}\,P_j$	9	(4-11)
$Z_i = \sum_j h_{ij}\,\Delta K_j$	9	(4-12)
Import Demand		
$Q_i = B_i\left[\delta_i M_i^{-\rho_i} + (1 - \delta_i) D_i^{-\rho_i}\right]^{-1/\rho_i}$	9	(4-13)
$P_iQ_i = PD_i\,D_i + PM_i\,M_i$	9	(4-14)
$(M_i/D_i) = (PD_i/PM_i)^{\sigma_i}(\delta_i/(1 - \delta_i))^{\sigma_i}$	9	(4-15)
$PM_i = \overline{PW}_i(1 + tm_i)ER$	9	(4-16)

TABLE IX (Continued)

Description	Number of equations	Equation number
Export Demand		
$PWE_i = PD_i/[(1 + te_i)ER]$	9	(4-18)
$E_i = E_O(\Lambda_i/PWE_i)^{\eta i}$	9	(4-19)
Production Function		
$X_i = A_i \prod_s L_{is}^{\alpha is} K_i^{\alpha^*}$	9	(4-22)
Demand for Labor		
$PN_i = PD_i(1 - td_i) - \sum_j P_j a_{ji}$	9	(4-25)
$PN_i (\alpha_{is}/L_{is}) X_i = \omega_{is} W_s$	9x4	(4-27)
Intermediate Demand		
$V_i = \sum_j a_{ij} X_j$	9	(4-28)
Income Equations		
$Y_k = \theta_k RVA + TR_k + \sum_s \varphi_{ks} \sum_i \omega_{is} W_s L_{is}$	6	(4-29)
$Y_e = TR_e + \kappa^* RVA$	1	(4-30)
$RVA = \sum_i (PN_i X_i - \sum_s \omega_{is} W_s L_{is})$	1	

TABLE IX (Continued)

Description	Number of equations	Equation number
$Y_g = \sum_k td_k Y_k + tc\ RVA + tp\ Y_e$		
$+ \sum_i tm_i PW_i M_i + \sum_i ti_i\ PD_i\ X_i + TR_g$	1	(4 - 31)
Balance-of-payment		
$\sum_i \overline{PW}_i\ M_i - \sum_i PWE_i\ E_i - F = 0$	1	(4-32)
Labor Market Equilibrium		
$\sum_i L_{is} - \overline{L}_s = 0$	4	(4-33)
Composite Good Identity		
$Q_i = V_i + C_i + Z_i$	9	(4-34)
Product Market Equilibrium		
$(D_i + E_i) - X_i = 0$	9	(4-35)
Price-level Equation		
$\sum_i P_i\ \Omega_i = \overline{P}$	1	(4-36)
Total number of equations:	250	

TABLE X

LIST OF ALL ENDOGENOUS VARIABLES IN THE CGE MODEL OF THE INDONESIA ECONOMY

Symbol	Descriptions	Number
C_{ik}	Consumer demand by household group	9x6
C_{ig}	Government consumption	9
C_i	Aggregate consumption demand of good i	9
TS	Total saving	1
I_i	Capital good price	9
ΔK_i	Real investment by sector of destination	9
Z_i	Investment good demand by sector of origin	9
P_i	Price of composite goods	9
Q_i	Composite goods	9
PD_i	Price of domestically produced goods	9
PM_i	Price of imported good	9
M_i	Imported goods	9
D_i	Domestically produced goods	9
PWE_i	Dollar price of domestic goods	9
E_i	Exported goods	9
X_i	Domestic output or sectoral production	9
L_{is}	Labor demanded of category s by sector i	9x4
W_s	Wage of labor by category	4
V_i	Aggregate intermediate input demanded	9

TABLE X (Continued)

Symbol	Description	Number
PN_i	Net prices	9
Y_k	Household income	9
Y_g	Government income	1
Y_e	Enterpreneur income	1
F	Foreign savings	1
RVA	Payment to capital	1
Total number of endogenous variables:		249

TABLE XI

LIST OF ALL EXOGENOUS VARIABLES IN THE CGE MODEL OF THE INDONESIA ECONOMY

Symbol	Description	Number
$\bar{H}$	Share of investment going to sector i	9
ER	Exchange rate	1
$\overline{PW}_i$	World price of imports	9
E_{oi}	Total world demand	9
K_i	Capital stock	9
TR_k	Transfer to household	6
TR_e	Transfer to private companies	1
TR_g	Transfer to government	1
$\bar{L}$	Labor supply by labor category	4
$\bar{P}$	Inflation level	1
tm_i	Tariff rate	9
te_i	Export subsidy	9
Λ_i	Aggregate world export price	9

TABLE XII

LIST OF ALL PARAMETERS IN THE CGE MODEL OF THE INDONESIA ECONOMY

Symbol	Description	Number
γ_{ik}	Subsistence minima for household	9x6
γ_{ig}	Subsistence minima for government	9
β_{ik}	Budget shares for household	9x6
β_{ig}	Budget shares for government	9
s_k	Marginal propensity to save by households	6
s_g	Marginal propensity to save by government	1
s_e	Marginal propensity to save by private companies	1
h_{ij}	Shares in the capital composition matrix	9x9
δ_i	Share parameter of the CES	9
B_i	Shift parameter of the CES	9
ρ_i	Parameter of the CES	9
σ_i	Trade substitution elasticities	9
η_i	Export demand elasticities	9
α_{is}	Share parameter of the production function	9x4
α_i^*	Share parameter of the production function	9
a_{ij}	Input-output coefficients	9x9
ω_{is}	Wage proportionality factor	9x4
θ_k	Household share of capital	6
A_i	Shift parameter of the production function	9
φ_{ks}	Proportion of labor owned by household	6x4
κ	Private companies share of residual value added	1

TABLE XII (Continued)

Symbol	Description	Number
Ω_i	Weights in the price level equation	9
td_k	Direct taxes on households	6
tc	Direct tax on capital	1
tp	Direct tax on private companies	1
ti_i	Indirect taxes on domestic production	9

CHAPTER V

DATA AND PROGRAMMING

Complete specification of the computable general equilibrium model requires that all parameters have to be determined. Some of the parameters are generated from the base year SAM. Other parameters require data not contained in the base period SAM. This chapter presents those data sources and method of estimation. The chapter is organized in parallel fashion to chapter IV where the model was presented. In the last section of the chapter, implementation of the model using GAMS is presented.

Data for Commodity Demand

Consumer Demand

A simplified variation of the linear expenditure system (LES) described in chapter IV is adopted. Consumer demand is derived from maximization of the utility function

$$U_k = \sum_i \beta_{ik} \ln C_{ik} \tag{5-1}$$

subject to household disposable income, $DISP_k$. The β_{ik} are budget shares that determine the allocation of after tax and after saving income. C_{ik} is the level of consumption of good i by household k. The result is the linear expenditure system given by the following equation:

$$C_{ik} = (\beta_{ik}/P_i)\ DISP_k. \tag{5-2}$$

In the above specification, the cross price elasticities are zero (i.e., want independence assumption). However, cross price effects can still be captured indirectly through income. With highly aggregated sectors, the above system is expected to behave similar to the original specification described in chapter IV.

Equation (5-2) contains only one set of parameters, i.e., the β_{ik}. These parameters are obtained from the base period SAM by first combining domestic commodities and imports thus yielding total household consumption. The share parameters are derived by dividing household disposable income by commodity consumption. The budget shares are presented in Table XIII.

Investment Demand

Four equations determine investment demand, i.e., total saving, total real investment, price of capital, and investment demand composition (equations 4-8, 4-10, 4-11, and 4-12). Equation (4-8) contains the parameters s_k, s_e, and s_g. These parameters, the marginal propensities to save by households, private companies, and government are described in Table V.

Equation (4-10) and (4-11) contain parameters H_i and h_{ij} which are not available for Indonesia. However, the base period SAM provides information on sectoral capital goods (column 41). Let c_i denote the proportion of domestic investment spent on good i (see Table XIV). With this information, a modification of the investment demand is adopted given by

$$Z_i = c_i\ TS/P_i. \tag{5-3}$$

TABLE XIII

HOUSEHOLD AND GOVERNMENT BUDGET SHARES FOR INDONESIA, 1980

	Household						
Commodity	Agric. laborers	Agric. operators	Non-agric. rural-low	Non-Agric. rural-high	Non-agric. urban-low	Non-Agric. urban-high	Government
Food crops	.31346	.24479	.18110	.12916	.10242	.04251	.00000
Non-food crops	.07088	.04597	.03587	.02120	.01867	.01261	.00228
Livestocks	.04084	.04457	.03405	.04463	.04429	.05373	.00000
Forestry	.02629	.01450	.00902	.00506	.00256	.00075	.00000
Fisheries	.04609	.04316	.04422	.04954	.04368	.03808	.00000
Food processing	.38215	.27696	.27955	.26799	.21087	.19278	.00079
Mining	.00361	.00320	.00224	.00207	.00172	.00154	.00000
Manufacturing	.04256	.12155	.14718	.18630	.16490	.18990	.11110
CONSTSERV	.07412	.20531	.26676	.29426	.41088	.46811	.88583

With this modification, investment demand is completely specified by equations (5-3) where the only parameter involved (c_i) is determined (Table XIV).

TABLE XIV

COMPOSITION OF DOMESTIC INVESTMENT
BY COMMODITY

Commodity	c_i
Food crops	0.00999
Non-food crops	0.00464
Livestock	0.00862
Forestry	0.00048
Fisheries	0.00000
Food processing	0.00220
Mining	0.07594
Manufacturing	0.31830
CONSTSERV	0.57983

Import Demand

Import demand is represented by equations (4-13), (4-14), (4-15), and (4-16). Equation (4-14) does not have any parameters. Equation (4-13) and (4-15) have four parameters to be estimated, i.e., B_i, δ_i, ρ_i, and σ_i. ρ_i is related to σ_i from the identity $\sigma_i = 1/(1+ \rho_i)$. σ_i, the "trade substitution" elasticity, is not available for Indonesia. However, what is important is the degree of product homogeneity or product differentiation. For instance, agriculturally related commodities are relatively more homogenous than manufacturing commodities. The least homogeneous commodity is CONSTSERV. The elasticities are adopted from Dervis et. al. (1985) which represent the Turkey study (Table XV). The higher figures are three times larger than the lower values.

TABLE XV

TRADE SUBSTITUTION ELASTICITIES
BY COMMODITY

Commodity	Trade substitution elasticity low	high
Food crops	2.00	6.00
Non-food crops	2.00	6.00
Livestock	2.00	6.00
Forestry	2.00	6.00
Fisheries	2.00	6.00
Food processing	2.00	6.00
Mining	1.50	4.50
Manufacturing	0.75	2.25
CONSTSERV	0.25	0.75

Source: Dervis et. al. (1985)

Given σ_i, δ_i are computed from equation (4-15) by assuming the base period values for M_i and D_i and by setting the values of PD_i and PM_i equal to one. Choosing the values of prices to be unity does not affect the analysis since interest is with respect to changes relative to the base period. To compute B_i, Q_i must be known. Q_i is obtained from equation (4-14) by setting all prices to unity and again assuming the values of M_i and D_i for the base period. Equation (4-13) is used to solve for B_i. The actual computations are implemented in the program (see Appendix B).

The last parameters to be estimated are $\overline{PW}_i$ and tm_i in equation (4-16). The tm_i are obtained from the base period SAM, row 42, columns 32 to 40. Each tm_i is computed by dividing the import tax by the corresponding commodity imports. These data are presented in Table XVI. $\overline{PW}_i$ is computed from equation (4-16) by setting the values of PM_i and ER equal to unity.

TABLE XVI

COMMODITY TARIFF RATE ON IMPORTS, 1980

Commodity	Rate (%)
Food crops	7.73
Non-food crops	3.66
Livestock	15.43
Forestry	20.83
Fisheries	33.33
Food processing	-11.06
Mining	0.23
Manufacturing	-0.39
CONSTSERV	0.13

Export demand

Export demand is represented by equations (4-18) and (4-19). Four parameters have to be estimated, i.e., te_i, E_o, Λ_i, and η_i. There are no explicit export subsidies imposed on any of the commodities, hence the te_i are zero. From equation (4-19) E_o is equal to E_i when $\Lambda_i = PWE_i$. Because in the base period Λ_i is set equal to PWE_i, E_o is total exports in the base period (column 43, rows 23 to 31 of the SAM). The last parameters, η_i, are adopted from Dervis et. al. (1985) and given in Table XVII using two different values for each commodity.

TABLE XVII

COMMODITY EXPORT DEMAND ELASTICITIES

	Elasticity	
Commodity	Low	High
Food crops	2.0	4.0
Non-food crops	2.0	4.0
Livestock	2.0	4.0
Forestry	2.0	4.0
Fisheries	2.0	4.0
Food processing	2.0	4.0
Mining	3.0	6.0
Manufacturing	2.0	4.0
CONSTSERV	2.0	4.0

Data for Domestic Commodity Supply and Factor Demand

The share parameters (α_{is}) in the production function (equation 4-22) are obtained from equation (4-27) by setting all variables to their base period values. For instance, the base value of PN_i is given by equation (4-25) where a_{ji} is the input-output coefficient given in Table VI, ti_i is the indirect taxes given in Table XVIII (from row 42, columns 23 to 31 of the SAM), and PD_i is the unit price.

TABLE XVIII

COMMODITY INDIRECT TAXES MINUS SUBSIDIES, 1980

Commodity	Tax rate
Food crops	0.00498
Non-food crops	0.00729
Livestock	0.00413
Forestry	0.00612
Fisheries	0.00435
Food processing	0.03360
Mining	0.00415
Manufacturing	-0.03877
CONSTSERV	0.01890

X_i is total domestic output for the base period as given in Table VII. L_{is} is labor of skill s used in sector i and is obtained from the Indonesian SAM data book. The data are presented in Table II. ω_{is} is the wage proportionality factor and is obtained from the average wage received by labor of skill s from each sector divided by the average labor wage over all sectors. These data are presented in Tables XIX and XX.

TABLE XIX

SECTORAL WAGE PROPORTIONALITY FACTORS

Sector	Agric. laborers	Prod. workers	Sales & services	Proff. & management
Food crops	0.88335	0.59689	0.52954	0.36281
Non-food crops	1.39300	0.71740	0.77797	0.69646

TABLE XIX (Continued)

Sector	Agric. laborers	Prod. workers	Sales & services	Proff. & management
Livestock	1.26136	1.11884	1.57920	1.21663
Forestry	2.25143	1.01826	1.24883	0.58258
Fisheries	1.73035	0.64169	0.65170	0.45504
Food processing	0.00000	0.73077	1.13783	0.55519
Mining	0.00000	1.41179	5.45386	3.68898
Manufacturing	0.00000	0.80276	1.39555	1.56154
CONSTSERV	0.00000	1.10174	0.98139	0.97644

TABLE XX

AVERAGE LABOR WAGE OVER ALL SECTORS (1000 Rupiah)

Labor category	Average wage
Agricultural laborers	199.25893
Production workers	350.63830
Sales and services	425.16925
Professionals and management	1074.39423

The share parameters are substituted into equation (4-22) to solve for the shift parameter A_i. However, capital stock in the base period must first be deremined. The values in row 5, columns 14 to 22 of the SAM are regarded as the flow of domestic capital services in the base period, which when multiplied by the annual rate of return to capital produces the level of capital stock.

Because the rate of return to capital is assumed the same for all sectors of the economy, the base period capital stock by sector is a fixed multiple of the capital services. Therefore, capital services is used as a surrogate for capital stock (Table XXI).

TABLE XXI

SECTORAL CAPITAL STOCK REPRESENTED BY CAPITAL SERVICES (BILLION RUPIAH)

Sector	Capital services
Food crops	2,201.01
Non-food crops	1,563.93
Livestock	892.44
Forestry	1,155.44
Fisheries	497.47
Food processing	1,016.91
Mining	12,084.11
Manufacturing	2,416.11
CONSTSERV	8,148.75

Finally, the parameters representing intermediate input demands (equation 4-28), a_{ji}, are the input-output coefficients given in Table VI.

Data for Income Formation

Household income (equation 4-29) contains several parameters to be estimated. θ_k, the capital shares owned by households, are computed from column 5 of the SAM and presented in Table XXII.

TABLE XXII

CAPITAL SHARES BY HOUSEHOLD CATEGORY

Household category	Share
Agricultural laborers	0.00544
Agricultural operators	0.19875
Rural non-agricultural low income	0.04334
Rural non-agricultural high income	0.00905
Urban low income	0.05073
Urban high income	0.02339

The φ_{ks}, the proportion of labor of skill s originating from household category k, are calculated from rows 6 to 11, columns 1 to 4 of the SAM and are presented in Table XXIII. The wage proportionality factors, ω_{is} are provided in Table XIX. TR_k, the total transfer to household k, is the summation of all data in columns 6 through 13, and column 43 of the SAM, for each household row category (rows 6 to 11).

TABLE XXIII

PROPORTION OF LABOR SKILL OWNED BY HOUSEHOLD CATEGORY

Household category	Labor skill			
	Agric. laborers	Prod. workers	Sales & services	Proff. & management
Agric. laborers	0.19640	0.03337	0.02019	0.01587
Agric. operators	0.74692	0.09108	0.06820	0.03534
Rural Non-agric. low income	0.04257	0.41381	0.24757	0.06424
Rural non-agric. high income	0.00861	0.02840	0.08830	0.32135
Urban low income	0.00424	0.39340	0.34755	0.09667
Urban high income	0.00126	0.03993	0.22820	0.46654

Two parameters in the private companies income formation are κ and TR_e. κ = 0.58535 and is the private companies share of the residual value added. It is the value in row 12 column 5 of the SAM divided by the value in row 45 column 5. TR_e, the total transfers to private companies of 343.43 billion rupiah is the sum of the values in row 12 column 12 and row 12 column 43 of the SAM.

There are five parameters to be determined in the government revenue equation (4-31). td_k, the direct tax by household category, is obtained by dividing its row 13 entries from the SAM for columns 6 to 11 by the total income formation given in row 45. These results are presented in Table XXIV.

TABLE XXIV

DIRECT TAX RATE BY HOUSEHOLD CATEGORY

Household category	Tax rate
Agricultural laborers	0.02130
Agricultural operators	0.02010
Rural non-agricultural low income	0.01827
Rural non-agricultural high income	0.01901
Urban low income	0.02495
Urban high income	0.03375

The direct tax on residual value added, tc = 0.00412, is obtained by dividing row 13 column 5 of the SAM by the total of column 5 (row 45). The direct tax on private companies, tp = 0.43645, is obtained by dividing row 13 column 12 of the SAM by the total of column 12 (row 45). tm_i, the tariff rates on imports are the same as those presented inTable XVI.

Data for Price Level and Market Equilibriums

The net foreign resource flow (capital flight), F, is not treated separately, but it is included in the accounts of the institutions. Total labor supplied by each labor skill (equation 4-33) is from Table II. The price level P in equation (4-36) is set to unity and the weights used, Ω_i, are the commodity shares in the value of domestic production. The results are presented in Table XXV.

TABLE XXV

COMMODITY PRICE INDEX WEIGHTS

Commodity	Weight
Food crops	0.10251
Non-food crops	0.04981
Livestock	0.02622
Forestry	0.02674
Fisheries	0.01774
Food processing	0.08636
Mining	0.16771
Manufacturing	0.15636
CONSTSERV	0.36655

Solution Algorithm

In the previous sections the parameters were estimated, resulting in a completely specified set of equations that model the economy. In this section, the solution algorithm is explained. The optimization route is pursued using the GAMS (General Algebraic Modeling System) software.

Like other programming languages, GAMS is a software that can be used to solve problems, in particular, linear, non-linear, and mixed integer programming problems. GAMS by itself does not have solvers. It calls existing programming packages (like MINOS, ZOOM, etc.) to do the solution (see Brooke, et. al., pp. 105 for the list of solvers available to GAMS). However, it enables programmers, especially economists, to write programming problems in a manner easy to read, write, and understand. The complete program is presented in Appendix B.

The first part of the GAMS program is definition of identifier sets. In mathematical programming, indexes are usually defined as sets. For example, in line 13 of the program listing (Appendix B), identifier I is the elements of the set defined as sectors (SECTOR1 to SECTOR9). Likewise, LC, and HH (lines 24 and 30) are defined as sets with their corresponding elements. LC is a set of labor skills and HH is a set of household categories. Any other identifier that assumes the same elements of a set is defined using the command ALIAS. For instance, in line 38, the identifier IST assumes the same set as HH.

The next step is to declare all parameters in the model. Parameter identifiers assume constant values during the execution of the program. Parameters can be associated with exogenous variables as in a regular mathematical programming problem. Parameter declaration begins with a keyword PARAMETER. For instance, DELTA(I) is defined to be a parameter which holds nine values, one for each value of I (sectors). All parameters are declared in lines 46 to 94. Scalars are parameters which hold single values. Scalars are declared in lines 97 to 106, beginning with a keyword SCALAR in line 96. Another convenient way to represent parameters is by using the command TABLE. A TABLE is two dimensional set of parameters. For example, line 108 declares INTDMD(I,HH) as a two dimensional parameter set containing the intermediate input demand data.

The assignment of a value to a parameter is done with a declaration or assignment statement. However, once the value is assigned, it remains the same during the execution of the program. All statements in lines 206 through 310 are assignments of values to parameters. Some values of parameters are assigned early in the declaration. For example, YLABORO is assigned its value in line 87 when it is declared. Since calibration is in essence an assignment of values to parameters, it is placed in the parameter part of the program (lines 291 through 310).

The common way to define endogenous variables in GAMS is by declaring them with the keyword VARIABLES (see line 318), followed by the list of all endogenous variables in the model. For example, price of the composite good P_i is declared in this section as P(I) and assumes nine values each corresponding to good I. A variable is an identifier where its value can be changed during the execution of the program. A special feature of GAMS is that an exogenous variable can be declared "variable", however its value has to be fixed during initialization. For instance, exchange rate, ER, is declared to be "variable" (line 353) but later in line 502, its value is fixed. This is a convenient way to declare all policy variables. A simulation with different values of policy variables is implemented by changing the line where the value of the variables is fixed before running the program.

Each equation in the model has to be named and declared followed by its specification. It was decided to name all equations in the Indonesia CGE model according to their number in the text. For instance, the consumer demand system declared in line 374 was named EQ5020(I, HH). This declaration states that there are 36 equations of this type, one for each household and commodity. Later in line 420, this equation is specified according to its definition in the text. In line 415, one extra equation is declared, OBJ, to accomodate the objective function. This is necessary because the maximization algorithm is used to solve the system of equations where all other equations are treated as constraints.

In non-linear programming, it is necessary to set all endogenous variables at a starting point for the algorithm from which a search is performed to find the optimal values. It is common practice to set the initial values equal to the base period values as seen in lines 482 through 492. The values of exogenous variables which are declared to be "variables" are also fixed. This is done in lines 510 through 516.

Listing the equations in lines 420 through 477 does not automatically imply that the GAMS would consider them. A MODEL statement (line 514) is needed to determine which equations are to be included in a particular model. This gives a degree of flexibility to the programmer to change models without changing equations.

The last statement in the program, the SOLVE statement (line 518), tells the GAMS compiler to proceed and solve the model. In this case, it is to solve the model named INDCGE by maximizing the objective equation named UTILITY, using the non-linear algorithm signified by the keyword NLP.

The first solution to the model which replicates the base year SAM can be found in the program listing presented in Appendix B. Some values of endogenous variables in contrast to their base year SAM counterparts are described in Table XXVI. It can be observed that all production levels and household incomes in this solution are identical to their corresponding values in the SAM. All commodity prices are also unity as the prices in the base period were set equal to unity. With these results, it appears that the model is completely and correctly specified and should be ready to implement the various experiments.

TABLE XXVI

COMPARISON BETWEEN CGE SOLUTION AND THE BASE SAM FOR SOME ENDOGENOUS VARIABLES

Endogenous variables	Base SAM	CGE Solution
Price of domestically produced good:		
1. Food crops	1.0000	1.0000
2. Non-food crops	1.0000	1.0000
3. Livestock	1.0000	1.0000
4. Forestry	1.0000	1.0000
5. Fisheries	1.0000	1.0000
6. Food processing	1.0000	1.0000
7. Mining	1.0000	1.0000
8. Manufacturing	1.0000	1.0000
9. CONSTSERV	1.0000	1.0000
Domestic output by sector (billion rupiah):		
1. Food crops	87.7214	87.7214
2. Non-food crops	42.6245	42.6245
3. Livestock	22.4399	22.4399
4. Forestry	22.8835	22.8835
5. Fisheries	15.1835	15.1835
6. Food processing	73.8987	73.8987
7. Mining	143.5204	143.5204
8. Manufacturing	133.8049	133.8049
9. CONSTSERV	313.6762	313.6762
Imports (billion rupiah):		
1. Food crops	153.6000	153.6000
2. Non-food crops	188.1500	188.1500
3. Livestock	8.5300	8.5300
4. Forestry	0.8700	0.8700
5. Fisheries	0.7200	0.7200
6. Food processing	583.0200	583.0200
7. Mining	697.5800	697.5800
8. Manufacturing	7,119.5300	7,119.5300
9. CONSTSERV	1,055.1500	1,055.1500

TABLE XXVI (Continued)

Endogenous variables	Base SAM	CGE Solution
Exports (billion rupiah):		
1. Food crops	36.0000	36.0000
2. Non-food crops	1,382.3100	1,382.3100
3. Livestock	13.5500	13.5500
4. Forestry	1,028.3900	1,028.3900
5. Fisheries	132.9400	132.9400
6. Food processing	119.1700	119.1700
7. Mining	11,333.0100	11,333.0100
8. Manufacturing	1,414.0200	1,414.0200
9. CONSTSERV	702.7700	702.7700
Investment demand (billion rupiah):		
1. Food crops	118.8300	118.8300
2. Non-food crops	55.1800	55.1800
3. Livestock	102.5300	102.5300
4. Forestry	5.6600	5.6600
5. Fisheries	0.0000	0.0000
6. Food processing	26.2000	26.2000
7. Mining	903.3000	903.3000
8. Manufacturing	3,785.9400	3,785.9400
9. CONSTSERV	6,896.7700	6,896.7700
Household income (billion rupiah):		
1. Agricultural laborers	1,622.9800	1,622.9800
2. Agricultural operators	11,277.2000	11,277.2000
3. Rural non-agricultural low income	5,370.0600	5,370.0600
4. Rural non-agricultural high income	1,970.9100	1,970.9100
5. Urban low income	6,337.4100	6,337.4100
6. Urban high income	4,593.7300	4,593.7300
Government revenue (billion rupiah):	10,240.2300	10,240.2300

CHAPTER VI

MODEL RESULTS AND POLICY SIMULATIONS

Policy experiments

Formulation of the Indonesian CGE (computable general equilibrium) model and parameter estimation were presented in chapters IV and V. This chapter presents model results and analysis for alternative policy simulations. The policy alternatives are at two levels of devaluation, a 20 percent and a 30 percent. Because data on trade substitution elasticities and export demand elasticities are not available for Indonesia, the devaluation scenarios were applied assuming four different combinations of trade and export demand elasticities. The impacts of the policy simulations are evaluated relative to the effects on endogenous variables including commodity and factor prices, sectoral production, household and institutional incomes, imports and exports, investment, government accounts, and foreign exchange earnings.

The following eight policy experiments are discussed:

Experiment-1 (E-1): 20 percent devaluation assuming low trade substitution elasticities and low export demand elasticities.

Experiment-2 (E-2): The same as experiment-1 but with 30 percent devaluation.

Experiment-3 (E-3): 20 percent devaluation assuming high trade substitution elasticities and low export demand elasticities.

Experiment-4 (E-4): The same as experiment-3 but with 30 percent devaluation.

Experiment-5 (E-5): 20 percent devaluation assuming low trade substitution elasticities and high export demand elasticities.

Experiment-6 (E-6): The same as experiment-5 but with 30 percent devaluation.

Experiment-7 (E-7): 20 percent devaluation assuming high trade substitution elasticities and high export demand elasticities.

Experiment-8 (E-8): The same as experiment-7 but with 30 percent devaluation.

The first solution of the model is used to validate the model, that is to confirm that the model was correctly specified and any unintentional errors have been removed. Furthermore, the fact that the solution reproduces the base year SAM, it can be used as a benchmark equilibrium to which the results of the experiments can be compared. In each experiment the value for the exogenous variable is altered, and then the model is again solved. As in all comparative static analysis, there is no assurance that the economy actually will arrive at a new solution or new equilibria because other changes might intervene in the mean time. Nevertheless, it is useful to compare directions toward which the economy might be pushed by alternative policies.

In general, devaluation affects the relative price of tradeables to non-tradeables, i.e., the price of tradeables increases relative to the price of non-tradeables. Because the general price level is fixed, the price of non-tradeables must fall. A sector can be characterized as producing tradeables if the share of exports in total production and the share of imports in domestic use are large. In this study there are no "pure" tradeables or non-tradeables. Instead, sectors can be ranked by degrees of tradeability depending on the magnitude of the export and import shares.

As a result of devaluation, the price of close import substitutes will tend to rise while the price of commodities that behave as import complements will tend to fall. The resulting reallocation of resources will lead to an expansion in the production of exports and import substitutes and a contraction in the production of non-tradeables and import complements. A new pattern of consumption and investment will also emerge.

The high trade substitution elasticity is set at three times that of the low trade substitution elasticity. The high export demand elasticity is set at twice that of the low export demand elasticities. In general, the impact of devaluation on domestic prices under high trade substitution elasticities is expected to be higher as some sectors become import substitutes. Similarly, the impact of devaluation on the volume of exports under high export demand elasticities is expected to be larger compared to the situation under low export demand elasticities. However, it is important to note that there is no simple rule of thumb to explain the impact of devaluation under the two sets of elasticities as other things are not equal in a general equilibrium framework. In fact, one of the advantages of general equilibrium modeling is that it reveals some results which otherwise would be concealed under partial equilibrium analysis.

Impacts on Foreign Trade

Export Prices

The prices that affect exports are the "dollar" price of exports (equation 4-19). The small country assumption implies that the effect of the price of exports on the world aggregate demand for certain commodities can be ignored. But the impact of changes in export prices on the market share can not be neglected. For example, the impact of an increase in the price of the Indonesian forest products on the aggregate world demand can be safely ignored. But Indonesia's share in the world market for forest products is sensitive to changes in Indonesia's prices relative to all other countries' prices. This assumption strongly affects the results of the simulation as will be explained later in this section.

The impact of devaluation on export prices is presented in Table XXVII. The table reveals that all export prices are decreased as a result of devaluation. Sectors with relatively large changes in domestic prices will experience smaller changes in export prices. For example, because the increase in domestic price of mining is relatively large, its export price decreased less relative to other export prices. This relationship is governed by equation (4-18). The pattern of prices under different experiments is also determined by equation (4-18), that is if the domestic price change is large, its export price change is relatively small.

TABLE XXVII

IMPACT OF DEVALUATION ON EXPORT PRICES
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Exported Good	Low Trade Substitution Elasticities	High Trade substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Food Crops	-16.68	-14.85	-15.65	-14.03
Non-food Crops	-10.05	-8.63	-6.72	-5.93
Livestock	-21.29	-21.27	-21.76	-21.73
Forestry	-6.85	-6.88	-4.06	-4.07
Fisheries	-18.16	-17.67	-15.73	-15.33

TABLE XXVII (continued)

Exported Good	Low Export Demand Elasticities: Low Trade Substitution Elasticities	Low Export Demand Elasticities: High Trade substitution Elasticities	High Export Demand Elasticities: Low Trade Substitution Elasticities	High Export Demand Elasticities: High Trade Substitution Elasticities
Food Processing	-19.72	-18.17	-19.06	-17.66
Mining	-1.21	-1.21	-0.84	-0.90
Manufacturing	-18.84	-15.91	-18.38	-16.94
CONSTSERV	-27.60	-28.80	-29.03	-29.92
30 Percent Devaluation				
Food Crops	-23.02	-20.86	-21.67	-19.75
Non-food Crops	-13.86	-12.86	-9.23	--8.29
Livestock	-29.47	-29.39	-30.55	-30.40
Forestry	-9.50	-9.52	-5.65	-5.61
Fisheries	-24.85	-24.15	-21.05	-20.47
Food Processing	-27.25	-25.44	-26.24	-24.61
Mining	-1.76	-1.88	-1.50	-1.59
Manufacturing	-26.37	-24.12	-25.98	-24.59
CONSTSERV	-37.94	-39.06	-39.79	-40.44

Import Prices

Because of the small country assumption, import prices are linearly related to exchange rates (see equation 4-16). A 20 percent devaluation increased the price of imports by 20 percent uniformly across all commodities. Similarly, a 30 percent devaluation increased import prices by 30 percent irrespective of the assumption on trade substitution and export demand elasticities. Theoretically, these changes will have direct impacts on domestic sales and imports as explained in the succeeding subsections. Indirectly however, these changes affect the rest of the economy.

Exports

Changes in export demand presented in Table XXVIII is a straightforward translation of equation (4-19). For example, export demand over all commodities increased in parallel to increases in export prices. Exports of non-food crops and forestry, which are the most exportable agricultural commodities, increase by 23.6 and 15.2 percent respectively as a result of a 20 percent devaluation under low trade substitution and low export demand elasticities. Exports of sectors which are less tradeable, such as food crops, livestock and fisheries, increase by a larger amount. For instance, a 20 percent devaluation results in a 44 percent increase in food crops export, a 61 percent increase in livestock, and a 49 percent increase in fisheries. Because these are less trade-

TABLE XXVIII

IMPACT OF DEVALUATION ON SECTOR EXPORTS (PERCENT CHANGE FROM BASE SOLUTION)

Exported Good	Low Export Demand Elasticities: Low Trade Substitution Elasticities	Low Export Demand Elasticities: High Trade Substitution Elasticities	High Export Demand Elasticities: Low Trade Substitution Elasticities	High Export Demand Elasticities: High Trade Substitution Elasticities
	20 Percent Devaluation			
Food Crops	44.06	37.92	97.58	83.11
Non-food crops	23.59	19.78	32.10	27.71
Livestock	61.40	61.33	166.79	166.42
Forestry	15.24	15.31	18.04	18.07
Fisheries	49.29	47.53	98.32	94.58
Food Processing	55.17	49.36	132.98	117.52
Mining	3.43	3.72	5.18	5.60
Manufacturing	51.83	44.86	125.37	110.15
CONSTSERV	90.78	97.27	294.09	314.55
	30 Percent Devaluation			
Food Crops	68.75	59.67	156.58	141.14
Non-food Crops	34.78	29.61	47.32	41.35
Livestock	101.03	100.59	329.96	326.13
Forestry	22.10	22.16	26.17	25.99
Fisheries	77.06	73.80	157.38	149.92
Food Processing	88.97	79.90	237.80	209.61
Mining	5.46	5.85	9.49	10.06
Manufacturing	84.46	73.66	233.05	209.29
CONSTSERV	159.63	169.25	661.08	694.77

able sectors, their domestic prices change very little or even decrease relative to the more tradeable sectors. These reductions in prices imply even larger decreases in export prices (see equation 4-18) resulting in large increases in exports. However, these are still small relative to total exports as each contributes little to the total (see Table VIII). Experiments with high export demand elasticities show higher increases in exports. With constant supply of labor and capital in the economy, increases in exports are possible at the expense of decreases in domestic sales as domestic sales plus exports equal total sectoral outputs.

Imports

As the price of imports rise because of the devaluation, the volume of imports falls as observed from Table XXIX. Even though the increase in import prices is uniform across commodities, the reduction in imports is not. For example, a 20 percent devaluation under low trade substitution and low export demand elasticities results in a 31.9 percent decrease in food crops imports, 19.6 percent decrease in non-food crops imports and a 9 percent decrease in mining imports. As expected, the higher the trade substitution elasticities, the higher the reduction in imports. This is so because with a high trade substitution elasticity, it is easier to substitute domestically produced goods for foreign produced goods. It appears that there is no general pattern which exists under low and high export demand elasticities.

TABLE XXIX

IMPACT OF DEVALUATION ON SECTOR IMPORTS
(PERCENT CHANGE FROM BASE SOLUTION)

Imported Good	Low Export Demand Elasticities: Low Trade Substitution Elasticities	Low Export Demand Elasticities: High Trade Substitution Elasticities	High Export Demand Elasticities: Low Trade Substitution Elasticities	High Export Demand Elasticities: High Trade Substitution Elasticities
		20 Percent Devaluation		
Food Crops	-31.87	-62.51	-30.78	-60.59
Non-food crops	-19.62	-41.07	-14.44	-30.76
Livestock	-39.62	-76.91	-41.15	-78.08
Forestry	-16.09	-37.93	-11.49	-26.44
Fisheries	-36.11	-69.44	-33.33	-65.28
Food processing	-35.64	-69.46	-35.17	-68.52
Mining	-9.03	-13.42	-14.78	-18.67
Manufacturing	-17.54	-32.63	-22.42	-36.90
CONSTSERV	-11.04	-26.38	-16.43	-31.43
		30 Percent Devaluation		
Food crops	-42.40	-76.05	-41.19	-74.27
Non-food crops	-26.56	-53.41	-19.80	-40.88
Livestock	-52.17	-88.16	-54.98	-89.45
Forestry	-21.84	-58.28	-16.09	-34.48
Fisheries	-47.22	-81.94	-43.06	-76.39
Food processing	-47.21	-82.48	-46.55	-81.50
Mining	-14.70	-20.97	-28.65	-34.18
Manufacturing	-25.71	-45.59	-36.52	-54.15
CONSTSERV	-16.57	-36.55	-28.35	-46.24

Foreign Exchange Earnings

To understand the impact of devaluation on foreign exchange earnings as presented in Table XXX one should remember that the model assumes a balance of payments equilibrium which is imposed by equation (4-32). In other words, zero balance of payments is assumed in the economy. Thus, if total value of exports increases more than total value of imports, it is necessary that the value of foreign savings be negative to maintain equilibrium in the balance of payments. The negative value of foreign savings is further channeled to a total savings pool resulting in a reduction of total savings. The negative figures in the foreign exchange earnings should be interpreted carefully. A 20 percent devaluation with low trade substitution and low export demand elasticities would increase the foreign exchange reserve by 3,806.9 billion. In other words, a 20 percent devaluation should be able to accomodate a sudden decrease in foreign exchange reserves of 3,806.9 billion. This figure might not be meaningful since it is based upon a unit exchange rate in the base year. Therefore, foreign exchange earnings relative to value of total imports in the base year is presented in Table XXX. Thus under experiment-1, a sudden decrease in foreign exchange of about 38.8 percent of the base period value of total imports can be accomadated by a 20 percent devaluation if the balance of payment is to be maintained.

TABLE XXX

IMPACT OF DEVALUATION ON FOREIGN EXCHANGE EARNINGS
(PERCENT CHANGE FROM BASE YEAR TOTAL VALUE OF IMPORTS)

Low Export Demand Elasticities		High Export Demand Elasticities	
Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation		
-38.82	-54.29	-68.17	-82.55
	30 Percent Devaluation		
-56.74	-76.22	-114.67	-131.52

Impacts on Commodity Markets

Import prices increase as a result of the devaluation. Increases in import prices bring about changes in relative prices of imports to domestic prices resulting in re-arrangement of domestic sales and imports. Adjustment also occurs in composite goods' prices, consumer demand for composite goods, domestic prices, and domestic production until a new equilibrium is achieved. Equations closely related to these changes are (4-13), (4-14), and (4-15).

Composite Good Prices

The experiment with 20 percent devaluation under low trade substitution and low export demand elasticities results in 0.27 percent increase in the price of food crops, 8.6 percent increase in the price of non-food crops, and 11.8 percent increase in the price of forestry and forest products. However, the price of livestock, fisheries, and food processing are decreased by 5.5, 1.8, and 2.2 percent respectively (Table XXXI). Food crops still play an important role in the economic and political stability in the country. However, the less than 1 percent increase in food crops price is negligible and should be of little concern to policy makers.

Table XXXI indicates a similar pattern in the structure of composite good prices across experiments. The difference is in the magnitude of the change. For instance, a 30 percent devaluation appears to affect the prices more than the 20 percent devaluation in absolute terms. Similarly, in general, the higher the trade substitution elasticities, the higher the changes in prices. Similar results occur with high export demand elasticities and low export demand elasticities. In general, experiments which assume high level export demand elasticities affect prices more relative to experiments which assume high trade

TABLE XXXI

IMPACT OF DEVALUATION ON COMPOSITE GOOD PRICES
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Composite Good	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
		20 Percent Devaluation		
Food crops	0.27	2.38	1.49	3.35
Non-food crops	8.61	10.14	12.40	13.25
Livestock	-5.47	-5.47	-6.03	-6.03
Forestry	11.79	11.75	15.13	15.12
Fisheries	-1.78	-1.20	1.13	1.61
Food processing	-2.24	-0.86	-1.48	-0.25
Mining	18.91	18.81	19.18	19.12
Manufacturing	5.41	6.31	5.78	6.29
CONSTSERV	-12.06	-13.55	-13.72	-14.86
		30 Percent Devaluation		
Food crops	0.48	3.13	2.22	4.57
Non-food crops	12.94	14.87	18.67	19.75
Livestock	-8.21	-8.15	-9.62	-9.46
Forestry	17.65	17.63	22.67	22.71
Fisheries	-2.29	-1.38	2.65	3.40
Food processing	-3.48	-1.93	-2.20	-0.86
Mining	28.14	28.00	28.41	28.31
Manufacturing	7.59	8.17	7.94	7.69
CONSTSERV	-17.78	-19.38	-20.12	-21.14

elasticities. Experiments E-5, E-6, E-7, and E-8 seem to produce different outcomes in the price of fisheries compared to other experiments. There is no simple explanation for this seemingly inconsistent result because everything changes in a general equilibrium framework. It is observed from Table VIII that the fisheries sector is relatively more exportable than importable. Furthermore, its production is almost independent of imports. Therefore, the assumption of high export demand elasticities will affect its price more than high trade substitution elasticities. That is, if export demand is assummed to be high, the sector becomes more exportable and the price will increase more. The structure of the composite good prices directly affect the pattern of consumption and investment. Indirectly, however, the rest of the economy is also affected by the change in the structure of the prices as discussed later.

Domestic Prices

The impact of the different experiments on the domestic prices of goods is presented in Table XXXII. In general, the prices of more exportable goods rise relative to the less exportable goods. For instance, the price of non-food crops increased by 7.9 percent, forestry by 11.8 percent, mining by 18.7 percent under experiment-1. Not surprisingly, the price of the most nontraded sector, CONSTSERV, decreases the most (13.1 percent). Similar patterns of change in prices occur under other experiments. Manufacturing, which is a relatively tradeable sector, experiences decreases in price. However, it is also the most import dependent sector in the economy as its intermediate input imports constitute about 47 pecent of total intermediate inputs (Table VIII). Moreover, its less homogenous characteristic further worsen its substitutability compared to other goods. A sector with these characteristics is less protected by a devaluation. The impact of changes in domestic prices is expected to be experienced by production sectors as explained later in the next section.

Net Prices

The prices that affect the structure of sectoral output are net prices. The pattern of changes in net prices is in turn determined by the degree of each sector's dependence on imported intermediate inputs and the price of domestic goods, governed by equation (4-25). Thus, net prices of the most import dependent sectors like manufacturing and food processing decrease (see

TABLE XXXII

THE IMPACT OF DEVALUATION ON DOMESTIC PRICES
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Domestic Good	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Food Crops	-0.01	2.18	1.21	3.16
Non-food crops	7.94	9.64	11.93	12.88
Livestock	-5.55	-5.52	-6.11	-6.08
Forestry	11.79	11.75	15.13	15.12
Fisheries	-1.79	-1.21	1.12	1.60
Food processing	-3.67	-1.81	-2.87	-1.19
Mining	18.66	18.55	19.00	18.92
Manufacturing	-2.61	-0.30	-2.06	-0.33
CONSTSERV	-13.12	-14.56	-14.83	-15.90
	30 Percent Devaluation			
Food crops	0.08	2.88	1.83	4.32
Non-food crops	11.98	14.19	18.00	19.23
Livestock	-8.31	-8.21	-9.72	-9.52
Forestry	17.65	17.62	22.66	22.70
Fisheries	-2.30	-1.39	2.64	3.39
Food processing	-5.43	-3.08	-4.11	-2.00
Mining	27.72	27.56	28.05	27.94
Manufacturing	-4.32	-1.35	-3.77	-1.97
CONSTSERV	-19.32	-20.77	-21.73	-22.57

Table XXXIII). Net prices of the livestock and CONSTSERV sectors also decrease. These decreases, however, are due to the decreases in domestic prices. The domestic price of fisheries decreases by 1.8 percent while its net price increases by 4.4 percent. This result seems to contradict the definition of net prices. However, from equation (4-25) this result is consistent in its formulation. For example, looking at the input-output coefficients presented in Table VI, one can observe that production of fisheries highly depends on both CONSTSERV and manufacturing sectors, while at the same time, the prices of both CONSTSERV and manufacturing decrease by large percentages. Therefore, fisheries intermediate input cost under Experiment-1 is far less than before the experiment which brings about a relative increase in its net price. Other changes in prices are explained similarly.

TABLE XXXIII

THE IMPACT OF DEVALUATION ON NET PRICES
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Food Crops	1.82	4.76	3.62	6.20
Non-food prices	15.80	18.86	22.37	24.20
Livestock	-4.29	-3.97	-4.71	-4.46
Forestry	25.11	25.83	31.33	31.91
Fisheries	4.37	6.34	10.60	12.19
Food processing	-16.23	-11.79	-16.68	-12.15
Mining	21.67	21.63	22.17	22.15
Manufacturing	-13.56	-3.58	-10.18	-2.48
CONSTSERV	-21.10	-23.41	-23.81	-25.51
	30 Percent Devaluation			
Food crops	2.82	6.57	5.40	8.69
Non-food crops	23.71	27.66	33.58	35.86
Livestock	-6.49	-6.06	-7.99	-7.54
Forestry	37.48	38.28	46.73	47.36
Fisheries	7.05	9.70	17.35	19.39
Food processing	-24.29	-18.70	-24.40	-18.95
Mining	32.20	32.12	32.74	32.72
Manufacturing	-21.41	-8.37	-17.49	-8.64
CONSTSERV	-39.97	-33.21	-34.78	-35.93

Consumer Demand

Total consumption by households and government are presented in Table XXXIV. Under Experiment-1, a 20 percent devaluation with low trade substitution and low export demand elasticities, consumption of most commodities is less compared to the base solution with the exception of the CONSTSERV sector. For instance, food crops consumption decreased by almost 4 percent. Consumption of mining is most affected by devaluation with about 19 percent reduction from the base period consumption. Consumption of CONSTSERV, however, increases by about 9 percent. These phenomenon are explained by the demand systems that govern consumer behavior. In equation (5-2), demand for a consumption good is dependent on disposable income and its own price. The equation states that an increase in the composite good price results in a reduction in consumption demand. Simultaneously, this is dependent on the changes in household or institutional income which are changing at the same time. This law of demand is confirmed by food crops, non-food crops, forestry, mining, and manufacturing where total consumption decreases in parallel to increases in their corresponding prices. Increases in CONSTSERV consumption also complies with the law of demand, where its price decreases by 12 percent under Experiment-1.

The impacts of devaluation on the other goods appear to contradict the law of demand. For instance, a 5.5 percent decrease in the price of livestock results in a 0.65 percent reduction in consumption. Similar results are experienced by fisheries and food processing where a 1.8 percent and a 2.2 percent decrease in the prices results in 4.5 and 3.3 percent decrease in consumption, respectively. Explanation to these seemingly contradictory results depend on linkages that are quite intricate. For example, effects of changes in

TABLE XXXIV

IMPACT OF DEVALUATION ON SECTOR CONSUMPTION
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
		20 Percent Devaluation		
Food Crops	-3.75	-5.07	-4.55	-5.67
Non-food crops	-11.12	-11.76	-13.81	-13.92
Livestock	-0.65	-0.49	-0.27	-0.05
Forestry	-12.35	-11.49	-14.32	-13.61
Fisheries	-4.45	-4.82	-7.38	-7.57
Food processing	-3.28	-4.31	-4.06	-4.89
Mining	-19.48	-19.00	-19.51	-19.06
Manufacturing	-11.03	-11.75	-11.66	-11.95
CONSTSERV	8.84	10.93	10.70	12.52
		30 Percent Devaluation		
Food crops	-5.40	-6.73	-6.46	-7.51
Non-food crops	-15.83	-16.26	-19.42	-19.23
Livestock	-0.68	-0.13	0.63	1.22
Forestry	-17.37	-16.13	-19.92	-18.89
Fisheries	-6.78	-7.03	-11.46	-11.40
Food processing	-4.56	-5.29	-5.78	-6.22
Mining	-26.73	-25.91	-27.25	-25.81
Manufacturing	-15.43	-15.48	-16.10	-15.32
CONSTSERV	14.16	17.18	17.25	19.77

household incomes can not be ignored as disposable income is an important factor that determines consumer demand.

Intermediate Input Demand

Changes in intermediate input demands depend on the changes in domestic sectoral output according to equation (4-28). However, the changes are not necessarily in the same direction as in domestic sectoral output, but they reflect both interindustry relationships and the change in sectoral outputs. Results of the impact of devaluation on intermediate input demand are shown in Table XXXV. In most cases the impact is less than a five percent change.

TABLE XXXV

IMPACT OF DEVALUATION ON INTERMEDIATE INPUT DEMAND (PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
		20 Percent Devaluation		
Food Crops	-0.06	1.10	-0.05	1.15
Non-food crops	2.97	4.29	4.03	5.12
Livestock	-1.56	-2.16	-2.14	-2.64
Forestry	-0.96	-2.05	-1.48	-2.37
Fisheries	0.04	-0.33	0.81	0.52
Food processing	-0.51	-0.38	-0.71	-0.48
Mining	1.36	3.95	2.72	4.63
Manufacturing	0.40	1.59	1.04	1.88
CONSTSERV	1.12	2.24	1.88	2.70
		30 Percent Devaluation		
Food crops	-0.08	1.29	0.19	1.60
Non-food crops	4.37	5.94	6.09	7.29
Livestock	-2.41	-3.19	-3.44	-4.03
Forestry	-1.56	-3.06	-2.42	-3.50
Fisheries	0.10	-0.41	1.49	1.11
Food processing	-0.82	-0.77	-1.01	-0.77
Mining	1.78	5.27	3.67	5.82
Manufacturing	0.40	1.98	1.22	2.15
CONSTSERV	1.51	2.99	2.59	3.50

Investment Demand

Investment demand is represented by equations (5-5), and (5-6). With these specifications, changes in sectoral investment demand are equal across sectors. This is reflected by the results of the experiments described in Table XXXVI. The results show that the higher the trade substitution elasticities, the larger the reduction in the investment demand. Similarly, the larger the export demand elasticities, the larger the reduction in investment demand. The logical explanation for this is that with larger trade and export demand elasticities, exports increase and imports decrease which in turn create more available foreign savings. Larger foreign savings imply lower total savings available for domestic investment because the model assumes balance of payments in the economy.

TABLE XXXVI

IMPACT OF DEVALUATION ON INVESTMENT DEMAND
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Food Crops	-34.71	-49.57	-64.09	-78.20
Non-food crops	-34.70	-49.57	-64.10	-78.20
Livestock	-34.71	-49.57	-64.09	-78.19
Forestry	-34.63	-49.65	-64.13	-78.27
Fisheries	0.00	0.00	0.00	0.00
Food processing	-34.69	-48.58	-64.08	-78.21
Mining	-34.71	-49.57	-64.09	-78.19
Manufacturing	-34.71	-49.57	-64.09	-78.19
CONSTSERV	-34.71	-49.57	-64.09	-78.19

TABLE XXXVI (continued)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
		30 Percent Devaluation		
Food crops	-56.31	-76.96	-121.67	-140.12
Non-food crops	-56.31	-76.95	-121.67	-140.11
Livestock	-56.31	-76.95	-121.67	-140.12
Forestry	-56.36	-77.03	-121.73	-140.11
Fisheries	0.00	0.00	0.00	0.00
Food processing	-56.30	-76.95	-121.68	-140.11
Mining	-56.31	-76.96	-121.67	-140.11
Manufacturing	-56.31	-76.96	-121.67	-140.11
CONSTSERV	-56.31	-76.96	-121.67	-140.11

Composite Good Supply

Summation of consumer demand, investment demand, and intermediate demand should be equal to composite good supply according to equation (4-34). Therefore, changes in composite goods should also reflect changes in the three demands for the composite goods given earlier. The impact of devaluation on the composite good supply is described in Table XXXVII. Composite goods supply is further distributed to imports and domestic sales discussed in the next section.

Domestic Production

What happens to sectoral output as a result of devaluation to some degree is determined by the changes in relative net prices according to the firm profit maximizing behavior through equations (4-22), (4-25), and (4-27). However, in a general equilibrium framework everything changes. When price

TABLE XXXVII

IMPACT OF DEVALUATION ON COMPOSITE GOOD SUPPLY
(PERCENT CHANGES FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Food Crops	-2.42	-2.76	-3.23	-3.43
Non-food crops	-1.87	-1.43	-2.47	-2.01
Livestock	-2.61	-3.48	-4.02	-4.77
Forestry	-3.34	-4.11	-4.27	-4.91
Fisheries	-3.65	-4.03	-5.93	-6.14
Food processing	-3.03	-3.95	-3.83	-4.56
Mining	-7.77	-9.46	-13.90	-15.92
Manufacturing	-9.12	-11.54	-14.72	-17.09
CONSTSERV	-3.86	-5.85	-9.24	-11.30
	30 Percent devaluation			
Food crops	-3.58	-3.90	-4.88	-5.00
Non-food crops	-2.70	-2.12	-3.75	-3.20
Livestock	-3.99	-5.00	-6.77	-7.57
Forestry	-4.90	-5.95	-6.38	-7.12
Fisheries	-5.56	-5.86	-9.17	-9.19
Food processing	-4.24	-4.94	-5.55	-5.96
Mining	-12.83	-15.26	-27.32	-30.20
Manufacturing	-14.39	-17.58	-27.03	-29.97
CONSTSERV	-6.44	-9.21	-19.08	-21.79

increases output is expected to increase. However, domestic consumption also decreases because the prices faced by the producers are the same prices faced by consumers. Explanation of some seemingly contradictory results in Table XXXVIII are based on the above arguments.

Under Experiment-1, i.e., a 20 percent devaluation with low trade elasticities and low export demand elasticities, domestic output of food crops decreases by 1.7 percent while its net price increases by 1.8 percent. In

TABLE XXXVIII

IMPACT OF DEVALUATION ON DOMESTIC PRODUCTION
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
Commodities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
		20 Percent Devaluation		
Food Crops	-1.67	-1.48	-2.29	-2.01
Non-food crops	7.21	7.27	9.29	8.93
Livestock	-2.07	-2.78	-2.83	-3.43
Forestry	5.01	4.63	5.76	5.42
Fisheries	1.00	0.52	3.21	2.71
Food processing	0.77	2.54	1.12	2.89
Mining	1.13	1.14	1.20	1.21
Manufacturing	2.29	6.72	4.62	7.90
CONSTSERV	-1.45	-2.73	-2.16	-3.20
		30 Percent Devaluation		
Food crops	-2.51	-2.25	-3.46	-3.07
Non-food crops	10.59	10.57	13.15	12.98
Livestock	-3.14	-4.01	-4.52	-5.20
Forestry	7.24	6.70	8.25	7.77
Fisheries	1.69	1.16	5.43	4.78
Food processing	1.19	3.27	2.11	4.17
Mining	1.70	1.69	1.81	1.79
Manufacturing	3.08	9.05	6.33	10.07
CONSTSERV	-2.29	-4.04	-3.43	-4.68

contrast, the net prices of food processing and manufacturing sectors decrease while outputs increase. In equation (4-35), the product market equilibrium condition states that sectoral output must equal domestic sales plus exports. Domestic sales of food crops, food processing, and manufacturing decrease because of decreases in their corresponding prices. However, food crops are relatively less tradeable compared to both food processing and manufacturing so that even though its exports increase by 44 percent, they are still small relative to the reduction in domestic sales. On the other hand, a 55 percent increase in food processing exports and a 51 percent increase in manufacturing exports are relatively larger than the decreases in their corresponding domestic sales thus resulting in increases in domestic outputs. Other sectors which are more tradeable experience increases in output parallel to the corresponding increases in net prices.

In general, outputs of the more tradeable agricultural sectors increase relative to the outputs of less tradeable sectors. For example, non-food crops output increases by about 7 percent and forestry by 5 percent. The smaller increase in food processing presumably is because it is relatively more import dependent. As the price of imports increase because of the devaluation, production becomes more costly leading to reductions in domestic output.

Impacts on Factor Markets

As new equilibria occur in domestic outputs because of the devaluation, equilibria in factor markets also shift. Given fixed sectoral capital stocks, and fixed labor supply by labor category, a new equilibrium in labor use and wages emerge. Furthermore, as capital rent is defined to be a linear combination of capital goods prices, a new level of capital rents is also set. A new residual value added accruing to capital (or payment to capital) also emerges.

Wages and Payments to Labor

The impact of devaluation on wages, total payment to each labor category, and payment to capital is presented in Table XXXIX. The results show that a 20 percent devaluation under low trade substitution and low export demand elasticities increase wages paid to agricultural laborers by 3 percent. In fact, agricultural laborers is the only labor category experiencing increases in wages. Wages paid to production workers decrease by 17.2 percent, sales and services decrease by 21.5 percent, and professionals and management decrease by 21.2 percent. Under all experiments, wages paid to agricultural laborers increase.

TABLE XXXIX

IMPACT OF DEVALUATION ON WAGES
(PERCENT CHANGE FROM BASE SOLUTION)

LABOR	Low Export Demand Elasticities: Low Trade Substitution Elasticities	Low Export Demand Elasticities: High Trade Substitution Elasticities	High Export Demand Elasticities: Low Trade Substitution Elasticities	High Export Demand Elasticities: High Trade Substitution Elasticities
		20 Percent Devaluation		
Agricultural laborers	2.96	5.87	5.22	7.68
Production workers	-17.17	-15.52	-17.94	-16.46
Sales and services	-21.52	-24.39	-24.48	-26.60
Professionals and management	-21.21	-23.81	-24.03	25.94
		30 Percent devaluation		
Agricultural laborers	4.62	8.28	7.88	11.04
Production workers	-25.56	-22.93	-26.73	-24.44
Sales and services	-31.54	-34.41	-35.63	-37.21
Professionals and management	-31.10	-33.65	-35.02	-36.38

Not surprisingly, total payments received by agricultural laborers also increase by about 5 percent. The impacts of devaluation on payments to labor are presented in Table XL.

TABLE XL

IMPACT OF DEVALUATION ON PAYMENTS TO LABOR
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
LABOR	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Agricultural laborers	4.67	7.43	7.52	9.81
Production workers	-17.40	-16.75	-18.63	-17.93
Sales and services	-20.93	-23.65	-23.81	-25.80
Professionals and management	-20.60	-22.92	-23.28	-24.97
	30 Percent Devaluation			
Agricultural laborers	7.19	10.71	11.46	14.35
Production workers	-25.80	-24.38	-27.57	-26.16
Sales and services	-30.66	-33.37	-34.66	-36.12
Professionals and management	-30.23	-32.43	-33.98	-35.12

Capital Rents

Under the first experiment, i.e., a 20 percent devaluation with low trade and low export demand elasticities, the capital rent increases by 4.2 percent. Similar results occur for the other experiments (Table XLI). In summary, capital becomes more expensive as a result of the devaluation.

TABLE XLI

IMPACT OF DEVALUATION ON CAPITAL RENTS
(PERCENT CHANGE FROM BASE SOLUTION)

	Low Export Demand Elasticities		High Export Demand Elasticities	
	Low Trade Substitution Elasticities	High Trade Substitution Elasticities	Low Trade Substitution Elasticities	High Trade Substitution Elasticities
	20 Percent Devaluation			
Capital rents	4.16	5.07	4.95	5.70
	30 Percent Devaluation			
Capital rents	6.34	7.71	7.47	8.58

Impacts on Income Formation

Households

The impact of devaluation on household incomes is decribed in Table XLI. The data show that a 20 percent devaluation under low trade and low export demand elasticities decreases agricultural laborers' income by 0.28 percent. The less than one percent decline in income is negligible. Interestingly, however, as devaluation increases to 30 percent, the reduction in income is less. Moreover, as the assumption of low trade and low export demand elasticities changes to the high levels, agricultural laborers' income increases under both 20 and 30 percent devaluation. This is additional evidence that in a general equilibrium framework, the sign of the impact may be different under different situations.

TABLE XLII

IMPACT OF DEVALUATION ON HOUSEHOLD, GOVERNMENT, AND PRIVATE COMPANIES INCOME (PERCENT CHANGE FROM BASE SOLUTION)

INSTITUTION	Low Export Demand Elasticities: Low Trade Substitution Elasticities	Low Export Demand Elasticities: High Trade Substitution Elasticities	High Export Demand Elasticities: Low Trade Substitution Elasticities	High Export Demand Elasticities: High Trade Substitution Elasticities
		20 Percent Devaluation		
Agricultural laborers	-0.28	1.40	1.25	2.68
Agricultural operators	2.28	3.64	3.54	4.69
Rural non-agricultural low income	-11.41	-11.68	-12.42	-12.50
Rural non-agricultural high income	-14.67	-16.13	-16.46	-17.50
Urban low income	-11.69	-12.28	-12.90	-13.25
Urban high income	-11.67	-12.92	-13.15	-14.04
Government	2.03	2.61	2.41	2.99
Private companies	4.08	4.97	4.85	5.59
		30 Percent devaluation		
Agricultural laborers	-0.19	2.10	2.13	4.10
Agricultural operators	3.58	5.49	5.45	7.05
Rural non-agricultural low income	-16.75	-16.60	-18.15	-17.71
Rural non-agricultural high income	-21.49	-22.77	-23.98	-24.54
Urban low income	-17.16	-17.40	-18.85	-18.71
Urban high income	-17.08	-18.19	-19.14	-19.65
Government	3.20	4.11	3.79	4.73
Private companies	6.22	7.56	7.33	8.41

Agricultural operators gain the most among households from devaluation as their income increases by 2.3 percent under Experiment-1. Moreover, the increase in income becomes larger as the structure of trade and export demand elasticities in the base period are altered. Other household groups experience large decreases in income as a result of devaluation.

To better understand the above phenomenon, it is necessary to trace out the impact of devaluation step by step through equation (4-29), i.e., the income generating equation for households. Endogenously determined variables that play important roles in determining household income include: payments to capital, wages by labor category, and demand for labor by labor category. Payment to capital by itself is dependent on total sectoral outputs, net prices, wages, and demand for labor. Some parameters in the equation are also important in determining the final value of income. Transfers from household to household, from goverment to household, and from private companies to household may not be important because they are set to a constant value and are independent of any endogenous variable. However, parameters such as capital shares by each household, proportion of each labor category originated or supplied by households, and wage proportionality factors are important. Attempts to explain these linkages is tedious. Nevertheless, some seemingly contradictory results deserve explanation.

The 2.3 percent increase in income of the agricultural operators is explained. The main source of income for households is from their endowment of labor which they sell to the production sectors. A large proportion (about 75 percent) of agricultural operators' labor endowment is agricultural laborers. Moreover, agricultural operators also own about 20 percent of the capital (see Table XX). Total capital payments is increased by about 4 percent under Experiment-1. Similar explanation can be applied in analyzing other household group income.

In general, agricultural operators gain the most from devaluation. Agricultural laborers appear to lose but only a relatively small percentage. Furthermore, as the assumptions on trade and export demand elasticities are altered, it appears that agricultural laborers gain from the devaluation. On the other hand, other household groups appear to experience large losses in income as a result of devaluation.

Private Companies

Two components determine private companies income: (1) transfers from other institutions and the rest of the world, and (2) returns accruing to capital (see equation 4-30). The former is assumed constant in the model, therefore it should not affect the change in private companies income. The latter constitutes about 59 percent of income and explains the increases in private companies income (see Table VIIIL).

Government

Government revenue increases by about 2 percent as a result of a 20 percent devaluation under low trade and low export demand elasticities (Table XLII), slightly less than the increase in private companies income. This increase is governed by equation (4-31).

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

Objective of the Study

Foreign exchange shortages is one of the many problems often faced by less developing countries. It can be because the goverment pursued inflationary fiscal or monetary policies which increased the domestic price level well above the world price level and lead to an appreciation of the real exchange rate and an excess demand for foreign exchange. Alternatively, it can be caused by exogenous changes in the country's terms of trade, i.e., declines in export prices or increases in import prices as a result of world conditions. To alleviate the problem, many developing countries have pursued a policy of devaluation.

During the 1971-1978 period, Indonesia experienced an inflationary economy primarily because of oil price increases. Increased revenue from oil provided an incentive to spend more by both the private and public sectors. On the other hand, domestic capacity grew at a slower pace than the increase in demand. Imports increased more than exports. As a result, the domestic price level increased well above the world inflation level leading to foreign exchange shortages. By the end of 1978, devaluation was undertaken to alleviate the problem. Later, in 1983 another devaluation occurred to alleviate the same problem. However, this time the cause was the sudden decline in oil prices.

Devaluation, however, requires adjustments at both macro and micro levels. A new structure of prices and wages emerges. Resouces are reallocated to sectors where there is room for import substitution and/or where exports can be expanded. As the structure of production and resouce use is rearranged, a new adjustment in the distribution of income and employment also occurs. The objective of this study is to explore the impacts of devaluation on the structure of the Indonesian economy. In particular, the emphasis was placed on the impact of devaluation on the agriculture and related sectors.

Procedure

To achieve the objective, a computable general equilibrium (CGE) model of the Indonesia economy was constructed. The equations of the model represent the behavior of each agent in the economy. Eight institutions were identified in the model: six household groups, government, and private companies. The household groups are: agricultural laborers, agricultural operators, rural non-agricultural low income, rural non-agricultural high income, urban low income, and urban high income. Household preferences were assumed to be represented by a Stone-Geary utility maximizing function subject to disposable income and results in a demand system of the Linear Expenditure System (LES) form.

Five factors composed of four labor categories and one capital stock were specified in the model. The labor categories included: agricultural laborers, production workers, sales and services, and professional and management. The factors were assumed to be owned by the household groups and the other institutions in constant proportion, which in turn, forms institutional income. Capital stock was assumed constant during the period modeled. Total labor by category supplied to the labor markets was assumed fixed and full employment was assumed to prevail in the economy.

Nine production sectors, six agriculturally related, were defined. The sectors are: food crops, non-food crops, livestock, forestry, fisheries, food processing, mining, manufacturing, and CONSTSERV. The latter was composed of services, construction, utilities, and government related activities. Production sectors were assumed to maximize profit and a Cobb-Douglas production technology. The maximization behavior is represented by a set of factor demand equations and the production functions. Production sectors were identified with their corresponding product, therefore, there are nine commodities sold in the product market.

The model was an open economy model where demand for goods was further allocated to domestically produced goods and/or imports according to an Armington constant elasticity of substitution formulation. Excess supply is exported to the world market where demand was assumed to be negatively sloped.

The model was calibrated to the 1980 base year Social Accounting Matrix of Indonesia which was assumed to be in general equilibrium at that time. This assures that changes in the solution by altering any of the exogenous variables are measured relative to the base year. Two levels of trade substitution elasticities between imports and domesically produced goods and two levels of export demand elasticities were identified and combined with two exogenously determined levels of devaluation.

The CGE model was then used to examine the impacts of devaluation on the economy as a whole. In particular, eight experiments were carried out: Experiment-1, a 20 percent devaluation with low trade elasticities and low export demand elasiticities; Experiment-2, the same as experiment-1 with a 30 percent devaluation; Experiment-3, a 20 percent devaluation with high trade elasticities and low export demand elasticities; Eperiment-4, the same as experiment-3 with a 30 percent devaluation; Experiment-5, a 20 percent devaluation with low trade elasticities and high export demand elasticities; Experiment-6, the same as experiment-5 with a 30 percent devaluation; Experiment-7, a 20 percent devaluation with both high trade and high export demand elasiticities; Experiment-8, the same as experiment-7 with a 30 percent devaluation.

Results

Results of the general equilibrium model indicate that devaluation significantly affects foreign trade, commodity markets, factor markets, and income formation. A 20 percent devaluation increased exports from all sectors as a result of the decrease in prices. Exports from the food crops sector increased by 44.1 percent, non-food crops by 23.6 percent, livestock by 61.4 percent, forestry by 15.2 percent, fisheries by 49.3 percent, and food processing by 55.2 percent. A 30 percent devaluation resulted in larger increases in exports. For example, exports from the food crops sector increased by 68.8 percent under both low trade and low export demand elasticities. Similarly, assumptions of high export demand elasticities resulted in larger increases in exports. On the other hand, the assumption of high trade substitution elasticities resulted in smaller increases in exports.

A 20 percent devaluation under low trade and low export demand elasticities decreased imports in all sectors. Food crops sector decreased by 31.9 percent, non-food crops by 19.6 percent, livestock by 39.6 percent, forestry by 16.1 percent, fisheries by 36.1 percent and food processing by 35.6 percent. A 30 percent devaluation affected imports more in absolute value compared to the 20 percent devaluation. For example, imports of food processing decreased by 47.2 percent as a result of a 30 percent devaluation. In general, the assumption of high export demand elasticities cushioned the impact of devaluation on imports. For example, a 20 percent devaluation under low trade and high export demand elasticities decreased imports of non-food crops by 14.4 percent as opposed to a 19.6 percent decrease under low export demand elasticities. The assumption of high trade elasticities, however, magnified the impact of devaluation over all sectors. For example, a 20 percent devaluation under high trade and low export demand elasticities decreased imports of food crops by 62.5 percent, almost twice the impact as under low trade and low export demand elasticities of a 31.9 percent decrease.

As a result of the increases in exports and decreases in imports, foreign exchange earnings increased by 38.8 percent of the base period value of total imports. This is equivalent to saying that a shortage in foreign exchange earnings by 38.8 percent of the base period total value of imports can be accomodated by a 20 percent devaluation. A 30 percent devaluation increased the impact to almost one and a half times the 20 percent devaluation, all under different assumptions of trade and export demand elasticities.

The prices faced by producers and consumers are altered because of the devaluation. A 20 percent devaluation under low trade and low export demand elasticities decreased the food crops domestic price by one-tenth of one percent. The domestic price increased for non-food crops by 7.9 percent, livestock by 5.6 percent, forestry by 11.8 percent, fisheries by 1.8 percent, and food processing by 3.7 percent. In general, a 30 percent devaluation under different trade and export demand elasticities resulted in larger impacts on domestic prices in absolute value. Larger impacts also occurred under high trade and high export demand elasticities.

Changes in domestic prices are translated into changes in domestic production and consumption. Domestic production in food crops contracted by 1.7 percent as a result of a 20 percent devaluation under both low trade and low export demand elasticities. Non-food crops production, however, increased by 7.2 percent. The increase in domestic production of the non-food crops sector, however, is mainly exported because total consumption decreased by 11.1 percent. Livestock production decreased by 2.1 percent. As domestic consumption also decreased by 0.7 percent, it appears that increases in exports of livestock occurred at the expense of domestic consumption. Forestry production increased by 5.0 percent, while consumption decreased by 12.4 percent. Similarly, fisheries domestic production increased by 1 percent and domestic consumption declined by 4.5 percent. Food processing production increased by 0.8 percent while consumption decreased by 3.3 percent. Again, output increases are mostly exported.

As a result of devaluation, a new equilibrium in factor markets occurred. Wages paid to agricultural laborers increased by 3.0 percent, wages paid to production workers decreased by 17.2 percent, wages paid to sales and sevices decreased by 21.5 percent, and wages paid to professionals and management decreased by 21.2 percent. These results assume a 20 percent devaluation and low trade and low export demand elasticities. In general, other experiments resulted in larger changes in wages for all labor categories. For example, a 30 percent devaluation under low trade and low export demand elasticities increased wages paid to agricultural laborers by 4.6 percent as opposed to the 3.0 percent increase under a 20 percent devaluation. A 20 percent devaluation under low trade and high export demand elasticities increased the wages paid to agricultural laborers by 5.2 percent.

A 20 percent devaluation under low trade and low export demand elasticities increased total payments to capital (or the residual value added accruing to capital) by 4.2 percent. Other experiments showed similar patterns of change, that is increases in payments to capital. For example, under high trade substitution elasticities and low export demand elasticities, payments to capital increased by 5.1 percent. A 30 percent devaluation under low trade and low export demand elasticities increased payments to capital by 6.3 percent.

Agricultural operators appeared to gain the most from devaluation as their incomes increased under all experiments. For example, a 20 percent devaluation under low trade and low export demand elasticities increased agricultural operators' income by 2.3 percent. Moreover, the increases in income became larger as the structure of trade and export demand elasticities in the base period were altered. Other household groups experienced large decreases in income as a result of devaluation. Agricultural laborers appeared to lose from devaluation with a 0.3 percent reduction in income. However, as devaluation increased to 30 percent, the reduction in income became less. Moreover, as the assumption of low trade and low export demand elasticities were changed to high levels, agricultural laborers' income increased under both 20 and 30 percent devaluation.

A 20 percent devaluation under low trade and low export demand elasticities increased private companies income by 4.1 percent and government revenue by 2.0 percent. The increases are mainly because about 59 percent of the private companies' income originates from the return to capital, while the direct tax rate on the private companies income is about 44 percent.

Conclusions

It was shown using the CGE framework that significant changes in the structure of the Indonesian economy occurs as a result of devaluation. In particular, new equilibria in prices emerge, leading to reallocation of resources toward sectors where there is scope for import substitution and/or export expansion. Prices not only allocate resouces, but also generate income. It was shown that devaluation significantly affects the distribution of income among households and institutions. Because government revenue increased from devaluation, direct or indirect income transfers to socioeconomic groups can occur who lose from the devaluation. Similarly, private companies gained from devaluation and thus increased tax revenue is available to distribute to the different socioeconomic groups. Indeed, devaluation was shown to be able to accomodate shortages in foreign exchange earnings. However, devaluation is not the only policy that can be used to alleviate shortages in foreign exchange earnings. Therefore, it would be interesting to compare the above results with other policy results such as those occurring from foreign exchange rationing.

Limitations

The results and conclusions of this study are limited by the accuracy of the data and assumptions used. In particular, determination of trade substitution and export demand elasticities greatly affect the results of the simulations. Better estimates that more closely represent the situation in Indonesia would improve the results of the model. For example, some seemingly overestimated export demands in some sectors, such as CONSTSERV, might be because of inappropriate export demand elasticities.

Once better estimates of elasticities are obtained, the model can be easily solved for changes in policies of devaluation.

Supply of exports from any sector is assumed to be equal to domestic production minus domestic use. This is equivalent to saying that the price elasticity of export supply is determined by the price elasticity of total domestic production and the price elasticity of domestic demand. This specification is appropriate as long as the domestically produced good that is consumed domestically is identical to the one exported. However, if the exports in a large aggregate sector are in fact distinct products from the domestically consumed good, it might overestimate the export supply responsivenes to price changes. Dervis et. al., (1985), proposed a logistic export supply function to replace the current specification. This, however, requires additional parameters to be estimated while at the same time adds to the size and complexity of the model. Nevertheless, this would be interesting to pursue in future reseach.

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APPENDIX A

THE 1980 SOCIAL ACCOUNTING MATRIX

FOR INDONESIA

TABLE XLIII

SOCIAL ACCOUNTING MATRIX FOR INDONESIA, 1980 (BILLION RUPIAH)

EXPENDITURES	Factors of Production				
RECIPTS	1	2	3	4	5
FACTORS OF PRODUCTION:					
1. Agricultural laborers					
2. Production workers					
3. Sales and Services					
4. Professional and management					
5. Capital					
INSTITUTIONS/HOUSEHOLD:					
6. Agricultural laborers	1051.91	152.44	122.74	40.17	163.07
7. Agricultural operators	4000.58	416.02	414.62	89.47	5957.82
8. Rural non-agric. low income	228.01	1890.17	1505.03	162.64	1299.15
9. Rural non-agric. high income	46.13	129.72	536.78	813.59	271.32
10. Urban low income	22.70	1796.92	2112.84	244.74	1520.66
11. Urban high income	6.75	182.39	1387.23	1181.20	701.03
12. Private companies	0.00	0.00	0.00	0.00	17546.85
13. Government	0.00	0.00	0.00	0.00	123.40
PRODUCTION SECTORS:					
14. Food crops					
15. Non-food crops					
16. Livestock					
17. Forestry					
18. Fisheries					
19. Food processing					
20. Mining					
21. Manufacturing					
22. Constserv					
DOMESTIC COMMODITIES:					
23. Food crops					
24. Non-food crops					
25. Livestock					
26. Forestry					
27. Fisheries					
28. Food processing					
29. Mining					
30. Manufacturing					
31. Constserv					
IMPORTS:					
32. Food crops					
33. Non-food crops					
34. Livestock					
35. Forestry					
36. Fisheries					
37. Food processing					
38. Mining					
39. Manufacturing					
40. Constserv					
BALANCES:					
41. Capital account					
42. Indirect taxes minus subsidy					
43. Rest of the world					2393.13
44. Margins					
TOTAL	5356.08	4567.66	6079.24	2531.81	29976.43

TABLE XLIII (Continued)

RECIPTS \ EXPENDITURES	Institutions/Households 6	7	8	9	10	11
FACTORS OF PRODUCTION:						
1. Agricultural laborers						
2. Production workers						
3. Sales and Services						
4. Professional and management						
5. Capital						
INSTITUTIONS/HOUSEHOLD:						
6. Agricultural laborers	4.23	7.98	3.48	1.01	5.03	3.15
7. Agricultural operators	7.57	61.32	21.85	6.25	30.49	18.75
8. Rural non-agric. low income	3.61	23.54	17.91	2.92	14.68	9.19
9. Rural non-agric. high income	0.24	1.93	1.65	0.56	5.10	1.99
10. Urban low income	6.91	43.84	18.66	5.43	36.23	18.10
11. Urban high income	0.78	8.64	1.29	2.56	3.56	8.50
12. Private companies	0.00	0.00	0.00	0.00	0.00	0.00
13. Government	34.57	226.67	98.12	37.47	158.11	155.04
PRODUCTION SECTORS:						
14. Food crops						
15. Non-food crops						
16. Livestock						
17. Forestry						
18. Fisheries						
19. Food processing						
20. Mining						
21. Manufacturing						
22. Constserv						
DOMESTIC COMMODITIES:						
23. Food crops	473.89	2338.94	843.93	208.20	544.60	143.83
24. Non-food crops	107.41	441.61	168.27	34.23	99.94	42.93
25. Livestock	61.96	428.31	159.92	72.08	237.33	184.13
26. Forestry	39.89	139.61	42.44	8.24	13.78	2.57
27. Fisheries	69.94	415.57	208.12	80.55	234.66	130.57
28. Food processing	562.39	2458.00	1208.41	385.34	1007.99	552.79
29. Mining	5.48	30.78	10.54	3.37	9.25	5.31
30. Manufacturing	59.06	998.11	550.39	243.99	744.51	550.99
31. Constserv	111.93	1934.93	1226.15	459.78	2131.56	1517.47
IMPORTS:						
32. Food crops	1.78	18.73	8.57	2.36	5.69	2.78
33. Non-food crops	0.14	1.13	0.61	0.33	0.37	0.56
34. Livestock	0.01	0.93	0.38	0.67	0.61	1.18
35. Forestry	0.00	0.07	0.03	0.01	0.00	0.00
36. Fisheries	0.00	0.13	0.04	0.21	0.03	0.76
37. Food processing	17.50	209.46	107.58	51.23	124.99	112.08
38. Mining	0.00	0.00	0.00	0.00	0.00	0.00
39. Manufacturing	5.53	172.56	142.45	59.72	141.49	103.94
40. Constserv	0.55	42.43	29.63	19.93	76.05	96.99
BALANCES:						
41. Capital account	47.61	1271.98	499.64	284.47	711.36	930.13
42. Indirect taxes minus subsidy						
43. Rest of the world						
44. Margins						
TOTAL	1622.98	11277.20	5370.06	1970.91	6337.41	4593.73

TABLE XLIII (Continued)

EXPENDITURES / RECIPTS	12	13	14	15	16	17
			Production sectors			
FACTORS OF PRODUCTION:						
1. Agricultural laborers			3827.92	761.87	279.31	202.91
2. Production workers			16.22	23.57	2.04	25.10
3. Sales and Services			7.88	21.50	6.11	12.69
4. Professional and management			5.73	8.68	1.83	1.69
5. Capital			2201.01	1563.93	892.44	1155.70
INSTITUTIONS/HOUSEHOLD:						
6. Agricultural laborers	0.00	58.90				
7. Agricultural operators	0.00	175.29				
8. Rural non-agric. low income	93.16	95.58				
9. Rural non-agric. high income	128.92	27.37				
10. Urban low income	196.73	285.82				
11. Urban high income	935.69	151.51				
12. Private companies	268.35	0.00				
13. Government	7808.16	1174.13				
PRODUCTION SECTORS:						
14. Food crops						
15. Non-food crops						
16. Livestock						
17. Forestry						
18. Fisheries						
19. Food processing						
20. Mining						
21. Manufacturing						
22. Constserv						
DOMESTIC COMMODITIES:						
23. Food crops	0.00	0.00	1271.03	1.50	17.07	0.00
24. Non-food crops	0.00	10.12	0.46	705.82	11.23	0.00
25. Livestock	0.00	0.00	24.79	5.39	569.06	0.00
26. Forestry	0.00	0.00	2.63	10.91	1.27	45.49
27. Fisheries	0.00	0.00	0.00	0.00	0.29	0.00
28. Food processing	0.00	3.52	0.00	0.01	83.55	0.00
29. Mining	0.00	0.00	0.00	0.00	0.16	0.00
30. Manufacturing	0.00	314.20	237.21	146.76	8.87	44.10
31. Constserv	0.00	3595.18	60.14	123.44	21.31	100.76
IMPORTS:						
32. Food crops	0.00	0.00	1.79	0.00	0.00	0.00
33. Non-food crops	0.00	0.00	0.00	0.15	0.02	0.00
34. Livestock	0.00	0.00	0.00	0.00	2.28	0.00
35. Forestry	0.00	0.00	0.00	0.00	0.00	0.00
36. Fisheries	0.00	0.00	0.00	0.00	0.00	0.00
37. Food processing	0.00	0.00	0.00	0.00	13.88	0.00
38. Mining	0.00	0.00	0.00	0.00	0.00	0.00
39. Manufacturing	0.00	178.44	54.05	50.42	0.96	22.67
40. Constserv	0.00	332.87	0.00	0.10	0.00	0.18
BALANCES:						
41. Capital account	8314.24	3133.02				
42. Indirect taxes minus subsidy						
43. Rest of the world	145.03	724.28				
44. Margins						
TOTAL	17890.28	10240.23	7710.86	3424.05	1911.68	1611.29

TABLE XLIII (Continued)

EXPENDITURES / RECIPTS	Production sectors 18	19	20	21	22	23
FACTORS OF PRODUCTION:						
1. Agricultural laborers	284.07	0.00	0.00	0.00	0.00	
2. Production workers	1.35	394.73	192.12	744.23	3168.30	
3. Sales and Services	2.66	47.99	93.68	129.29	5757.44	
4. Professional and management	0.44	6.80	48.75	115.93	2341.96	
5. Capital	497.47	1016.91	12084.11	2416.11	8148.75	
INSTITUTIONS/HOUSEHOLD:						
6. Agricultural laborers						
7. Agricultural operators						
8. Rural non-agric. low income						
9. Rural non-agric. high income						
10. Urban low income						
11. Urban high income						
12. Private companies						
13. Government						
PRODUCTION SECTORS:						
14. Food crops						7710.86
15. Non-food crops						
16. Livestock						
17. Forestry						
18. Fisheries						
19. Food processing						
20. Mining						
21. Manufacturing						
22. Constserv						
DOMESTIC COMMODITIES:						
23. Food crops	0.59	2598.66	0.00	3.74	153.29	
24. Non-food crops	0.00	1055.38	0.00	63.90	71.53	
25. Livestock	0.26	31.01	0.00	35.18	319.36	
26. Forestry	10.92	4.09	0.15	17.86	913.84	
27. Fisheries	108.25	44.75	0.00	0.12	92.01	
28. Food processing	10.47	372.94	0.01	17.31	445.16	
29. Mining	4.79	10.06	418.74	1080.29	546.56	
30. Manufacturing	41.57	131.26	344.09	1623.65	3215.37	
31. Constserv	27.00	102.52	437.06	306.93	3002.20	
IMPORTS:						
32. Food crops	0.00	128.51	0.00	0.00	1.43	
33. Non-food crops	0.00	73.60	0.00	122.97	0.40	
34. Livestock	0.00	0.11	0.00	0.50	0.99	
35. Forestry	0.00	0.00	0.00	1.27	0.10	
36. Fisheries	0.00	0.00	0.00	0.00	0.13	
37. Food processing	0.00	33.45	0.00	7.84	41.62	
38. Mining	0.00	0.13	0.02	683.17	4.66	
39. Manufacturing	14.65	83.80	140.82	2785.98	2088.45	
40. Constserv	0.02	1.00	263.88	4.78	188.37	
BALANCES:						
41. Capital account						
42. Indirect taxes minus subsidy						43.67
43. Rest of the world						
44. Margins						996.49
TOTAL	1004.51	6137.70	14023.43	10161.05	30501.92	8751.02

TABLE XLIII (Continued)

EXPENDITURES / RECIPTS	Domestic Commodities 24	25	26	27	28	29
FACTORS OF PRODUCTION:						
1. Agricultural laborers						
2. Production workers						
3. Sales and Services						
4. Professional and management						
5. Capital						
INSTITUTIONS/HOUSEHOLD:						
6. Agricultural laborers						
7. Agricultural operators						
8. Rural non-agric. low income						
9. Rural non-agric. high income						
10. Urban low income						
11. Urban high income						
12. Private companies						
13. Government						
PRODUCTION SECTORS:						
14. Food crops						
15. Non-food crops	3424.05					
16. Livestock		1911.68				
17. Forestry			1611.29			
18. Fisheries				1004.51		
19. Food processing					6137.70	
20. Mining						14023.43
21. Manufacturing						
22. Constserv						
DOMESTIC COMMODITIES:						
23. Food crops						
24. Non-food crops						
25. Livestock						
26. Forestry						
27. Fisheries						
28. Food processing						
29. Mining						
30. Manufacturing						
31. Constserv						
IMPORTS:						
32. Food crops						
33. Non-food crops						
34. Livestock						
35. Forestry						
36. Fisheries						
37. Food processing						
38. Mining						
39. Manufacturing						
40. Constserv						
BALANCES:						
41. Capital account						
42. Indirect taxes minus subsidy	31.07	9.26	14.01	6.60	284.05	18.07
43. Rest of the world						
44. Margins	790.44	321.27	662.44	506.66	829.26	296.95
TOTAL	4245.56	2242.21	2287.74	1517.77	7251.01	14338.45

TABLE XLIII (Continued)

EXPENDITURES RECIPTS	I 30	31	32	33	34	35
FACTORS OF PRODUCTION:						
1. Agricultural laborers						
2. Production workers						
3. Sales and Services						
4. Professional and management						
5. Capital						
INSTITUTIONS/HOUSEHOLD:						
6. Agricultural laborers						
7. Agricultural operators						
8. Rural non-agric. low income						
9. Rural non-agric. high income						
10. Urban low income						
11. Urban high income						
12. Private companies						
13. Government						
PRODUCTION SECTORS:						
14. Food crops						
15. Non-food crops						
16. Livestock						
17. Forestry						
18. Fisheries						
19. Food processing						
20. Mining						
21. Manufacturing	10161.05					
22. Constserv		30501.92				
DOMESTIC COMMODITIES:						
23. Food crops						
24. Non-food crops						
25. Livestock						
26. Forestry						
27. Fisheries						
28. Food processing						
29. Mining						
30. Manufacturing						
31. Constserv						
IMPORTS:						
32. Food crops						
33. Non-food crops						
34. Livestock						
35. Forestry						
36. Fisheries						
37. Food processing						
38. Mining						
39. Manufacturing						
40. Constserv						
BALANCES:						
41. Capital account						
42. Indirect taxes minus subsidy	-518.82	592.81	11.02	6.65	1.14	0.15
43. Rest of the world			142.58	181.50	7.39	0.72
44. Margins	2099.12	271.13	21.12	16.89	1.78	0.61
TOTAL	11741.35	31365.86	174.72	205.04	10.31	1.48

TABLE XLIII (Continued)

EXPENDITURES	Imports					I
RECIPTS	36	37	38	39	40	41
FACTORS OF PRODUCTION:						
1. Agricultural laborers						
2. Production workers						
3. Sales and Services						
4. Professional and management						
5. Capital						
INSTITUTIONS/HOUSEHOLD:						
6. Agricultural laborers						
7. Agricultural operators						
8. Rural non-agric. low income						
9. Rural non-agric. high income						
10. Urban low income						
11. Urban high income						
12. Private companies						
13. Government						
PRODUCTION SECTORS:						
14. Food crops						
15. Non-food crops						
16. Livestock						
17. Forestry						
18. Fisheries						
19. Food processing						
20. Mining						
21. Manufacturing						
22. Constserv						
DOMESTIC COMMODITIES:						
23. Food crops						115.75
24. Non-food crops						50.42
25. Livestock						99.88
26. Forestry						5.66
27. Fisheries						
28. Food processing						23.95
29. Mining						880.11
30. Manufacturing						1073.20
31. Constserv						6896.64
IMPORTS:						
32. Food crops						3.08
33. Non-food crops						4.76
34. Livestock						2.65
35. Forestry						
36. Fisheries						
37. Food processing						2.25
38. Mining						23.19
39. Manufacturing						2712.74
40. Constserv						0.13
BALANCES:						
41. Capital account						
42. Indirect taxes minus subsidy	0.18	-72.49	1.59	-28.11	1.39	
43. Rest of the world	0.54	655.51	695.99	7147.64	1053.76	3278.04
44. Margins	0.58	138.86	13.59	1639.14	1.76	
TOTAL	1.30	721.88	711.17	8758.67	1056.91	15172.45

TABLE XLIII (Continued)

EXPENDITURES RECIPTS	Balances 42	43	44	Total
FACTORS OF PRODUCTION:				
1. Agricultural laborers				5356.08
2. Production workers				4567.66
3. Sales and Services				6079.24
4. Professional and management				2531.81
5. Capital				29976.43
INSTITUTIONS/HOUSEHOLD:				
6. Agricultural laborers		8.87		1622.98
7. Agricultural operators		77.17		11277.20
8. Rural non-agric. low income		24.47		5370.06
9. Rural non-agric. high income		5.61		1970.91
10. Urban low income		27.83		6337.41
11. Urban high income		22.60		4593.73
12. Private companies		75.08		17890.28
13. Government	402.24	22.32		10240.23
PRODUCTION SECTORS:				
14. Food crops				7710.86
15. Non-food crops				3424.05
16. Livestock				1911.68
17. Forestry				1611.29
18. Fisheries				1004.51
19. Food processing				6137.70
20. Mining				14023.43
21. Manufacturing				10161.05
22. Constserv				30501.92
DOMESTIC COMMODITIES:				
23. Food crops		36.00		8751.02
24. Non-food crops		1382.31		4245.56
25. Livestock		13.55		2242.21
26. Forestry		1028.39		2287.74
27. Fisheries		132.94		1517.77
28. Food processing		119.17		7251.01
29. Mining		11333.01		14338.45
30. Manufacturing		1414.02		11741.35
31. Constserv		702.77	8608.09	31365.86
IMPORTS:				
32. Food crops				174.72
33. Non-food crops				205.04
34. Livestock				10.31
35. Forestry				1.48
36. Fisheries				1.30
37. Food processing				721.88
38. Mining				711.17
39. Manufacturing				8758.67
40. Constserv				1056.91
BALANCES:				
41. Capital account				15172.45
42. Indirect taxes minus subsidy				402.24
43. Rest of the world				16426.11
44. Margins				8608.09
TOTAL	402.24	16426.11	8608.09	

APPENDIX B

LISTING OF THE GAMS PROGRAM TO SOLVE THE INDONESIAN CGE MODEL (BASE PERIOD RUN)

NEW MARGINS: 1 - 120

```
**************************************************************************************************
*                                                                                                *
*    A Program to solve the Indonesian Computable General Equilibrium Model                      *
*                                                                                                *
*    Written by:  Togar Alam Napitupulu                                                          *
*                                                                                                *
**************************************************************************************************
*
  SET  I      List of all sectors in the model
              /SECTOR1   Food crops
               SECTOR2   Non-food crops
               SECTOR3   Livestocks
               SECTOR4   Forestry
               SECTOR5   Fisheries
               SECTOR6   Food Processing
               SECTOR7   Mining Industry Construction Electricity Gas and Water
               SECTOR8   Trade Hotel Trasportation Communication and Services
               SECTOR9   Bank Insurance Real estate Education Defence and Health Program /
*
       LC     Labor categories
              /LABOR1    Agricultural labor
               LABOR2    Production labor
               LABOR3    Sales and services
               LABOR4    Professional and Management /
*
       HH     Household groups
              /HOUSEHOLD1   Agricultural household laborers
               HOUSEHOLD2   Agricultural household operators
               HOUSEHOLD3   Non-Agricultural rural-low
               HOUSEHOLD4   Non-Agricultural rural-high
               HOUSEHOLD5   Non-Agricultural urban-low
               HOUSEHOLD6   Non-Agricultural urban-high /
*
  ALIAS(HH,IST)
  ALIAS(I,J)
*
* Declaration of all parameters.  SCALAR is parameter with zero dimensional.
* TABLE is two or more dimensional parameter.  PARAMETER is one dimensional
* parameter.
*
```

```
PARAMETER
  DELTA(I)          Share parameter of equation (5-13)
  B(I)              Shift parameter of equation (5-13)
  RHO(I)            Exponent parameter of equation (5-13)
  ETA(I)            Export demand elasticity equation (5-19)
  A(I)              Production function shift parameter equation (5-22)
  ALPHA(I,LC)       Labor share parameter in production function equation (5-22)
  TMO(I)            Import tariff
  TE(I)             Export duty rates
  TI(I)             Indirect tax
  TD(HH)            Direct tax
  GOVSH(I)          Government consumption share
  IMAT(I,J)         Capital composition matrix
  MPS(HH)           Marginal propensity to save by household
  HHKSH(HH)         Household share of capital
  IO(I,J)           Input output coefficients
  COEF(I)
  OMEGA(I)
*
* Some dummy parameters to hold base year data (SAM-1980)
*
  MO(I)             Volume of imports  ('80 Hundred bill. Rp.)
  EO(I)             Volume of exports  ('80 hundred bill. Rp.)
  XO(I)             Volume of domestic output by sectors ('80 hundred bill. Rp.)
  VO(I)             Volume of intermediate input demand ('80 hundred bill. Rp.)
  DO(I)             Volume of domestic sales by sectors ('80 hundred bill. Rp.)
  QO(I)             Volume of composite goods   ('80 hundred bill. Rp.)
  PWEO(I)           Dollar price of exports  (Unity)
  PWMO(I)           World market price of imports (Unity)
  PDO(I)            Domestic good price  (Unity)
  PMO(I)            Domestic price of imports (unity)
  PNO(I)            Net price or value added price by sector (Unity)
  WAO(LC)           Average wage rate by labor category ('80 hundred thousand Rp. per worker)
  KO(I)             Volume of capital stocks by sector ('80 hundred bill. Rp.)
  KIO(I)            Share of investment by sector of destination ('80 hundred bill. Rp.)
  LSO(LC)           Labor supply by category  (100.000 persons)
  XLB(I,LC)         Dummy variable for labor supply with no zeroes (100.000 persons)
  ZO(I)             Investment demand ('80 hundred bill. Rp.)
  YHO(HH)           Household income in the base year ('80 hundred bill. Rp.)
  KTR(HH)           Capital transfer to household ('80 hundred bill. Rp. )
  GOVTR(HH)         Government transfer to household ('80 hundred bill. Rp. )
```

```
    WRLDTR(HH)       World transfer to household ('80 hundred bill. Rp.)
    YLABORO(LC)      Total payment to each labor category
         /LABOR1 53.5608, LABOR2 45.6766, LABOR3 60.7924, LABOR4 25.3181/
    PSI(HH,LC)       Proportion of each labor category supplied by household
    SHARE(I,HH)      Average budget share by each household for each sector
*
* Some temporary parameters for calculation purposes
*
    XTEMP(I)         Temporary for calculation of XO
*
  SCALAR
    YGO              Government revenue ('80 hundred bill. Rp.)  / 102.4023 /
    GOVTOTO          Government total consumption ('80 hundred bill. Rp.  / 44.3433 /
    FSAVEO           Foreign saving ('80 hundred bill. Rp. )  / 0.0 /
    MPSE             Marginal propensity to save by capitalist
    MPSG             Marginal propensity to save by government
    TPC              Corporate tax
    TC               Tax on capital input
    ERO              Real exchange rate at the base year  / 1.0  /
    PCKSH            Private companies capital share
    PLEVEL           Price level / 1.0 /
*
  TABLE   INTDMD(I,J)   Intermediate demand ('80 bill. Rp.)

             SECTOR1   SECTOR2   SECTOR3   SECTOR4   SECTOR5   SECTOR6   SECTOR7   SECTOR8   SECTOR9
  SECTOR1    1272.82      1.50     17.07                 .59   2727.17                3.74    154.72
  SECTOR2        .46    705.97     11.25                       1128.98              186.87     71.93
  SECTOR3      24.79      5.39    571.34                 .26     31.12               35.68    320.35
  SECTOR4       2.63     10.91      1.27     45.49     10.92      4.09       .15     19.13    913.94
  SECTOR5                            .29              108.25     44.75                 .12     92.14
  SECTOR6                  .01     97.43               10.47    406.39       .01     25.15    486.78
  SECTOR7                            .16                4.79     10.19    418.76   1763.46    551.22
  SECTOR8     291.26    197.18      9.83     66.77     56.22    215.06    484.91   4409.63   5303.82
  SECTOR9    1077.75    930.87    344.36    763.99    534.26   1071.64   1011.48   4049.97   3463.46
*
  TABLE  XLE(I,LC)    Employment by sector and labor category (100.000 persons)

             LABOR1      LABOR2    LABOR3    LABOR4

  SECTOR1    217.4770     .7750     .3500     .1470
  SECTOR2     27.4480     .9370     .6500     .1160
```

```
   SECTOR3     11.1130       .0520       .0910       .0140
   SECTOR4      4.523        .7030       .2390       .0270
   SECTOR5      8.2390       .0600       .0960       .0100
   SECTOR6                 15.4050       .9922       .1140
   SECTOR7                  3.8810       .4040       .1230
   SECTOR8                 26.4400      2.1790       .6910
   SECTOR9                 82.0140    137.9830     22.3240
 *
   TABLE WDIST(I,LC)  Wage proportionality factors
                 LABOR1       LABOR2       LABOR3       LABOR4
   SECTOR1      .88334779    .59688381    .52953702    .36280530
   SECTOR2     1.39300404    .71739879    .77797073    .69646303
   SECTOR3     1.26135513   1.11883868   1.57920304   1.21663243
   SECTOR4     2.25143323   1.01826085   1.24882584    .58258497
   SECTOR5     1.73034650    .64168689    .65170126    .40953310
   SECTOR6                   .73076726   1.13760025    .55518841
   SECTOR7                  1.41178830   5.45385604   3.68897610
   SECTOR8                   .80276118   1.39555147   1.56154363
   SECTOR9                  1.10173957    .98139082    .97643602
 *
   TABLE   FACHH(HH,LC)   Household income originated from each labor category ('80 hundred bill. Rp.)
                  LABOR1       LABOR2       LABOR3        LABOR4
   HOUSEHOLD1    10.5191       1.5244       1.2274         .4017
   HOUSEHOLD2    40.0058       4.1602       4.1462         .8947
   HOUSEHOLD3     2.2801      18.9017      15.0503        1.6264
   HOUSEHOLD4      .4613       1.2972       5.3678        8.1359
   HOUSEHOLD5      .2270      17.9692      21.1284        2.4474
   HOUSEHOLD6      .0675       1.8239      13.8723       11.8120
 *
   TABLE HHCONS(I,HH)    Household consumption ('80 hundred bill. Rp.)
                  HOUSEHOLD1   HOUSEHOLD2   HOUSEHOLD3   HOUSEHOLD4   HOUSEHOLD5   HOUSEHOLD6
   SECTOR1         4.7567      23.5767       8.5250       2.1056       5.5029       1.4661
   SECTOR2         1.0755       4.4274       1.6888        .3456       1.0031        .4349
   SECTOR3          .6197       4.2924       1.6030        .7275       2.3794       1.8531
   SECTOR4          .3989       1.3968        .4247        .0825        .1378        .0257
```

```
      SECTOR5         .6994       4.1570      2.0816        .8076       2.3469       1.3133
      SECTOR6        5.7989      26.6746     13.1599       4.3657      11.3298       6.6487
      SECTOR7         .0548        .3078       .1054        .0337        .0925        .0531
      SECTOR8         .6459      11.7067      6.9284       3.0371       8.8600       6.5493
      SECTOR9        1.1248      19.7736     12.5578       4.7971      22.0761      16.1446
*
      TABLE  MICEL(*,I)  Micellaneous parameters and initial data

              SECTOR1   SECTOR2   SECTOR3   SECTOR4   SECTOR5   SECTOR6   SECTOR7   SECTOR8   SECTOR9

      MO      1.5360    1.8815    .0853     .0087     .0072     5.8302    6.9758    71.1953   10.5515
      EO      .360      13.8231   .1355     10.2839   1.3294    1.1917    113.3301  14.1402   7.0277
      XO      87.7214   42.6245   22.4399   22.8835   15.1835   73.8987   143.5204  133.8049  313.6762
      SIGMA   2         2         2         2         2         2         1.5       .75       .25
      ETA     2         2         2         2         2         2         3         2         2
      PDO     1         1         1         1         1         1         1         1         1
      TMO     .1102     .0665     .0114     .0015     .0018     -.7249    .0159     -.2811    .0139
      TE
      TI      .4367     .3107     .0926     .1401     .0660     2.8405    .1807     -5.1882   5.9281
      GOVSH             .1012                                   .0352               4.9264    39.2805
      KO      22.0101   15.6393   8.9244    11.5570   4.9747    10.1691   120.8411  24.1611   81.4875
      ZO      1.1883    .5518     1.0253    .0566               .2620     9.0330    37.8594   68.9677
      OMEGA   .10251    .04981    .02622    .02674    .01774    .08636    .16771    .15636    .36655
*
      TABLE TRANS(HH,IST)  Transfers from household to household

                     HOUSEHOLD1  HOUSEHOLD2  HOUSEHOLD3  HOUSEHOLD4  HOUSEHOLD5  HOUSEHOLD6

      HOUSEHOLD1       .0423       .0798       .0348       .0101       .0503       .0315
      HOUSEHOLD2       .0757       .6132       .2185       .0625       .3049       .1875
      HOUSEHOLD3       .0361       .2354       .1791       .0292       .1468       .0919
      HOUSEHOLD4       .0024       .0193       .0165       .0056       .0510       .0199
      HOUSEHOLD5       .0691       .4384       .1866       .0543       .3623       .1810
      HOUSEHOLD6       .0078       .0864       .0129       .0256       .0356       .0850
      ;
*
* Compute average budget share by each household for each sector
*
      SHARE(I,HH) = HHCONS(I,HH)/SUM(J,HHCONS(J,HH));
*
* compute proportion of each labor category supplied by households
```

```
*
  PSI(HH,LC) = FACHH(HH,LC)/YLABORO(LC);
*
* Compute input output coefficients
*
  IO(I,J) = INTDMD(I,J)/(MICEL("XO",J)*100);
*
* Initialization of the value of parameters
*
  WAO("LABOR1") =  .19925893;
  WAO("LABOR2") =  .35063830;
  WAO("LABOR3") =  .42516925;
  WAO("LABOR4") = 1.07439423;
*
  COEF(I) = MICEL("ZO",I)/118.9441;
*
  MPS("HOUSEHOLD1") =   47.61/1622.98;
  MPS("HOUSEHOLD2") = 1271.98/11277.20;
  MPS("HOUSEHOLD3") =  499.64/5370.06;
  MPS("HOUSEHOLD4") =  284.47/1970.91;
  MPS("HOUSEHOLD5") =  711.36/6337.41;
  MPS("HOUSEHOLD6") =  930.13/4593.73;
*
  YHO("HOUSEHOLD1") = 16.2298;
  YHO("HOUSEHOLD2") = 112.7720;
  YHO("HOUSEHOLD3") = 53.7006;
  YHO("HOUSEHOLD4") = 19.7091;
  YHO("HOUSEHOLD5") = 63.3741;
  YHO("HOUSEHOLD6") = 45.9373;
*
  TD("HOUSEHOLD1") =  34.57/1622.98;
  TD("HOUSEHOLD2") = 226.67/11277.20;
  TD("HOUSEHOLD3") =  98.12/5370.06;
  TD("HOUSEHOLD4") =  37.47/1970.91;
  TD("HOUSEHOLD5") = 158.11/6337.41;
  TD("HOUSEHOLD6") = 155.04/4593.73;
*
  KTR("HOUSEHOLD1") = 0.0;  GOVTR("HOUSEHOLD1") = .5890; WRLDTR("HOUSEHOLD1") = .0887;
  KTR("HOUSEHOLD2") = 0.0;  GOVTR("HOUSEHOLD2") = 1.7529; WRLDTR("HOUSEHOLD2")=.7717;
  KTR("HOUSEHOLD3") = .9316; GOVTR("HOUSEHOLD3")=.9558;  WRLDTR("HOUSEHOLD3")=.2447;
  KTR("HOUSEHOLD4") = 1.2892;GOVTR("HOUSEHOLD4")=.2737;  WRLDTR("HOUSEHOLD4") =.0561;
```

```
KTR("HOUSEHOLD5") = 1.9673;GOVTR("HOUSEHOLD5")=2.8582; WRLDTR("HOUSEHOLD5") =.2783;
KTR("HOUSEHOLD6") = 9.3569;GOVTR("HOUSEHOLD6")=1.5151; WRLDTR("HOUSEHOLD6") = .226;
*
HHKSH("HOUSEHOLD1") =  163.07/29976.43;
HHKSH("HOUSEHOLD2") = 5957.82/29976.43;
HHKSH("HOUSEHOLD3") = 1299.15/29976.43;
HHKSH("HOUSEHOLD4") =  271.32/29976.43;
HHKSH("HOUSEHOLD5") = 1520.66/29976.43;
HHKSH("HOUSEHOLD6") =  701.03/29976.43;
*
MPSE = 8314.24/17890.28;
MPSG = 3113.02/10240.23;
TPC  = 7808.16/17890.28;
TC   = 123.40/29976.43;
PCKSH = 17546.85/29976.43;
*
RHO(I) = (1/MICEL("SIGMA",I)) - 1;
ETA(I) = MICEL("ETA",I);
TMO(I) = MICEL("TMO",I)/(MICEL("MO",I)-MICEL("TMO",I));
TE(I) = MICEL("TE",I);
TI(I) = MICEL("TI",I)/MICEL("XO",I);
GOVSH(I) = MICEL("GOVSH",I)/44.3433;
XLB(I,LC) = XLE(I,LC) + (1 - SIGN(XLE(I,LC)));
MO(I) = MICEL("MO",I);
EO(I) = MICEL("EO",I);
XO(I) = MICEL("XO",I);
KO(I) = MICEL("KO",I);
PDO(I) = MICEL("PDO",I);
PMO(I) = PDO(I);
PWMO(I) = PMO(I)/((1 + TMO(I))*ERO);
PWEO(I) = PDO(I)*(1 + TE(I))/ERO;
PNO(I) = PDO(I) - SUM(J, IO(J,I)*PDO(J)) - TI(I);
DO(I) = XO(I) - EO(I);
ZO(I) = MICEL("ZO",I);
LSO(LC) = SUM(I, XLE(I,LC));
OMEGA(I) = MICEL("OMEGA",I);
*
* Calibration of all shift and share parameters
*
* Compute delta from equation (5-15)
*
```

```
  DELTA(I) = PMO(I)/PDO(I) * (MO(I)/DO(I))**(1 + RHO(I));
  DELTA(I) = DELTA(I)/(1 + DELTA(I));
*
* Assuming P equal to 1 at base year, equation (5-14) gives composite good at base year
*
  QO(I) = PDO(I)*DO(I) + PMO(I)*MO(I);
*
  B(I) = QO(I)/(DELTA(I)*MO(I)**(-RHO(I)) + (1-DELTA(I))*DO(I)**(-RHO(I)))**(-1/RHO(I));
*
* Compute intermediate input demand at the base year, equation (5-28)
*
  VO(I) = SUM(J, IO(I,J)*XO(J));
*
* Get labor share from equation (5-27)
*
  ALPHA(I,LC) = (WDIST(I,LC)*WAO(LC)*XLE(I,LC))/(PNO(I)*XO(I));
*
* Get shift parameter A from equation (5-22)
*
  A(I) = XO(I)/(PROD(LC, XLB(I,LC)**ALPHA(I,LC))*KO(I)**(1 - SUM(LC, ALPHA(I,LC))));
*
*************************
*
* Declaration of variables
*
***************************
*
 VARIABLES
*
* Endogenous variables
*
* Price block
    P(I)        Price of composite good  (unity)
    PD(I)       Price of domestically produced good (unity)
    PM(I)       Domestic price of imports (unity)
    PWE(I)      Dollar price of domestic good (unity)
    PN(I)       Value added price by sector (unity)
* Production block
    Q(I)        Composite good supply (100 Bill. rupiahs)
    X(I)        Domestic output by sector (100 Bill. rupiahs)
    D(I)        Domestic sales (100 Bill. rupiahs)
```

```
     M(I)        Imports (100 Bill. rupiahs)
     E(I)        Exports by sector (100 bill. rupiahs)
* Factors block
     WA(LC)      Average wage rate by labor category  (mill. rupiahs)
     L(I,LC)     Employment by sector and labor category (100.000 persons)
* Demand block
     V(I)        Intermediate demand (100 bill. rupiahs)
     CH(I,HH)    Final demand for private consumption (100 bill. rupiahs)
     CG(I)       Final demand for government consumption (100 bill. rupiahs)
     Z(I)        Investment demand by sector of origin (100 bill. rupiahs)
     YH(HH)      Household income (100 bill. rupiahs)
     YG          Government revenue (100 bill. rupiahs)
     YK          Payment to capital input (100 bill. rupiahs)
     YPC         Private companies income (100 bill. rupiahs)
     TS          Total saving (100 bill. rupiahs)
     C(I)        Total consumption of good i (100 bill. rupiahs)
* Welfare indicator for objective function
     UTILITY     Objective function variable
*
* Exogenous variables
*
     ER          Exchange rate
     TM(I)       Tariff rate
     LS(LC)      Labor supply by labor category (100 thousand persons)
     FSAVE       Foreign savings (100 bill. rupiahs)
*
* Temporary variables
     YLABOR(LC)  Payment to each labor category (100 bill. rupiahs)
     DIRTAX      Total income over all household (100 bill. rupiahs)
     TARIFF      Government revenue from tariff (100 bill. rupiahs)
     INDTAX      Government revenue from indirect tax (100 bill. rupiahs)
*
*****************************************************
*
*  Declaration of equations
*
*****************************************************
*
 EQUATIONS
*
* Consumer demand or household demand.  Note that the last three digits
```

```
* is the same as the number of equation in the text
     EQ5020(I,HH)   Consumer demand systems
     EQ5021(I)      Government demand
     EQ407(I)       Total household consumption
* Investment demand
     EQ408          Total savings
     EQ503(I)       Investment demand by sector of origin
* Import demand
     EQ413(I)       Composite good aggregation function
     EQ414(I)       Value of domestic sales
     EQ415(I)       First order condition for composite good minimization
     EQ416(I)       Definition of domestic import price
* Export demand
     EQ418(I)       Definition of dollar export price
     EQ419(I)       Export demand
* Production function
     EQ422(I)       Cobb-Douglass production function
* Demand for labor
     EQ425(I)       Definition of net prices
     EQ427(I,LC)    First order condition for profit maximization
* Intermediate demand
     EQ428(I)       Definition of total intermediate demand
* Income equation
     EQ429(HH)      Household income
     EQ430          Payment to capital input
     EQ4301         Private companies income
     EQ431          Government revenue
     EQ4291(LC)     Definition of total income to labor category
     EQ4292         Total income over all household
     EQ4293         Definition of government income from tariff
     EQ4294         Definition of government income from indirect tax
* Balance of payment
     EQ432          Definition of balance of payment
* Labor market equation
     EQ433(LC)      Definition of labor market
* Composite good identity
     EQ434(I)       Definition of composite good identity
* Product market equilibrium
     EQ435(I)       Definition of market equilibrium
* Price level definition
     EQ436          Price level definition
```

```
* Objective function
    OBJ           Objective function
    ;
*
* Specification of the equations
*
    EQ5020(I,HH)..  P(I)*CH(I,HH) =E= SHARE(I,HH)*((1-MPS(HH)-TD(HH))*YH(HH)-SUM(IST,TRANS(IST,HH)));

    EQ5021(I)..   CG(I)*P(I) =E= GOVSH(I) * ((1-MPSG)*YG - 26.9288);

    EQ407(I)..  C(I) =E= CG(I) + SUM(HH,CH(I,HH));

    EQ408..  TS =E= SUM(HH,MPS(HH)*YH(HH)) + MPSG*YG + MPSE*YPC + FSAVE*ER;

    EQ503(I)..  Z(I) =E= (COEF(I) * (TS - 32.7804))/P(I);

    EQ413(I)..  Q(I) =E= B(I)*(DELTA(I)*M(I)**(-RHO(I)) + (1-DELTA(I))*D(I)**(-RHO(I)))**(-1/RHO(I));

    EQ414(I)..  P(I)*Q(I) =E= PD(I)*D(I) + PM(I)*M(I);

    EQ415(I)..  M(I)/D(I) =E= ((PD(I)/PM(I))*(DELTA(I)/(1-DELTA(I))))**(1/(1+RHO(I)));

    EQ416(I)..  PM(I) =E= PWMO(I)*(1+TM(I))*ER;

    EQ418(I)..  PWE(I) =E= PD(I)*(1+TE(I))/ER;

    EQ419(I)..  E(I)/EO(I) =E= (PWEO(I)/PWE(I))**ETA(I);

    EQ422(I)..  X(I) =E= A(I)*PROD(LC$WDIST(I,LC),L(I,LC)**ALPHA(I,LC))*KO(I)**(1-SUM(LC,ALPHA(I,LC)));

    EQ425(I)..  PN(I) =E= PD(I)*(1-TI(I))-SUM(J,P(J)*IO(J,I));

    EQ427(I,LC)$WDIST(I,LC)..  WDIST(I,LC)*WA(LC)*L(I,LC) =E= PN(I)*ALPHA(I,LC)*X(I);

    EQ428(I)..  V(I) =E= SUM(J,IO(I,J)*X(J));

    EQ4291(LC)..  YLABOR(LC) =E= SUM(I, WDIST(I,LC)*WA(LC)*L(I,LC));

    EQ4292..  DIRTAX =E= SUM(HH, TD(HH)*YH(HH));

    EQ4293..  TARIFF =E= SUM(I, TM(I)*PWMO(I)*ER*M(I));
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      EQ4294..  INDTAX =E= SUM(I, TI(I)*X(I)*PD(I));

      EQ429(HH)..  YH(HH) =E= SUM(LC,PSI(HH,LC)*YLABOR(LC))+HHKSH(HH)*YK
                              + SUM(IST,TRANS(HH,IST)) + KTR(HH) + GOVTR(HH) + WRLDTR(HH);

      EQ430..  YK =E= SUM(I,(PN(I)*X(I)-SUM(LC, WDIST(I,LC)*WA(LC)*L(I,LC))));

      EQ4301..  YPC =E= PCKSH * YK + 2.6835 + .7508;

      EQ431..  YG =E= DIRTAX + TPC*YPC + INDTAX + TARIFF + TC*YK + 11.7413 + .2232;

      EQ432..  SUM(I, PWMO(I)*M(I)) + 65.4048*ER =E=  SUM(I,PWE(I)*E(I)) + FSAVE + (SUM(HH,WRLDTR(HH))+.2232+.7508)
                                                                                                      *ER;

      EQ433(LC)..  LS(LC) =E= SUM(I,L(I,LC));

      EQ434(I)..  Q(I) =E= V(I) + C(I) + Z(I);

      EQ435(I)..  D(I) + E(I) =E= X(I);

      EQ436..  PLEVEL =E= SUM(I, OMEGA(I)*P(I));

      OBJ..     UTILITY =E= SUM(HH, PROD(I,CH(I,HH)**SHARE(I,HH)))
                              + PROD(I,CG(I)**GOVSH(I));
 *
 * Assignment of initial value of some endogenous variables
 *
   Q.L(I) = QO(I); X.L(I) = XO(I); D.L(I) = DO(I); M.L(I) = MO(I); E.L(I) = EO(I);
   Z.L(I) = ZO(I); V.L(I) = VO(I); PD.L(I) = PDO(I); PM.L(I) = PMO(I); PWE.L(I) = PWEO(I);
   P.L(I) = PDO(I); PN.L(I) = PNO(I); WA.L(LC) = WAO(LC); L.L(I,LC) = XLE(I,LC);
   YG.L = YGO; TS.L = 151.7245; ER.L = ERO;  YPC.L = 178.9028;
   YK.L = SUM(I, (PNO(I)*XO(I)-SUM(LC,WDIST(I,LC)*WAO(LC)*XLE(I,LC))));
   CH.L(I,HH) = SHARE(I,HH)*((1-MPS(HH)-TD(HH))*YHO(HH)-SUM(IST, TRANS(IST,HH)));
   CG.L(I) = GOVSH(I)*((1-MPSG)*YGO-26.9288); YH.L(HH) = YHO(HH); TARIFF.L = -.7848;
   INDTAX.L = 4.872; YLABOR.L("LABOR1") = 53.5608; YLABOR.L("LABOR2") = 45.6766;
   YLABOR.L("LABOR3") = 60.7924; YLABOR.L("LABOR4") = 25.3181;
   DIRTAX.L = 7.0998;
   C.L(I) = CG.L(I) + SUM(HH,CH.L(I,HH));  ER.L = ERO; FSAVE.L = .0001;
 *
 * Setting the lower bound of exogenous variables
```

```
*
  P.LO(I) = .01; PD.LO(I) = .01; PM.LO(I) = .01; PWE.LO(I) = .01; YG.LO = .01;
  PN.LO(I) = .01; X.LO(I) = .01; Q.LO(I) = .01; M.LO(I) = .0001; E.LO(I) = .01; D.LO(I) = .01;
  WA.LO(LC) = .01; L.LO(I,LC) = .0001; YK.LO = .01; YH.LO(HH)= .01; CH.LO(I,HH)=.001;
*
* Setting the value of exogenous variables
*
  ER.FX = ERO;
  LS.FX(LC) = LSO(LC);
  TM.FX(I) = TMO(I);
  L.FX("SECTOR6","LABOR1") = 0;
  L.FX("SECTOR7","LABOR1") = 0;
  L.FX("SECTOR8","LABOR1") = 0;
  L.FX("SECTOR9","LABOR1") = 0;
*
  OPTIONS ITERLIM = 1000, LIMROW = 0, LIMCOL = 0 ,SOLPRINT = OFF, DECIMALS = 5;
*
* Definition of the model
*
  MODEL INDCGE /EQ5020, EQ5021, EQ407, EQ503, EQ413, EQ414, EQ408
                EQ415, EQ416, EQ418, EQ419, EQ422, EQ425, EQ427, EQ428, EQ4291, EQ429
                EQ4292, EQ4293, EQ4294, EQ430, EQ4301, EQ431,  EQ433, EQ434, EQ435, EQ436, OBJ /;
*
  SOLVE INDCGE MAXIMIZING UTILITY USING NLP;
*
  DISPLAY P.L, PD.L, PM.L, PWE.L, PN.L, Q.L, X.L, D.L, M.L, E.L, WA.L, L.L;
  DISPLAY V.L, CH.L, CG.L, YH.L, YG.L, YK.L, YPC.L, TS.L, C.L, FSAVE.L;
  DISPLAY YLABOR.L, DIRTAX.L, TARIFF.L, INDTAX.L, LS.L, Z.L;
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SYMBOL     TYPE   REFERENCES

A          PARAM  DECLARED      50 ASSIGNED      310      REF      442
ALPHA      PARAM  DECLARED      51 ASSIGNED      306      REF    2*310    2*442      446
B          PARAM  DECLARED      47 ASSIGNED      298      REF      430
C          VAR    DECLARED     347 IMPL-ASN      518 ASSIGNED      492      REF      424      471      521
CG         VAR    DECLARED     340 IMPL-ASN      518 ASSIGNED      488      REF      422      424      478      492
                       521
CH         VAR    DECLARED     339 IMPL-ASN      518 ASSIGNED      487      498      REF      420      424      477
                       492     521
COEF       PARAM  DECLARED      61 ASSIGNED      223      REF      428
D          VAR    DECLARED     331 IMPL-ASN      518 ASSIGNED      482      497      REF      430      432      434
                       473     520
DELTA      PARAM  DECLARED      46 ASSIGNED      291      292      REF    2*292    2*298    2*430    2*434
DIRTAX     VAR    DECLARED     360 IMPL-ASN      518 ASSIGNED      491      REF      452      465      522
DO         PARAM  DECLARED      70 ASSIGNED      282      REF      291      296      298      482
E          VAR    DECLARED     333 IMPL-ASN      518 ASSIGNED      482      497      REF      440      467      473
                       520
EO         PARAM  DECLARED      67 ASSIGNED      274      REF      282      440      482
EQ407      EQU    DECLARED     376  DEFINED      424 IMPL-ASN      518      REF      514
EQ408      EQU    DECLARED     378  DEFINED      426 IMPL-ASN      518      REF      514
EQ413      EQU    DECLARED     381  DEFINED      430 IMPL-ASN      518      REF      514
EQ414      EQU    DECLARED     382  DEFINED      432 IMPL-ASN      518      REF      514
EQ415      EQU    DECLARED     383  DEFINED      434 IMPL-ASN      518      REF      515
EQ416      EQU    DECLARED     384  DEFINED      436 IMPL-ASN      518      REF      515
EQ418      EQU    DECLARED     386  DEFINED      438 IMPL-ASN      518      REF      515
EQ419      EQU    DECLARED     387  DEFINED      440 IMPL-ASN      518      REF      515
EQ422      EQU    DECLARED     389  DEFINED      442 IMPL-ASN      518      REF      515
EQ425      EQU    DECLARED     391  DEFINED      444 IMPL-ASN      518      REF      515
EQ427      EQU    DECLARED     392  DEFINED      446 IMPL-ASN      518      REF      515
EQ428      EQU    DECLARED     394  DEFINED      448 IMPL-ASN      518      REF      515
EQ429      EQU    DECLARED     396  DEFINED      458 IMPL-ASN      518      REF      515
EQ4291     EQU    DECLARED     400  DEFINED      450 IMPL-ASN      518      REF      515
EQ4292     EQU    DECLARED     401  DEFINED      452 IMPL-ASN      518      REF      516
EQ4293     EQU    DECLARED     402  DEFINED      454 IMPL-ASN      518      REF      516
EQ4294     EQU    DECLARED     403  DEFINED      456 IMPL-ASN      518      REF      516
EQ430      EQU    DECLARED     397  DEFINED      461 IMPL-ASN      518      REF      516
EQ4301     EQU    DECLARED     398  DEFINED      463 IMPL-ASN      518      REF      516
EQ431      EQU    DECLARED     399  DEFINED      465 IMPL-ASN      518      REF      516
EQ432      EQU    DECLARED     405  DEFINED      467
EQ433      EQU    DECLARED     407  DEFINED      469 IMPL-ASN      518      REF      516
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SYMBOL      TYPE   REFERENCES

EQ434       EQU    DECLARED      409  DEFINED      471 IMPL-ASN      518       REF       516
EQ435       EQU    DECLARED      411  DEFINED      473 IMPL-ASN      518       REF       516
EQ436       EQU    DECLARED      413  DEFINED      475 IMPL-ASN      518       REF       516
EQ5020      EQU    DECLARED      374  DEFINED      420 IMPL-ASN      518       REF       514
EQ5021      EQU    DECLARED      375  DEFINED      422 IMPL-ASN      518       REF       514
EQ503       EQU    DECLARED      379  DEFINED      428 IMPL-ASN      518       REF       514
ER          VAR    DECLARED      353 IMPL-ASN      518 ASSIGNED      485       492       502       REF       426       436
                        438      454    2*467
ERO         PARAM  DECLARED      104  DEFINED      104       REF     279       280       485       492       502
ETA         PARAM  DECLARED       49 ASSIGNED      267       REF     440
FACHH       PARAM  DECLARED      149  DEFINED      149       REF     210
FSAVE       VAR    DECLARED      356 IMPL-ASN      518 ASSIGNED      492       REF       426       467       521
FSAVEO      PARAM  DECLARED       99  DEFINED       99
GOVSH       PARAM  DECLARED       56 ASSIGNED      271       REF     422       478       488
GOVTOTO     PARAM  DECLARED       98  DEFINED       98
GOVTR       PARAM  DECLARED       85 ASSIGNED      246       247     248       249       250       251       REF       459
HH          SET    DECLARED       30  DEFINED       31       REF      38        55        58        59        83        84
                         85       86       89       90       149     160       192     2*206       210       339       342
                        374      396    6*420      424     2*426   2*452     3*458     4*459       467     2*477     5*487
                        488      492  CONTROL      206       210     420       424       426       452       458       467
                        477      487      488      492     2*498
HHCONS      PARAM  DECLARED      160  DEFINED      160       REF   2*206
HHKSH       PARAM  DECLARED       59 ASSIGNED      253       254     255       256       257       258       REF       458
I           SET    DECLARED       13  DEFINED       14       REF      39        46        47        48        49        50
                         51       52       53       54        56      57        60        61        62        66        67
                         68       69       70       71        72      73        74        75        76        78        79
                         81       82       90       94       108     121       135       160       174       206       214
                        223      266      267    3*268       269   2*270       271     2*272       273       274       275
                        276      277      278    2*279     2*280   3*281     2*282       283       284       285     5*291
                      2*292    4*296    8*298      302     4*306   5*310       323       324       325       326       327
                        329      330      331      332       333     336       338       339       340       341       347
                        354      374      375      376       379     381       382       383       384       386       387
                        389      391      392      394       409     411     3*420     3*422     3*424     3*428     9*430
                      6*432    7*434    3*436    3*438     5*440   7*442     4*444     6*446     2*448     2*450     3*454
                      3*456    4*461    4*467      469     4*471   3*473     2*475     2*477     2*478     5*482     5*483
                      3*484    4*486      487      488     2*492     504   CONTROL       206       214       223       266
                        267      268      269      270       271     272       273       274       275       276       277
                        278      279      280      281       282     283       284       285       291       292       296
                        298      302      306      310       420     422       424       428       430       432       434
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SYMBOL      TYPE    REFERENCES

                         436      438      440      442      444      446      448      450      454      456      461
                       2*467      469      471      473      475      477      478    5*482    5*483    3*484      486
                         487      488      492    4*496    6*497    2*498      504
IMAT        PARAM   DECLARED       57
INDCGE      MODEL   DECLARED      514  DEFINED      514      REF      518
INDTAX      VAR     DECLARED      362 IMPL-ASN      518 ASSIGNED      489      REF      456      465      522
INTDMD      PARAM   DECLARED      108  DEFINED      108      REF      214
IO          PARAM   DECLARED       60 ASSIGNED      214      REF      281      302      444      448
IST         SET     DECLARED       38      REF      192      420      459      487  CONTROL      420      459      487
J           SET     DECLARED       39      REF       57       60      108      206    2*214    2*281    2*302    2*444
                       2*448  CONTROL      206      214      281      302      444      448
KIO         PARAM   DECLARED       79
KO          PARAM   DECLARED       78 ASSIGNED      276      REF      310      442
KTR         PARAM   DECLARED       84 ASSIGNED      246      247      248      249      250      251      REF      459
L           VAR     DECLARED      336 IMPL-ASN      518 ASSIGNED      484      498      505      506      507      508
                         REF      442      446      450      461      469      520
LC          SET     DECLARED       24  DEFINED       25      REF       51       77       80       81       87       89
                         121      135      149    2*210    2*272      284    3*306    3*310      335      336      355
                         359      392      400      407    4*442    5*446    4*450    2*458    3*461    2*469    2*484
                       3*486      503  CONTROL      210      272      284      306    2*310    2*442      446      450
                         458      461      469    2*484      486    2*498      503
LS          VAR     DECLARED      355 IMPL-ASN      518 ASSIGNED      503      REF      469      522
LSO         PARAM   DECLARED       80 ASSIGNED      284      REF      503
M           VAR     DECLARED      332 IMPL-ASN      518 ASSIGNED      482      497      REF      430      432      434
                         454      467      520
MICEL       PARAM   DECLARED      174  DEFINED      174      REF      214      223      266      267    3*268      269
                       2*270      271      273      274      275      276      277      283      285
MO          PARAM   DECLARED       66 ASSIGNED      273      REF      291      296      298      482
MPS         PARAM   DECLARED       58 ASSIGNED      225      226      227      228      229      230      REF      420
                         426      487
MPSE        PARAM   DECLARED      100 ASSIGNED      260      REF      426
MPSG        PARAM   DECLARED      101 ASSIGNED      261      REF      422      426      488
OBJ         EQU     DECLARED      415  DEFINED      477 IMPL-ASN      518      REF      516
OMEGA       PARAM   DECLARED       62 ASSIGNED      285      REF      475
P           VAR     DECLARED      323 IMPL-ASN      518 ASSIGNED      484      496      REF      420      422      428
                         432      444      475      520
PCKSH       PARAM   DECLARED      105 ASSIGNED      264      REF      463
PD          VAR     DECLARED      324 IMPL-ASN      518 ASSIGNED      483      496      REF      432      434      438
                         444      456      520
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SYMBOL      TYPE   REFERENCES

PDO         PARAM  DECLARED       74 ASSIGNED      277        REF        278        280      2*281        291        296        483
                        484
PLEVEL      PARAM  DECLARED      106  DEFINED      106        REF        475
PM          VAR    DECLARED      325 IMPL-ASN      518 ASSIGNED          483        496        REF        432        434        436
                        520
PMO         PARAM  DECLARED       75 ASSIGNED      278        REF        279        291        296        483
PN          VAR    DECLARED      327 IMPL-ASN      518 ASSIGNED          484        497        REF        444        446        461
                        520
PNO         PARAM  DECLARED       76 ASSIGNED      281        REF        306        484        486
PSI         PARAM  DECLARED       89 ASSIGNED      210        REF        458
PWE         VAR    DECLARED      326 IMPL-ASN      518 ASSIGNED          483        496        REF        438        440        467
                        520
PWEO        PARAM  DECLARED       72 ASSIGNED      280        REF        440        483
PWMO        PARAM  DECLARED       73 ASSIGNED      279        REF        436        454        467
Q           VAR    DECLARED      329 IMPL-ASN      518 ASSIGNED          482        497        REF        430        432        471
                        520
QO          PARAM  DECLARED       71 ASSIGNED      296        REF        298        482
RHO         PARAM  DECLARED       48 ASSIGNED      266        REF        291      3*298      3*430        434
SHARE       PARAM  DECLARED       90 ASSIGNED      206        REF        420        477        487
SIGN        FUNCT       REF      272
TARIFF      VAR    DECLARED      361 IMPL-ASN      518 ASSIGNED          488        REF        454        465        522
TC          PARAM  DECLARED      103 ASSIGNED      263        REF        465
TD          PARAM  DECLARED       55 ASSIGNED      239        240        241        242        243        244        REF        420
                        452      487
TE          PARAM  DECLARED       53 ASSIGNED      269        REF        280        438
TI          PARAM  DECLARED       54 ASSIGNED      270        REF        281        444        456
TM          VAR    DECLARED      354 IMPL-ASN      518 ASSIGNED          504        REF        436        454
TMO         PARAM  DECLARED       52 ASSIGNED      268        REF        279        504
TPC         PARAM  DECLARED      102 ASSIGNED      262        REF        465
TRANS       PARAM  DECLARED      192  DEFINED      192        REF        420        459        487
TS          VAR    DECLARED      346 IMPL-ASN      518 ASSIGNED          485        REF        426        428        521
UTILITY     VAR    DECLARED      349 IMPL-ASN      518        REF        477        518
V           VAR    DECLARED      338 IMPL-ASN      518 ASSIGNED          483        REF        448        471        521
VO          PARAM  DECLARED       69 ASSIGNED      302        REF        483
WA          VAR    DECLARED      335 IMPL-ASN      518 ASSIGNED          484        498        REF        446        450        461
                        520
WAO         PARAM  DECLARED       77 ASSIGNED      218        219        220        221        REF        306        484        486
WDIST       PARAM  DECLARED      135  DEFINED      135        REF        306        442      2*446        450        461        486
WRLDTR      PARAM  DECLARED       86 ASSIGNED      246        247        248        249        250        251        REF        459
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SYMBOL      TYPE   REFERENCES

                       467
X           VAR    DECLARED     330 IMPL-ASN     518 ASSIGNED      482      497      REF      442      446      448
                       456      461      473     520
XLB         PARAM  DECLARED      81 ASSIGNED     272      REF      310
XLE         PARAM  DECLARED     121  DEFINED     121      REF    2*272      284      306      484      486
XO          PARAM  DECLARED      68 ASSIGNED     275      REF      282      302      306      310      482      486
XTEMP       PARAM  DECLARED      94
YG          VAR    DECLARED     343 IMPL-ASN     518 ASSIGNED      485      496      REF      422      426      465
                       521
YGO         PARAM  DECLARED      97  DEFINED      97      REF      485      488
YH          VAR    DECLARED     342 IMPL-ASN     518 ASSIGNED      488      498      REF      420      426      452
                       458      521
YHO         PARAM  DECLARED      83 ASSIGNED     232      233      234      235      236      237      REF      487
                       488
YK          VAR    DECLARED     344 IMPL-ASN     518 ASSIGNED      486      498      REF      458      461      463
                       465      521
YLABOR      VAR    DECLARED     359 IMPL-ASN     518 ASSIGNED    2*489    2*490      REF      450      458      522
YLABORO     PARAM  DECLARED      87  DEFINED      88      REF      210
YPC         VAR    DECLARED     345 IMPL-ASN     518 ASSIGNED      485      REF      426      463      465      521
Z           VAR    DECLARED     341 IMPL-ASN     518 ASSIGNED      483      REF      428      471      522
ZO          PARAM  DECLARED      82 ASSIGNED     283      REF      483


SETS

HH          HOUSEHOLD GROUPS
I           LIST OF ALL SECTORS IN THE MODEL
IST         ALIASED WITH HH
J           ALIASED WITH I
LC          LABOR CATEGORIES


PARAMETERS

A           PRODUCTION FUNCTION SHIFT PARAMETER EQUATION (5-22)
ALPHA       LABOR SHARE PARAMETER IN PRODUCTION FUNCTION EQUATION (5-22)
B           SHIFT PARAMETER OF EQUATION (5-13)
COEF
DELTA       SHARE PARAMETER OF EQUATION (5-13)
```

PARAMETERS

DO	VOLUME OF DOMESTIC SALES BY SECTORS ('80 HUNDRED BILL. RP.)
EO	VOLUME OF EXPORTS ('80 HUNDRED BILL. RP.)
ERO	REAL EXCHANGE RATE AT THE BASE YEAR
ETA	EXPORT DEMAND ELASTICITY EQUATION (5-19)
FACHH	HOUSEHOLD INCOME ORIGINATED FROM EACH LABOR CATEGORY ('80 HUNDRED BILL. RP.)
FSAVEO	FOREIGN SAVING ('80 HUNDRED BILL. RP.)
GOVSH	GOVERNMENT CONSUMPTION SHARE
GOVTOTO	GOVERNMENT TOTAL CONSUMPTION ('80 HUNDRED BILL. RP.
GOVTR	GOVERNMENT TRANSFER TO HOUSEHOLD ('80 HUNDRED BILL. RP.)
HHCONS	HOUSEHOLD CONSUMPTION ('80 HUNDRED BILL. RP.)
HHKSH	HOUSEHOLD SHARE OF CAPITAL
IMAT	CAPITAL COMPOSITION MATRIX
INTDMD	INTERMEDIATE DEMAND ('80 BILL. RP.)
IO	INPUT OUTPUT COEFFICIENTS
KIO	SHARE OF INVESTMENT BY SECTOR OF DESTINATION ('80 HUNDRED BILL. RP.)
KO	VOLUME OF CAPITAL STOCKS BY SECTOR ('80 HUNDRED BILL. RP.)
KTR	CAPITAL TRANSFER TO HOUSEHOLD ('80 HUNDRED BILL. RP.)
LSO	LABOR SUPPLY BY CATEGORY (100.000 PERSONS)
MICEL	MICELLANEOUS PARAMETERS AND INITIAL DATA
MO	VOLUME OF IMPORTS ('80 HUNDRED BILL. RP.)
MPS	MARGINAL PROPENSITY TO SAVE BY HOUSEHOLD
MPSE	MARGINAL PROPENSITY TO SAVE BY CAPITALIST
MPSG	MARGINAL PROPENSITY TO SAVE BY GOVERNMENT
OMEGA	
PCKSH	PRIVATE COMPANIES CAPITAL SHARE
PDO	DOMESTIC GOOD PRICE (UNITY)
PLEVEL	PRICE LEVEL
PMO	DOMESTIC PRICE OF IMPORTS (UNITY)
PNO	NET PRICE OR VALUE ADDED PRICE BY SECTOR (UNITY)
PSI	PROPORTION OF EACH LABOR CATEGORY SUPPLIED BY HOUSEHOLD
PWEO	DOLLAR PRICE OF EXPORTS (UNITY)
PWMO	WORLD MARKET PRICE OF IMPORTS (UNITY)
QO	VOLUME OF COMPOSITE GOODS ('80 HUNDRED BILL. RP.)
RHO	EXPONENT PARAMETER OF EQUATION (5-13)
SHARE	AVERAGE BUDGET SHARE BY EACH HOUSEHOLD FOR EACH SECTOR
TC	TAX ON CAPITAL INPUT
TD	DIRECT TAX
TE	EXPORT DUTY RATES
TI	INDIRECT TAX

PARAMETERS

TMO	IMPORT TARIFF
TPC	CORPORATE TAX
TRANS	TRANSFERS FROM HOUSEHOLD TO HOUSEHOLD
VO	VOLUME OF INTERMEDIATE INPUT DEMAND ('80 HUNDRED BILL. RP.)
WAO	AVERAGE WAGE RATE BY LABOR CATEGORY ('80 HUNDRED THOUSAND RP. PER WORKER)
WDIST	WAGE PROPORTIONALITY FACTORS
WRLDTR	WORLD TRANSFER TO HOUSEHOLD ('80 HUNDRED BILL. RP.)
XLB	DUMMY VARIABLE FOR LABOR SUPPLY WITH NO ZEROES (100.000 PERSONS)
XLE	EMPLOYMENT BY SECTOR AND LABOR CATEGORY (100.000 PERSONS)
XO	VOLUME OF DOMESTIC OUTPUT BY SECTORS ('80 HUNDRED BILL. RP.)
XTEMP	TEMPORARY FOR CALCULATION OF XO
YGO	GOVERNMENT REVENUE ('80 HUNDRED BILL. RP.)
YHO	HOUSEHOLD INCOME IN THE BASE YEAR ('80 HUNDRED BILL. RP.)
YLABORO	TOTAL PAYMENT TO EACH LABOR CATEGORY
ZO	INVESTMENT DEMAND ('80 HUNDRED BILL. RP.)

VARIABLES

C	TOTAL CONSUMPTION OF GOOD I (100 BILL. RUPIAHS)
CG	FINAL DEMAND FOR GOVERNMENT CONSUMPTION (100 BILL. RUPIAHS)
CH	FINAL DEMAND FOR PRIVATE CONSUMPTION (100 BILL. RUPIAHS)
D	DOMESTIC SALES (100 BILL. RUPIAHS)
DIRTAX	TOTAL INCOME OVER ALL HOUSEHOLD (100 BILL. RUPIAHS)
E	EXPORTS BY SECTOR (100 BILL. RUPIAHS)
ER	EXCHANGE RATE
FSAVE	FOREIGN SAVINGS (100 BILL. RUPIAHS)
INDTAX	GOVERNMENT REVENUE FROM INDIRECT TAX (100 BILL. RUPIAHS)
L	EMPLOYMENT BY SECTOR AND LABOR CATEGORY (100.000 PERSONS)
LS	LABOR SUPPLY BY LABOR CATEGORY (100 THOUSAND PERSONS)
M	IMPORTS (100 BILL. RUPIAHS)
P	PRICE OF COMPOSITE GOOD (UNITY)
PD	PRICE OF DOMESTICALLY PRODUCED GOOD (UNITY)
PM	DOMESTIC PRICE OF IMPORTS (UNITY)
PN	VALUE ADDED PRICE BY SECTOR (UNITY)
PWE	DOLLAR PRICE OF DOMESTIC GOOD (UNITY)
Q	COMPOSITE GOOD SUPPLY (100 BILL. RUPIAHS)
TARIFF	GOVERNMENT REVENUE FROM TARIFF (100 BILL. RUPIAHS)
TM	TARIFF RATE

VARIABLES

TS	TOTAL SAVING (100 BILL. RUPIAHS)
UTILITY	OBJECTIVE FUNCTION VARIABLE
V	INTERMEDIATE DEMAND (100 BILL. RUPIAHS)
WA	AVERAGE WAGE RATE BY LABOR CATEGORY (MILL. RUPIAHS)
X	DOMESTIC OUTPUT BY SECTOR (100 BILL. RUPIAHS)
YG	GOVERNMENT REVENUE (100 BILL. RUPIAHS)
YH	HOUSEHOLD INCOME (100 BILL. RUPIAHS)
YK	PAYMENT TO CAPITAL INPUT (100 BILL. RUPIAHS)
YLABOR	PAYMENT TO EACH LABOR CATEGORY (100 BILL. RUPIAHS)
YPC	PRIVATE COMPANIES INCOME (100 BILL. RUPIAHS)
Z	INVESTMENT DEMAND BY SECTOR OF ORIGIN (100 BILL. RUPIAHS)

EQUATIONS

EQ407	TOTAL HOUSEHOLD CONSUMPTION
EQ408	TOTAL SAVINGS
EQ413	COMPOSITE GOOD AGGREGATION FUNCTION
EQ414	VALUE OF DOMESTIC SALES
EQ415	FIRST ORDER CONDITION FOR COMPOSITE GOOD MINIMIZATION
EQ416	DEFINITION OF DOMESTIC IMPORT PRICE
EQ418	DEFINITION OF DOLLAR EXPORT PRICE
EQ419	EXPORT DEMAND
EQ422	COBB-DOUGLASS PRODUCTION FUNCTION
EQ425	DEFINITION OF NET PRICES
EQ427	FIRST ORDER CONDITION FOR PROFIT MAXIMIZATION
EQ428	DEFINITION OF TOTAL INTERMEDIATE DEMAND
EQ429	HOUSEHOLD INCOME
EQ4291	DEFINITION OF TOTAL INCOME TO LABOR CATEGORY
EQ4292	TOTAL INCOME OVER ALL HOUSEHOLD
EQ4293	DEFINITION OF GOVERNMENT INCOME FROM TARIFF
EQ4294	DEFINITION OF GOVERNMENT INCOME FROM INDIRECT TAX
EQ430	PAYMENT TO CAPITAL INPUT
EQ4301	PRIVATE COMPANIES INCOME
EQ431	GOVERNMENT REVENUE
EQ432	DEFINITION OF BALANCE OF PAYMENT
EQ433	DEFINITION OF LABOR MARKET
EQ434	DEFINITION OF COMPOSITE GOOD IDENTITY
EQ435	DEFINITION OF MARKET EQUILIBRIUM

EQUATIONS

EQ436	PRICE LEVEL DEFINITION
EQ5020	CONSUMER DEMAND SYSTEMS
EQ5021	GOVERNMENT DEMAND
EQ503	INVESTMENT DEMAND BY SECTOR OF ORIGIN
OBJ	OBJECTIVE FUNCTION

MODELS

INDCGE

COMPILATION TIME = 0.851 MINUTES

MODEL STATISTICS

BLOCKS OF EQUATIONS	28	SINGLE EQUATIONS	235
BLOCKS OF VARIABLES	31	SINGLE VARIABLES	253
NON ZERO ELEMENTS	1163	NON LINEAR N-Z	642
DERIVATIVE POOL	61	CONSTANT POOL	222
CODE LENGTH	8296		

GENERATION TIME = 0.834 MINUTES

EXECUTION TIME = 1.154 MINUTES

```
             S O L V E      S U M M A R Y

     MODEL   INDCGE              OBJECTIVE  UTILITY
     TYPE    NLP                 DIRECTION  MAXIMIZE
     SOLVER  MINOS5              FROM LINE  518

**** SOLVER STATUS     1 NORMAL COMPLETION
**** MODEL STATUS      2 LOCALLY OPTIMAL
**** OBJECTIVE VALUE             79.9321

 RESOURCE USAGE, LIMIT          4.805      1000.000
 ITERATION COUNT, LIMIT       182          1000
 EVALUATION ERRORS              0             0

     M I N O S    5.2    (Mar 1988)
     = = = = =

     B. A. Murtagh, University of New South Wales
       and
     P. E. Gill,  W. Murray,  M. A. Saunders and M. H. Wright
     Systems Optimization Laboratory, Stanford University.


 WORK SPACE NEEDED (ESTIMATE)  --   22510 WORDS.
 WORK SPACE AVAILABLE          --   26446 WORDS.

 EXIT -- OPTIMAL SOLUTION FOUND
 MAJOR ITNS, LIMIT              8      50
 FUNOBJ, FUNCON CALLS          19      22
 SUPERBASICS                    0
 INTERPRETER USAGE            .24
 NORM RG / NORM PI     0.000E+00


**** REPORT SUMMARY :        0     NONOPT
                             0 INFEASIBLE
                             0  UNBOUNDED
                             0     ERRORS
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----     520 VARIABLE  P.L          PRICE OF COMPOSITE GOOD  (UNITY)

SECTOR1 1.00000,    SECTOR2 1.00000,    SECTOR3 1.00000,    SECTOR4 1.00000,    SECTOR5 1.00000,    SECTOR6 1.00000
SECTOR7 1.00000,    SECTOR8 1.00000,    SECTOR9 1.00000

----     520 VARIABLE  PD.L         PRICE OF DOMESTICALLY PRODUCED GOOD (UNITY)

SECTOR1 1.00000,    SECTOR2 1.00000,    SECTOR3 1.00000,    SECTOR4 1.00000,    SECTOR5 1.00000,    SECTOR6 1.00000
SECTOR7 1.00000,    SECTOR8 1.00000,    SECTOR9 1.00000

----     520 VARIABLE  PM.L         DOMESTIC PRICE OF IMPORTS (UNITY)

SECTOR1 1.00000,    SECTOR2 1.00000,    SECTOR3 1.00000,    SECTOR4 1.00000,    SECTOR5 1.00000,    SECTOR6 1.00000
SECTOR7 1.00000,    SECTOR8 1.00000,    SECTOR9 1.00000

----     520 VARIABLE  PWE.L        DOLLAR PRICE OF DOMESTIC GOOD (UNITY)

SECTOR1 1.00000,    SECTOR2 1.00000,    SECTOR3 1.00000,    SECTOR4 1.00000,    SECTOR5 1.00000,    SECTOR6 1.00000
SECTOR7 1.00000,    SECTOR8 1.00000,    SECTOR9 1.00000

----     520 VARIABLE  PN.L         VALUE ADDED PRICE BY SECTOR (UNITY)

SECTOR1 0.69068,    SECTOR2 0.55826,    SECTOR3 0.52662,    SECTOR4 0.61096,    SECTOR5 0.51766,    SECTOR6 0.19844
SECTOR7 0.86529,    SECTOR8 0.25452,    SECTOR9 0.61900

----     520 VARIABLE  Q.L          COMPOSITE GOOD SUPPLY (100 BILL. RUPIAHS)

SECTOR1  88.89740,    SECTOR2  30.68290,    SECTOR3  22.38970,    SECTOR4  12.60830,    SECTOR5  13.86130
SECTOR6  78.53720,    SECTOR7  37.16610,    SECTOR8 190.86000,    SECTOR9 317.20000
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----    520 VARIABLE  X.L          DOMESTIC OUTPUT BY SECTOR (100 BILL. RUPIAHS)

SECTOR1  87.72140,    SECTOR2  42.62450,    SECTOR3  22.43990,    SECTOR4  22.88350,    SECTOR5  15.18350
SECTOR6  73.89870,    SECTOR7 143.52040,    SECTOR8 133.80490,    SECTOR9 313.67620


----    520 VARIABLE  D.L          DOMESTIC SALES (100 BILL. RUPIAHS)

SECTOR1  87.36140,    SECTOR2  28.80140,    SECTOR3  22.30440,    SECTOR4  12.59960,    SECTOR5  13.85410
SECTOR6  72.70700,    SECTOR7  30.19030,    SECTOR8 119.66470,    SECTOR9 306.64850


----    520 VARIABLE  M.L          IMPORTS (100 BILL. RUPIAHS)

SECTOR1  1.53600,    SECTOR2  1.88150,    SECTOR3  0.08530,    SECTOR4  0.00870,    SECTOR5  0.00720,    SECTOR6  5.83020
SECTOR7  6.97580,    SECTOR8 71.19530,    SECTOR9 10.55150


----    520 VARIABLE  E.L          EXPORTS BY SECTOR (100 BILL. RUPIAHS)

SECTOR1   0.36000,    SECTOR2  13.82310,    SECTOR3   0.13550,    SECTOR4  10.28390,    SECTOR5   1.32940
SECTOR6   1.19170,    SECTOR7 113.33010,    SECTOR8  14.14020,    SECTOR9   7.02770


----    520 VARIABLE  WA.L         AVERAGE WAGE RATE BY LABOR CATEGORY  (MILL. RUPIAHS)

LABOR1 0.19926,    LABOR2 0.35064,    LABOR3 0.42517,    LABOR4 1.07439


----    520 VARIABLE  L.L          EMPLOYMENT BY SECTOR AND LABOR CATEGORY (100.000 PERSONS)
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	LABOR1	LABOR2	LABOR3	LABOR4
SECTOR1	217.47700	0.77500	0.35000	0.14700
SECTOR2	27.44800	0.93700	0.65000	0.11600
SECTOR3	11.11300	0.05200	0.09100	0.01400
SECTOR4	4.52300	0.70300	0.23900	0.02700
SECTOR5	8.23900	0.06000	0.09600	0.01000
SECTOR6		15.40500	0.99220	0.11400
SECTOR7		3.88100	0.40400	0.12300
SECTOR8		26.44000	2.17900	0.69100

520 VARIABLE L.L EMPLOYMENT BY SECTOR AND LABOR CATEGORY (100.000 PERSONS)

	LABOR1	LABOR2	LABOR3	LABOR4
SECTOR9		82.01400	137.98300	22.32400

---- 521 VARIABLE V.L INTERMEDIATE DEMAND (100 BILL. RUPIAHS)

SECTOR1 41.77610, SECTOR2 21.05460, SECTOR3 9.88930, SECTOR4 10.08530, SECTOR5 2.45550
SECTOR6 10.26240, SECTOR7 27.48580, SECTOR8 110.34680, SECTOR9 132.47780

---- 521 VARIABLE CH.L FINAL DEMAND FOR PRIVATE CONSUMPTION (100 BILL. RUPIAHS)

	HOUSEHOLD1	HOUSEHOLD2	HOUSEHOLD3	HOUSEHOLD4	HOUSEHOLD5	HOUSEHOLD6
SECTOR1	4.75670	23.57670	8.52500	2.10560	5.50290	1.46610
SECTOR2	1.07550	4.42740	1.68880	0.34560	1.00310	0.43490
SECTOR3	0.61970	4.29240	1.60300	0.72750	2.37940	1.85310
SECTOR4	0.39890	1.39680	0.42470	0.08250	0.13780	0.02570
SECTOR5	0.69940	4.15700	2.08160	0.80760	2.34690	1.31330
SECTOR6	5.79890	26.67460	13.15990	4.36570	11.32980	6.64870
SECTOR7	0.05480	0.30780	0.10540	0.03370	0.09250	0.05310
SECTOR8	0.64590	11.70670	6.92840	3.03710	8.86000	6.54930
SECTOR9	1.12480	19.77360	12.55780	4.79710	22.07610	16.14460

---- 521 VARIABLE CG.L FINAL DEMAND FOR GOVERNMENT CONSUMPTION (100 BILL. RUPIAHS)

SECTOR2 0.10120, SECTOR6 0.03520, SECTOR8 4.92640, SECTOR9 39.28050

---- 521 VARIABLE YH.L HOUSEHOLD INCOME (100 BILL. RUPIAHS)

HOUSEHOLD1 16.22980, HOUSEHOLD2 112.77200, HOUSEHOLD3 53.70060, HOUSEHOLD4 19.70910, HOUSEHOLD5 63.37410
HOUSEHOLD6 45.93730

---- 521 VARIABLE YG.L = 102.40230 GOVERNMENT REVENUE (100 BILL. RUPIAHS)
VARIABLE YK.L = 299.76430 PAYMENT TO CAPITAL INPUT (100 BILL. RUPIAHS)

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       521 VARIABLE  YPC.L          =    178.90280 PRIVATE COMPANIES INCOME (100 BILL. RUPIAHS)
           VARIABLE  TS.L           =    151.72450 TOTAL SAVING (100 BILL. RUPIAHS)


----   521 VARIABLE  C.L           TOTAL CONSUMPTION OF GOOD I (100 BILL. RUPIAHS)

SECTOR1  45.93300,    SECTOR2   9.07650,    SECTOR3  11.47510,    SECTOR4   2.46640,    SECTOR5  11.40580
SECTOR6  68.01280,    SECTOR7   0.64730,    SECTOR8  42.65380,    SECTOR9 115.75450


----   521 VARIABLE  FSAVE.L        =      0.00000 FOREIGN SAVINGS (100 BILL. RUPIAHS)


----   522 VARIABLE  YLABOR.L      PAYMENT TO EACH LABOR CATEGORY (100 BILL. RUPIAHS)

LABOR1 53.56080,    LABOR2 45.67660,    LABOR3 60.79240,    LABOR4 25.31810


----   522 VARIABLE  DIRTAX.L       =      7.09980 TOTAL INCOME OVER ALL HOUSEHOLD (100 BILL. RUPIAHS)
           VARIABLE  TARIFF.L       =     -0.78480 GOVERNMENT REVENUE FROM TARIFF (100 BILL. RUPIAHS)
           VARIABLE  INDTAX.L       =      4.80720 GOVERNMENT REVENUE FROM INDIRECT TAX (100 BILL. RUPIAHS)


----   522 VARIABLE  LS.L          LABOR SUPPLY BY LABOR CATEGORY (100 THOUSAND PERSONS)

LABOR1 268.80000,    LABOR2 130.26700,    LABOR3 142.98420,    LABOR4  23.56600


----   522 VARIABLE  Z.L           INVESTMENT DEMAND BY SECTOR OF ORIGIN (100 BILL. RUPIAHS)

SECTOR1  1.18830,    SECTOR2  0.55180,    SECTOR3  1.02530,    SECTOR4  0.05660,    SECTOR6  0.26200,    SECTOR7  9.03300
SECTOR8 37.85940,    SECTOR9 68.96770
```

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**** FILE SUMMARY

INPUT   A:\HOME1.GMS
OUTPUT  A:\HOME1.LST

EXECUTION TIME       =        0.411 MINUTES
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VITA

Togar Alam Napitupulu

Candidate for the Degree of

Doctor of Philosophy

Thesis: STRUCTURAL ADJUSTMENT TO EXCHANGE RATE POLICY IN A GENERAL EQUILIBRIUM FRAMEWORK: THE CASE OF INDONESIA

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Balige North-Sumatra Indonesia January 26,1953, the son of Ruben Christian Napitupulu and Omas br Simandjuntak.

Education: Graduated from Balige High School in 1971; received an Insinjur degree in Wood Technology from Bogor Agricultural University in 1976; received a Master of Science degree in Applied Statistics from Bogor Agricultural University in 1980; received a Master of science degree in Computer Science from Southern Illinois University at Carbondale in 1983; completed requirements for the Doctor of Philosophy degree at Oklahoma StateUniversity in December, 1989.

Professional Experience: Chief Systems Analysis and Programming section of the Data Processing and Statistics Center, the Agency for Agricultural Research and development of the Ministry of Agriculture, Indonesia, 1978/1980.

Honors: The Honor Society of Agriculture "Gamma Sigma Delta".