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Abstract

This paper explores the use of multisector models as tools for analyzing the relationship between alternative development strategies, growth, and structural change in a developing country. The paper first considers the evolution of general equilibrium models used for development planning, including input-output models and the recent computable general equilibrium (CGE) models. The discussion focuses on the applicability of different models to different institutional and policy environments. In the second part of the paper, two models are used to analyze the macroeconomic and sectoral consequences of alternative development strategies. A dynamic input-output model and a dynamic CGE model are both applied to the 1963-73 period in South Korea, incorporating the major features of that country's export-led, open development strategy. The two models are then used to simulate the impact of an alternative strategy of inward-looking development based on lower export growth and extensive import substitution. While the broad results are similar, the mechanisms embodied in the two models are quite different. A comparison of the empirical results and of the behavioral assumptions in the two models illustrates the range of issues that can be fruitfully investigated with different types of multisector models.

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Multisector Models and The Analysis of Alternative Development Strategies

Summary

This paper explores the use of multisector models as tools for analyzing the relationship between alternative development strategies, growth, and structural change in a developing country. The paper first considers the evolution of multisector models used for development planning, beginning with a dynamic input-output model that permits analysis of structural changes in the economy without containing policy instruments, followed by the newer computable general equilibrium (CGE) models which, through their incorporation of market mechanisms, incentive policies, and price responsive behavioral functions and substitution policies, permit explicit focus on the policy environment.

In the second part of the paper, the two models are used to analyze the macroeconomic and sectoral consequences of alternative development strategies. Dynamic input-output and CGE models are both applied to the 1963-73 period in South Korea, incorporating the major structural economic features of the highly successful export-led, open development strategy pursued throughout the period. Since the models are to be used as simulation laboratories for the analysis of alternative development strategies and policy options, historical validation of the models is done by comparing their simulation results to actual data on Korea's performance. The two models are then used to simulate the impact of an alternative inward-looking strategy based on lower export growth and extensive import substitution. The intent is to isolate the importance of

key features of Korea's open development strategy by specifying experiments with each model that force the economy to adjust to a decline in the role of exports. While the macroeconomic results of this experiment are quite similar from the two models, the mechanisms by which the two models capture the adjustment are quite different. A comparison of the empirical results and behavioral assumptions in the two models illustrates the range of issues to which each type of model can be applied. In particular, the CGE model, with its focus on market interactions, can provide an analytic framework for examining policy alternatives that the dynamic input-output model cannot provide, given its focus on real variables alone.

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1. Introduction

Policy makers in developing countries have long been concerned with issues of growth and structural change in the medium to long run. In many of these countries - and certainly in China - much of the policy debate is concerned with issues related to the choice of an "appropriate" or "best" development strategy, and of the proper mix of supporting policies. The long-run policy focus is largely on issues of economic structure; for example, the evolving relationship between industry and agriculture, the allocation of resources between exporting and import-substitution activities, the role of foreign trade and foreign investment, and the balance in production between investment goods and consumer goods. In the post-war period, the debate both within countries and internationally about the desirability of different development strategies has also become steadily more sophisticated as our understanding of the structural transformations in economies undergoing modern economic growth has deepened. The work of Clark, Kuznets, and Chenery - and their many disciples - has provided both a quantitative and theoretical appreciation of the process of economic development and of the different feasible paths that can be followed.[1/]

Along with increased knowledge about the development process, there has also been an evolution in the nature of the policy tools that governments have used to support different development strategies. From the end of World War II to around the 1960s, a large number of countries representing a wide range of political systems and levels of development relied heavily on direct regulation of the economy, especially in the areas of foreign trade and investment allocation. The middle-income, socialist countries of Eastern Europe largely followed the Soviet model of central control of most economic activities, including price setting, without regard to market mechanisms. With few exceptions (e.g., Cuba and North Korea), developing countries did not completely ignore markets, but did attempt to set a number of prices directly as well as use various direct quantitative controls of imports, exports, investment, and foreign exchange allocation.

In the early stages of development, the economic system is relatively simple and it is feasible for government policy to include many direct quantitative controls. However, industrialization necessarily involves growing interdependence among sectors and increased articulation of the economic system through an increasingly complex network of links across markets. Even in countries with a tradition of strong direct controls, as in Eastern Europe, it becomes steadily more difficult to use such quantitative controls effectively as the economy becomes more sophisticated. The dramatic shifts in the planning system (or economic reforms) implemented in countries such as Hungary and Yugoslavia in the late 1960s reflect the tension between the desire of policy makers to control the development process and the constraints inherent in the functioning of a mixed-market system. While perhaps clearest in socialist countries, this tension and its resolution in favor of increased reliance on policy tools that work through the market mechanism are evident in many developing countries. For example, there was a major policy debate in Korea in the late 1960s which was cast in terms of the desirability of "indicative" versus "quantitative" planning. The resolution of this debate did not yield less government involvement in the economy, but certainly did lead to more sophisticated use of incentives that worked through market mechanisms and less reliance on quantitative controls.2/ A similar debate is currently underway in Turkey.

Along with the evolution in the nature of policy instruments, there have been parallel developments in the analytic tools used to support policy analysis. The input-output framework pioneered by Leontief has provided the starting point for virtually all policy analysis focused on issues of the structure of production and trade, and their change under different development strategies. Historically, multisector planning models based on the input-output framework have focused on the real sphere of the economy. Such models have been widely used, even in market economies, because they provide a consistent framework for considering changes that affect a number of productive sectors in an interdependent economy.

A major problem in using simple input-output models to analyze development in a mixed-market economy is that the models do not contain the incentive instruments that are the major policy tools of planning in such economies. Taxes, tariffs, subsidies and other instruments such as exchange rate policy that work through market mechanisms and prices are not explicitly included in such models. While input-output models can provide much useful information, they cannot directly capture many of the policy links that are of primary concern to policy makers.

In this paper, we present two multisector planning models and use them to analyze the impact of the choice of different development strategies in a particular country (South Korea). Our intent is to illustrate how multisector models can be used for policy analysis and medium-term planning. In the applications, we start with a dynamic input-output model and use it to trace out the structural changes in the real economy that are associated with an open versus a closed development strategy. Although the model contains no policy instruments, it nonetheless can provide a useful framework for exploring the impact of different scenarios. We then discuss fundamental extensions of the input-output model required to provide a model able to address a wider range of development policy issues. The result is the newer computable general equilibrium (CGE) models which incorporate substitution possibilities in production and and also explicitly include market mechanisms, incentive policies, and price responsive behavioral functions.

In the next section, we describe the basic structure and properties of the two models used in the applications. Both models are applied to Korea, cover the same period (1963-73), rely on the same data base, and are used to investigate the implications of the same alternative development strategies. Korea's economic performance and actual development strategy during the period are briefly discussed as part of the discussion of the validation of the models over the historical period. We then describe the simulation of alternative development strategies in both models and discuss the influence of differences in behavioral assumptions and model structures on the results.

2. The Basic Structure of Multisector Models

This section presents the basic features of the two dynamic multisector models used in the empirical applications: an input-output model and a computable general equilibrium (CGE) model. The presentation focuses on the essential features of the models and does not attempt to survey the many alternative specifications for planning models that have been used.[3] We first consider static models and then discuss the nature of intertemporal linkages included in the two models.

2.1 Material Balances, Imports, and Exports

All multisector planning models start from the basic material balance equations of the input-output system which specifies that supply equals demand for the output of each sector:

$$X_i^d = V_i^d + F_i^d + E_i^d \qquad (2.1)$$

where X_i^d is domestic production in sector i,

V_i^d is intermediate demand,

F_i^d is final demand,

E_i^d is export demand, and

"d" is a superscript denoting domestically produced goods.

Intermediate demand is given by:

$$V_i^d = \Sigma_j \; A_{ij}^d \; X_j^d \qquad (2.2)$$

where A_{ij}^d is the domestic input-output coefficient denoting the domestic intermediate inputs from sector i required per unit of production of sector j.

Extending the simple input-output model to include foreign trade has been done in a variety of ways. At one extreme, imports are assumed to be perfect substitutes for domestically produced goods and hence exports and imports are simply treated as additional sources of demand and supply. At the other extreme, imports are seen as completely non-competitive and hence cannot be included with domestically produced goods in the material balance equation for a given sector since they are by definition not comparable. The approach we use in the two models is to treat imports separately from domestically produced goods, but not require that they be classified as either perfectly competitive or perfectly non-competitive. In the input-output model, imports are viewed as perfect substitutes for domestic goods, but are related to domestic supply according to fixed sectoral coefficients. In the CGE model, they are viewed as imperfect substitutes for domestic goods, and the sectoral import coefficients are no longer assumed to be fixed.

Define the ratio of sectoral imports to sectoral supply to the domestic market as:

$$m_i = \frac{M_i}{X_i^d - E_i^d} \tag{2.3}$$

where M_i is sectoral imports. Given this coefficient, the material balance equation for sectoral imports is:

$$M_i = m_i(V_i^d + F_i^d) = m_i(X_i^d - E_i^d) \tag{2.4}$$

In the input-output model, the import ratios are assumed to be fixed exogenously. In the CGE model, the specification is more complicated. Consumers are assumed to demand a composite good which is an aggregation of domestic and imported goods. The composite good is defined by a trade aggregation function:

$$X_i = f_i(M_i, D_i) \tag{2.5}$$

where X_i is the composite good, $D_i = X_i^d - E_i^d$ is the domestic demand for domestic production, and f_i denotes a constant elasticity of substitution (CES) function.

Assuming that demanders want to minimize the cost of acquiring a given amount of composite good, the import ratio (m_i) is a function of the relative prices of the imported and domestic goods, and of the parameters of the trade aggregation function. Thus, in contrast to the input-output model, the CGE model has import ratios which are not fixed, but are solved endogenously as part of the general equilibrium system.

The effect of the treatment of imports in the CGE model is that goods have different degrees of "tradability" depending on the parameters of the trade aggregation function. If a country wishes to substitute domestic production for imports, the model implies that this can be done only with increasing difficulty or cost as the import ratio falls. The standard input-output model cannot incorporate degrees of tradability, but it can be adapted to include in a simple way the notion of increasing costs of import substitution. Such an extension is discussed below.

In the input-output model, exports are exogenous, whereas in the CGE model they are determined endogenously. Usually it is assumed that the country is a "small" supplier in the sense that its export sales have no effect on world prices.[4/] However, in the CGE model, producers are assumed to view the domestic and export markets differently, with separate supply functions for the two markets. Producers are assumed to divert an increasing share of output to the export market if the export price rises relative to the price on the domestic market.[5/]

2.2 Supply, Demand, and Prices

The material balance equations for domestic and imported goods - equations (2.1) and (2.4) - are the core of the static input-output model. Given exogenously specified final demand, they can be solved to give production and import requirements. They thus provide a consistent framework for analyzing the structure of the economy and how it must change given different development strategies and hence different exogenously specified target levels and structures of final demand.

The input-output framework can also be extended to include a simple notion of cost prices. Given the linear technology, these cost prices will be independent of the level and structure of final demand, so there is no interaction between supply and demand in the product markets. There is also no separate treatment of the markets for labor and foreign exchange, so the model cannot endogenously determine factor prices or the exchange rate. Thus, while some consideration of prices is feasible within the input-output framework, it is very simple and does not reflect standard views about the way markets actually work.

The CGE model differs from the input-output model in two essential respects. First, many of the linear relationships in the input-output model are replaced with non-linear functions which incorporate substitution possibilities in both production and demand. Second, and perhaps more important, the model simulates the workings of the markets for labor, commodities, and foreign exchange and so embodies prices and market mechanisms as major elements of the economic system and of planning. Given the specified technology and behavioral rules, the model endogenously determines: wages, profits, product prices, and the exchange rate; sectoral production, employment, consumption, investment, exports, and imports; and the nominal flow of funds including the government, private sector, and foreign trade accounts. The price system in the CGE model is thus much more elaborate than in the input-output model and requires that the model be fully "closed" in the sense that all elements determining supply and demand be included. In the rest of this section, we discuss the specification of the CGE model by considering, in turn, the markets for factors, products, and foreign exchange.

In the factor markets, the demand for labor arises from profit-maximizing behavior of producers. Production technology is given by neoclassical production functions in primary inputs (labor and capital), and fixed input-output coefficients for intermediate inputs.[6/] Within a period, sectoral capital stocks are assumed to be immobile and the aggregate supplies of labor by different skill categories are also given. There are four categories of labor, each with its own separate labor market: farmers, unskilled labor, skilled labor, and service sector labor. Within periods, farmers and service sector labor are tied to their particular sector (i.e., agriculture and services); unskilled labor works in all sectors and is mobile across sectors within each period. Skilled labor is also mobile, but only within the industrial sectors. The CGE model determines market-clearing wages and the resulting sectoral allocation of skilled and unskilled labor.[7/] Note that in contrast to the input-output model, the CGE model is supply constrained in that the aggregate supply of primary factors limits output and growth.

In the product markets, the CGE model determines all the flow-of-funds accounts within the economy. Private income is determined from factor incomes after subtracting all taxes. Government income is obtained from direct taxes on factor and/or household incomes when these are explicitly included as well as from indirect taxes on sectoral sales and from tariffs (net of subsidies) on imports. Private demand is responsive to changes in relative prices and income.[8/] Finally, for reasons that will become apparent below, we exogenously specify the aggregate savings rate out of total value added. Given savings and consumption functions for government, the savings rate out of enterprise income is determined endogenously to achieve the specified aggregate rate.[9/]

Finally, the market for foreign exchange arises from the demand for imports and the supply of exports. Summation over all sectors in equation (2.4) yields the aggregate demand for imports expressed in foreign currency (i.e. in dollars), and hence the demand for foreign exchange. The supply of foreign exchange (and hence of imports) is obtained by summing over sectors the foreign currency earnings of exports and adding exogenously given net foreign capital inflows, if any. As explained below, the market for foreign exchange is cleared by the exchange rate, which adjusts to equilibrate the demand and supply of foreign exchange.[10/]

The CGE model simulates both the supply and demand sides of the markets for labor, commodities, and foreign exchange. When the model is solved, it yields wages that clear the labor markets, output prices that clear the product markets, and an exchange rate that clears the market for foreign exchange.[11/] However, given the Walrasian spirit of the model, these prices must be interpreted with some care. The model is Walrasian in that the real demand and supply functions implicit in all the markets are homogeneous of degree zero in wages, product prices and the exchange rate. Thus, if all prices were doubled, the real solution would remain unchanged--the model cannot determine the absolute price level. This problem is solved by specifying the absolute price level exogenously. However, all solution prices must then be viewed relative to this numeraire price index, which in our case is the wholesale price index.

The exchange rate in the CGE model must also be viewed as a relative price. Given that world prices are fixed by assumption and that the average level of domestic prices is set exogenously by the numeraire price index, changes in the exchange rate will change the relative price of imports and domestic goods. Such changes affect desired imports and exports, and so external balance can be achieved in the model by finding the appropriate exchange rate. Given that the overall price index is assumed fixed, adjustments in the nominal exchange rate to achieve external balance after some external shock represent changes in the real exchange rate.

The specification of a fixed price index which serves as the numeraire implies that the model cannot be used to explore macroeconomic issues such as inflation and stabilization policy. The model used here focuses on the resource allocation role of relative prices and is not intended to address issues of macroeconomic, flow-of-funds equilibria.[12]

2.3 Dynamic Linkages

Static multisector models are made dynamic by adding intertemporal equations which serve to update the variables which are set exogenously in the static model. There are two kinds of intertemporal equations: (1) behavioral equations which depend on the history generated by the model, and (2) time-trend equations which simply impose exogenous trends on some variables independently of the model history. Table 2.1 provides a list of the variables which provide the important intertemporal linkages in the two models.

In both models, the endogenous variables with associated dynamic behavioral equations refer to factors of production. In the dynamic input-output model, total real investment and its sectoral allocation are solved

Table 2.1

Dynamic Multisector Models:
Intertemporal Linkage Variables

Input-Output Model	CGE Model
Variables Solved Endogenously:	
Total real investment	Total real investment
Sectoral investment	Sectoral investment
	Labor migration
Variables with Exogenous Trends:	
Input-output coefficients	Input-output coefficients
Import ratios*	Import share parameters*
Exports*	Export share parameters*
Consumption*	Aggregate savings rate
Capital coefficients	Labor force growth
	Technological change
	Consumption shares

Note: * Variables whose trends are changed as part of experiments with the model.

endogenously and capital is assumed to be the only factor of production that affects growth. In the CGE model, with neoclassical production functions, trends in the size and composition of the labor force also affect growth, and migration of workers between occupational skill groups is explicitly modelled.

In both models, exogenous trends are imposed on a number of variables. These trends are imposed by specifying the initial and terminal values of the variables, and interpolating to generate the values for the intervening years. As noted in Table 2.1, some of these exogenous trends are changed as part of the analysis of the impact of following a different development strategy. In the case of the input-output model, as will be discussed in more detail below, simulations of alternative strategies require that some of the trend variables be determined endogenously.

Dynamic CGE Model

Conceptually, the dynamic CGE model consists of two distinct submodels: the static, within-period CGE model and a separate between-period model which provides the needed intertemporal linkages. The between-period model takes as exogenous all variables solved in previous periods and generates all the variables which the within-period takes as exogenous in the next period. The model is thus recursive in time so that solving future periods only requires information from previous period solutions.

As noted above, total nominal investment in the CGE model is determined by assuming a fixed savings rate out of total value added. Total real investment depends on the endogenous solution of nominal income and on the prices of investment goods. The sectoral allocation of investment is done as part of the intertemporal model by specifying sectoral shares exogenously.

While the total labor force is assumed to grow at a constant rate, its composition by labor categories is determined endogenously in the intertemporal model. There is a labor migration submodel which first establishes a pool of mobile labor and then allocates it among the different categories as a function of wage differentials which are given by the CGE model solution in the previous period.[13/] The result is that labor categories whose average income rises faster will receive a larger share of the migrant pool.

In order to capture the fact that rapid sectoral productivity growth in Korea is related to capacity expansion, the CGE model specifies that technical change in the manufacturing sectors is embodied in new investment, so that investment in later years yields more "efficiency capital" than in earlier years. In the other sectors, technical change is assumed to be disembodied. The rates of technical change are quite high, reflecting actual Korean experience, and are imposed exogenously.[14/] While the model formulation does not explicitly allow for the phenomenon of increasing returns to scale, the dynamic effect of technical change in the CGE model is equivalent to assuming falling cost curves over time.

Private consumption demand within periods is given by expenditure functions with constant shares and hence unitary own-price and income elasticities of demand. However, these expenditure shares are assumed to change over time according to observed Korean trends, so that the model does capture dynamically the changes in the structure of demand that occur as income rises and reflects non-unitary income elasticities of demand estimated from cross-country and time-series demand studies.

Table 2.1 indicates the variables for which time trends are imposed. These trends are set so that the base run of the model replicates closely the actual Korean historical experience in the 1963-73 period.

Dynamic Input-Output Model

In the dynamic input-output model, the only factor of production which is assumed to limit growth is capital. Each sector has a fixed incremental capital-output ratio and the sectoral composition of capital goods is given by fixed shares which vary across sectors. Given the desired consumption growth, these assumptions permit the determination of investment by sector of destination and its translation into demand for investment goods by sector of origin. Investment is treated separately from consumption and is determined endogenously in the dynamic model as a function of the change in output in the period.

The "solution" of the dynamic input-output model yields a multisector "target equilibrium" function which satisfies the intertemporal equilibrium conditions determining investment and depends on the specified target path for consumption and exports, as well as on the trend values of the various sets of coefficients. 15/ The model is demand driven in that it will find a time path of investment, output, and imports that is consistent with the specified time path of consumption and exports. However, such a path need not be very realistic or sensible. It is mathematically possible to specify target consumption and export paths that yield unrealistic savings rates, trade balances, or gross production structures over time.

Consequently, in order to use the model as a realistic framework for comparing different scenarios, we have imposed various restrictions that limit how radically the existing structure of a developing economy can be transformed. The first constraint is that the economy's growth path start from a point reasonably "close" to actual sectoral production in the base year. Specifically, we require that aggregate production be the same in the base year, although the sectoral structure of output can be different.16/ The second constraint is that cumulative investment over the entire plan period be equal to an exogenously specified level. Since depreciation is ignored in the present analysis, this restriction is equivalent to requiring that the economy deliver, at the close of the period, a certain pre-specified amount of productive capacity to the next generation. Such a constraint on terminal capital stock is very common in planning models and permits comparisons of different scenarios in which aggregate investment performance is held constant, or is controlled. Third, the cumulative balance of trade over the plan period is set exogenously in real terms. Thus, aggregate net foreign capital inflows, which are an important constraint in a country's development strategy, can be regulated as an element in different scenarios. Finally, the agricultural sector is treated separately, with average output growth, imports, and consumption over the period specified exogenously.

In contrast to the dynamic CGE model, the dynamic input-output model is not recursive in time. The target equilibrium in a particular year cannot, except in very special cases, be expressed as a function only of variables from past years. The growth of production and investment is endogenously determined, even though the impetus for growth is given by the growth of sectoral consumption and exports. The imposition of the aggregate constraints discussed above does not really change the essential demand-driven characteristics of the model, although satisfying these constraints requires that additional variables related to aggregate demand be set endogenously. In order to satisfy the constraint that initial-year production in the model be close to actual production, the model varies the level of aggregate consumption in the initial year endogenously. In order to satisfy the constraint that cumulative aggregate investment over time equal an exogenously specified value, the model varies the level of aggregate consumption in the terminal year endogenously. Finally, in order to satisfy the constraint that the cumulative foreign capital inflow equal the available total inflow, the model varies the average import ratio in the terminal year endogenously.[17/] In using the model for counterfactual experiments, one can vary the exogenously imposed aggregate constraints, and let the model determine the time paths of sectoral production, consumption, investment, exports, and imports endogenously.

Since domestically produced goods and imports are perfect substitutes in the input-output model, there is no cost involved in changing import ratios. Indeed, if sectoral exports all grew at the same rate, nothing would happen to production in the model if exports and import coefficients were both reduced proportionately. The structure of demand would remain the same, with supply and demand being scaled down by the same amount in each sector. In the CGE model, such changes in import ratios impose costs through the increasing difficulty of moving along isoquants of the trade aggregation function. Empirically, it is clear that in fact there are increasing costs associated with increasing import substitution, and it is thus important to adapt the input-output model so that it can capture this effect.

In the dynamic input-output model, capital is the only scarce input. Increasing domestic resource costs due to increased import substitution can thus only be reflected in the model through increasing incremental capital-output ratios (ICORs). This is done by assuming that the sectoral capital-output ratios are an increasing function of the overall degree of import substitution. The higher is the average import ratio in the terminal year (and hence in all intervening years) relative to its historical value, the higher is the capital-output ratio in all sectors. In addition, sectors which are more dependent on intermediate imports (i.e., have higher ratios of imported to total intermediate inputs) are assumed to be more severely affected by increased overall import substitution.18/

Solving for the target equilibrium path is, in general, not an easy task. Under some very stringent assumptions about the way consumption and exports grow and about the technology, it is possible to derive an analytic solution. For practical applications, however, these assumptions are much too restrictive and one must rely on numerical solution techniques.19/ In particular, we assume that all the coefficients in the model (input-output coefficients, capital coefficients, import coefficients, consumption shares, and export shares) change over time.20/ The result is a more flexible model structure that still relies on fixed coefficients, but has a number of non-linear features.

3. Korea, 1963-73: Economic Performance and Model Validation

An important part of the application of any planning model is that of "validation." Since such a model is used as a simulation laboratory for the analysis of alternative development strategies and policy options, it is first necessary to ascertain whether it adequately reflects the structural characteristics of the economy before engaging in counterfactual simulation exercises. This section provides a brief summary of the distinctive features of Korea's economic performance during the 1963-73 period, and then describes how each of the two models captures these characteristics. Historical validation of the two models is done by comparing their simulation results to actual data on Korea's performance.

3.1 Korea's Export-Led Development Strategy 21/

Korea's phenomenal economic performance has led to its frequent characterization as a prototype for other developing countries. The role of international trade was crucial and rapid GNP growth was accompanied by profound structural changes. As the data in Table 3.1 illustrate, between 1960 and 1975, the share of manufacturing in GNP rose from 10.8 to 31.9 percent and the share of exports in GNP rose from 3 percent to an astonishing 30 percent. While the average annual rate of growth of exports in low and middle income countries was around 5 percent between 1960 and 1970, Korea's exports grew at an average rate of 35 percent.

Table 3.1

Major Economic Indicators: 1960-1975

	1960	1965	1970	1975
Percent Composition of Real Value Added (1970 prices):				
Primary production	42.6	41.0	29.5	23.0
Manufacturing	10.8	13.9	21.6	31.9
Social overhead	6.0	8.5	13.3	13.7
Services	40.6	36.6	35.9	31.4
Ratios to Real GDP (Percent, 1970 prices):				
Gross investment	8.6	12.9	27.2	26.3
Total exports	2.4	5.2	14.7	28.3
Total imports	10.4	9.8	24.8	27.2
Ratios to Nominal GDP (Percent, current prices):				
Government revenue	19.8	16.1	20.1	19.7
Government savings	4.1	5.7	7.5	3.6
Total domestic savings	1.6	7.7	17.1	17.7
Gross investment	10.9	15.1	27.2	27.1
Total exports	3.3	8.5	14.7	30.2
Total imports	12.6	15.9	24.8	39.0

Annual Growth Rates (Percent)	1960-65	1965-70	1970-75
Real GNP (1970 prices)	6.2	11.1	9.7
Index of manufacturing output	9.5	24.2	23.2
Real exports (1970 prices)	24.0	36.5	25.0

Source: Westphal (1978) Table 1.

Korea's remarkable achievement owes much to the aggressive, export-led development strategy that took shape following the implementation of wide-ranging reforms in 1965. By maintaining the exchange rate near the free trade level and by granting exporters free access to imported inputs as well as explicit export subsidies, the government provided, on average, roughly equal incentives to production for export and for domestic sales within the manufacturing sector. Periodic devaluations to correct for the differential between domestic and world inflation rates maintained a nearly constant value for purchasing power parity adjusted effective exchange rates for exports and imports. 22/ Thus, in contrast to many other developing countries, Korea was successful in avoiding the deleterious effects of high domestic inflation on the relative incentives between production for export markets and production for domestic import substitution. 23/

There were, however, other "exogenous" factors which also contributed to the outward-looking strategy that Korea pursued after 1965, and that make Korea's experience less generalizable. First, Korea benefitted from unusually high levels of official foreign assistance, which were supplemented by substantial private foreign capital inflows beginning in the mid 1960s. Consequently, between 1960 and 1975, about 40 percent of total investment was financed by foreign sources. Second, Korea also benefitted from favourable initial conditions including a relatively egalitarian distribution of assets and a strong cultural emphasis on education that resulted in one of the highest literacy rates in the world. Third, Korea's export performance was facilitated by institutional incentives through which the government put pressure on all industries, including "infants", to export. Although it is still debated whether or not disaggregated export targets were a necessary condition for Korea's phenomenal export performance, it is widely acknowledged that institutional incentives played an important role.24/

Certain other interesting features of Korean economic growth emerge from Table 3.1. First, there was a marked acceleration in the rate of growth of GNP, reflecting an almost tripling of the rate of growth of manufacturing output between 1960-65 and 1965-70. Second, there was a significant increase in the share of total domestic savings in GNP. This increase in private domestic savings was at least partially in response to the spectacular rise in the estimated rates of return to capital (from 26 percent in 1962-66 to 42 percent in 1972-76) resulting from the increase in investment demand.25/

In comparison with other countries, however, the Korean domestic savings rate is not particularly high. Why is this so? There would appear to be several interlinked reasons. First, there was a "crowding out" effect of private savings by high foreign investment and high government savings. Thus, while the domestic savings rate was low, the investment rate was much higher and rose rapidly. In addition, Korea has experienced one of the highest sustained rates of total factor productivity growth in the world, estimated at 4.1 percent per annum over the period 1960-73.26/ Among the modern developing nations, only Japan's 4.5 percent growth rate was higher. Furthermore, the substantial decline in the relative price of capital goods increased the real investment resulting from a given nominal level of savings. Between 1962-75, an index of the relative price of investment goods fell from 102.4 to 60.3.27/

In conclusion, Korea's export-led development strategy was associated with a number of structural changes. First, there was an extraordinary increase in the degree of "openness" of the economy, prompted by institutional as well as price-related incentives. Second, there was a large increase in the share of investment in GDP. Third, Korea benefitted from very high rates of total factor productivity growth. These are the major features that the models must capture.

3.2 Simulating Korean Performance: 1963-73

The data used in both models has been drawn from constant price input-output tables for 1963 and 1973. 28/ Input-output coefficients, imports coefficients, incremental capital-output ratios and exports for the initial and terminal years were taken from this data set and provide the basis for imposing exogenous trends in the base runs. 29/ For both models, the sectoral composition of aggregate capital is fixed over the period. 30/

In the CGE model, the interaction between changes in sectoral demands and supplies determine, via changes in relative prices, the rate and pattern of growth in the economy. The major impetus for growth comes from capital accumulation, growth of the labor force, and technological change. In addition, to reflect the fact that the purchasing power parity exchange rate was nearly constant over the period in Korea, we have made it explicitly so in the base run of model, and have calculated the foreign capital inflows over time that validate this exchange rate. This has been accomplished by leaving the nominal exchange rate and domestic and foreign price levels all constant, thereby leaving the real exchange rate unchanged as well. To capture the sectoral performance of exports and imports during this period, exogenous trends are imposed on the parameters of the export supply and import demand functions so that trade flows reflect the actual Korean experience.

Table 3.2 compares actual values for a number of macroeconomic variables with the results of the base run for each model. For the dynamic input-output model, the base run closely replicates Korean historical

Table 3.2

Macroeconomic Indicators: Model Results vs. Actual Performance

		Ratios (Percent)		
			Model Base Runs:	
		Actual	Input-Output	CGE
Investment/GDP	1963	15.4	15.9	14.0
	1973	25.2	25.2	27.9
Exports/Output	1963	2.4	2.7	2.4
	1973	17.0	18.0	16.3
Imports/Total Supply a/	1963	12.0	12.3	12.2
	1973	15.8	16.2	16.1
		Growth Rates, 1963-73 (Percent)		
Consumption b/		7.2	7.2	6.5
Investment		15.8	15.8	17.7
Exports		35.3	35.3	35.1
Imports		15.0	15.5	15.4
GDP		10.2	10.6	11.7
Gross Output		11.4	11.9	11.7
Total Absorption c/		10.4	10.9	10.6

Notes: a/ Total Supply = gross output + imports
b/ Private and government
c/ Total Absorption = gross output + import - exports

performance. Growth rates of GDP, gross output and imports are very close to actual values. Growth of consumption and exports is identical because these rates are imposed exogenously, and the investment growth rate is identical because the capital-output ratios were adjusted to replicate actual base and terminal-year aggregate investment. The CGE model also closely tracks Korean historical experience. The rate of growth of investment is somewhat high in the model (by 1.9 percentage points) and that for consumption is low (by 0.7

percentage points). All the other macroeconomic aggregates are quite close to the actual values.

Tables 3.3 and 3.4 continue the comparison of model results with actual data by providing the sectoral structures of production and trade. Since exports are exogenous in the dynamic input-output model, the model replicates actual exports in both the base and terminal years, so the export structure is omitted from Table 3.3. Similarly, since the CGE model exactly replicates the base year, only the 1973 structure is presented in Table 3.4. Note also that there are some differences in the definitions of the sectors between the two models. Mining is included in intermediates in the dynamic CGE model and construction is included in social overhead in the dynamic input-output model.

The dynamic input-output model closely replicates the structure of production and trade in both the base and terminal years. While this result may not seem surprising given the exogenous trends imposed on the model, note that those trends were all imposed smoothly over time, with no attempt to match the actual year-to-year changes. In general, the CGE model also performs quite well in tracking Korean historical experience. While the two models are quite close, in the CGE model the average deviation of the sectoral structure of production and trade in 1973 is slightly larger than in the dynamic input-output model. The difference partly reflects the richer behavioral specification of the CGE model, which allows more latitude for divergence between model behavior and actual trends.

The use of more complex endogenous processes in the CGE model also permits more sophisticated comparisons of model and actual results. For example, since the CGE model solves for both prices and quantities

Table 3.3

Dynamic Input-Output Model: Structure of Production and Imports
(Percent)

Sector	Gross Output: 1963 Actual	Gross Output: 1963 Model	Gross Output: 1973 Actual	Gross Output: 1973 Model	Imports: 1973 Actual	Imports: 1973 Model
Agriculture	30.7	31.2	13.6	13.3	15.5	14.8
Mining	1.9	1.9	1.0	1.0	1.5	1.3
Food	9.4	9.9	10.1	10.5	2.9	2.9
Consumer goods	16.0	16.2	21.1	21.8	16.1	16.1
Intermediate goods	7.9	7.9	14.6	14.7	29.9	29.1
Capital goods	3.0	3.0	7.4	7.9	32.6	34.4
Social overhead a/	10.2	10.7	13.6	13.2	1.2	1.1
Services	20.9	19.2	18.6	17.6	0.3	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
Average percent deviation b/		0.4		0.4		0.5

Notes: a/ Includes construction.
b/ Average absolute deviation between model results and actual values, in percentage points per sector.

Table 3.4

Dynamic CGE Model: Structure of Production and Trade in 1973
(Percent)

Sector	Gross Output Actual	Gross Output Model	Imports Actual	Imports Model	Exports Actual	Exports Model
Agriculture	13.6	15.4	15.5	16.5	2.9	4.2
Food	10.1	11.0	2.9	2.9	2.9	3.5
Consumer goods	21.1	20.8	16.1	17.4	45.6	44.8
Intermediate goods a/	15.6	14.4	31.4	28.8	13.6	13.1
Capital goods	7.4	7.1	32.6	32.9	18.2	17.1
Construction	7.7	7.2	0.0	0.0	0.6	0.6
Social overhead	5.9	5.9	1.2	1.2	8.6	8.7
Services	18.6	18.2	0.3	0.3	7.6	8.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
Average percent deviation b/		0.7		0.7		0.6

Notes: a/ Includes mining.
b/ Average absolute deviation between model results and actual values, in percentage points per sector.

endogenously, one can compare actual and model price as well as quantity trends. The CGE model does capture two major trends in relative prices that occurred during the period: a rise in the agricultural terms of trade (the relative price of agriculture compared to the weighted average price of all other commodities) and a relative fall in the price of capital goods (see Table 4.8 below).

The validation of multisector models intended for use in policy analysis requires more than a comparison of numerical outcomes.[31/] While it is encouraging that both models track Korean historical trends quite closely, neither model is designed for making unconditional projections or forecasts. They are intended to be used as simulation laboratories for the analysis of the effects of pursuing different development strategies and policy packages. Model validation depends as much on judging the quality of the structural specifications and their applicability to the questions to be addressed as it does on the empirical tracking of actual economic performance.

4. Simulating Alternative Trade Strategies

4.1 Modelling an Inward-Looking Development Strategy

In this section, the dynamic input-output and CGE models are used to explore the impact on growth and the structure of trade and production of different development strategies in Korea. The intent is to isolate the importance of certain key features of Korea's open development strategy by specifying simulation experiments with each model which force the economy to adjust to a decline in the role of exports. On a macroeconomic level, the effects of imposing an inward-looking strategy on Korea should be similar regardless of which model is used. Slower growth of exports implies a decline in foreign exchange earnings and, assuming no compensating increase in foreign capital inflows, an associated decrease in imports and increase in import substitution. Indeed, assuming that lower export growth would have brought lower levels of foreign borrowing, experiments are run with both models in which cumulative inflows of foreign capital are lowered. However, the mechanisms by which the two models capture this adjustment are quite different, and require different experimental designs.

In the dynamic input-output model, slower growth in exports is modelled by halving exogenous sectoral export growth rates. This yields cumulative foreign exchange earnings over the decade-long simulation period that are only 37 percent of the base-run value, indicating the extent of the import substitution that must occur to yield balance of payments equilibrium. Increased import substitution is modelled by lowering import coefficients in the terminal year, thus also lowering them in the interim years via the interpolation process used. As discussed above, the model captures the effects of increasing costs of additional import substitution by assuming that sectoral ICORs are an increasing function of overall import substitution.

In the CGE model, the inward-looking development strategy is modelled by eliminating the exogenous trends in the parameters of both the import demand and export supply functions. Thus, if there were no changes in relative prices, import coefficients and export supply ratios are assumed to remain at their initial-year values throughout the period. The sectoral costs of import substitution are captured endogenously by the specification that imports and domestic goods are not perfect substitutes in use, which differs from the the input-output model where this cost was captured by changing the sectoral ICORs.

4.2 Simulations with the Dynamic Input-Output Model

In this section, the dynamic input-output model is used to explore the nature of an inward-looking development strategy. All the experiments start from the same basic assumption that export growth in all sectors is cut in half. The experiments differ in their assumptions about other aggregate constraints: cumulative foreign capital inflows, cumulative investment, and the extent of import substitution in agriculture. The basic features of the experiments relative to the base run are summarized in Table 4.1 below.

Table 4.1

Dynamic Input-Output Experiments: Selected Exogenous Variables
(Ratio to Base Run, percent)

		Experiments		
Feature	Base Run	Exp. A-1	Exp. A-2	Exp. A-3
Export growth rates	100	50	50	50
Cumulative investment	100	100	100	70
Cumulative foreign capital inflow	100	100	75	75
Terminal year agricultural import coefficient	100	80	60	60

In the first experiment, the economy is forced to adjust to the change in export growth only through import substitution, with no changes in cumulative investment and foreign capital inflow. In experiment A-2, cumulative foreign capital inflow is cut by 25 percent to reflect the fact that with slower export growth, Korea would not have been able to borrow as much abroad. In addition, agricultural imports are also assumed to have been cut more than in experiment A-1. In experiment A-3, part of the adjustment to slower growth is allowed to occur through reduced cumulative investment. This final experiment is the most realistic scenario. The series of experiments illustrates how the model can be used to isolate the impact of the different components that characterize a change in development strategy.

The dynamic input-output model is demand driven, so the impact on aggregate investment demand of exogenously specified components of final demand determines the rate as well as the pattern of growth in the economy. For example, slower growth will result if there is a change in the structure of exogenous demand which results in an increase in aggregate investment because the structure of production has shifted towards sectors with high ICORs.

One method of analyzing this investment-growth link is by examining changes in the economywide ICOR. Changes in this overall measure can be attributed to three separate effects: (1) exogenous trends in sectoral ICORs; (2) changes in the sectoral structure of production; and (3) overall import substitution which is modelled as affecting sectoral ICORs (with the magnitude of the effect in each sector depending on the sectoral ratio of imported to total intermediate inputs).

Table 4.2 summarizes the relevant data for the base run. If initial-year weights are used to derive an economywide ICOR, the average gross output ICOR rises from 1.01 in the initial year to 1.17 in the final year. This increase is due almost entirely to the doubling of the ICOR in agriculture during the period. However, if current-year weights are used, the aggregate ICOR falls to only 0.97 in the final year, reflecting the significant changes in output composition that occurred in Korea during the period, especially the reduction in the agricultural share of output from 31.2 percent to 13.3 percent. Finally, the information on import dependence by sector in the table indicates that for a given amount of economywide import substitution, the intermediate and capital goods sectors will be the most strongly affected, since these sectors are the most import dependent.

Table 4.2

Dynamic Input-Output Model:
Sectoral Import Dependence and ICOR's in the Base Run

Sector	Import Dependence: a/ Terminal Year	ICOR b/ Initial Year	ICOR b/ Terminal Year
Agriculture	4.7	0.81	1.64
Mining	14.1	0.53	0.40
Food	30.5	0.15	0.18
Consumer goods	28.9	0.49	0.20
Intermediate goods	40.9	0.69	0.49
Capital goods	56.2	0.34	0.14
Social overhead	14.9	2.81	2.82
Services	7.9	1.52	1.32
Economywide average ICOR,			
initial-year weights	--	1.01	1.17
current weights	--	1.01	0.97

Note: a/ The import dependence ratio is given by the ratio of imported to total intermediate inputs required by the sector.
b/ The ICOR is defined for gross sectoral output, not value added.

The macroeconomic consequences of an inward-looking strategy under the different scenarios are given in Table 4.3. In the terminal year, the investment/GDP ratio rises from 25.2 in the base run to 32.9 in A-1 and 45.0 in A-2. Because such sacrifices in terms of foregone consumption to fulfill a predetermined cumulative investment target are not realistic, experiment A-3 was designed to lower cumulative investment by 30% so that the investment/GDP ratio is nearly the same in the terminal year as in the base run. As expected, the degree of openness of the economy (as measured by aggregate export/output and import/supply ratios) is low in all experiments compared with the base run. The economywide average ICORs are given in the second section of Table 4.3, defined with both current and initial-year output weights. As described earlier, changes in this average measure can be attributed to three separate effects, which do not necessarily work in the same direction. An inward-looking strategy leads to increased production in the intermediate and capital goods sectors, which are also the most dependent on intermediate imports; however, in these sectors, the trend values of the ICORs are also falling. The importance of changes in the structure of production is evident in the difference between the ICORs using the two weighting systems. However, in the inward-looking experiments, this effect is not substantial enough to offset the rise in sectoral ICORs associated with the increased costs of import substitution, so that regardless of the weighting scheme, the ICORs under an inward-looking strategy are significantly higher.[32/]

The remaining figures in Table 4.3 suggest just how high the costs of an inward-looking strategy are likely to be. Consumption grows at an average annual rate of 7.2 percent in the base run, but only 4.9 percent in A-1 and 3.6 percent in A-3. In A-2, the growth rate of consumption falls even further, to only 1.3 percent, because so much production must be diverted toward investment as a result of the decline in foreign capital inflow. It is interesting to note that although the decrease in cumulative capital inflow was not very large (a 25 percent reduction), it had a great impact on the

Table 4.3

Dynamic Input-Output Model:
Macroeconomic Performance in Alternative Simulations

	Base Run	Experiments Exp.A-1	Exp.A-2	Exp.A-3
Terminal Year Ratios (percent)				
Investment/GDP	25.2	32.9	45.0	25.4
Exports/Output	18.0	5.3	5.7	6.3
Imports/Domestic Supply a/	16.2	8.4	7.5	7.7
Economywide Average ICOR b/				
Initial-year weights	1.17	1.74	1.89	1.74
Current weights	0.97	1.51	1.67	1.49
Real Growth Rates (percent)				
Consumption	7.2	4.9	1.3	3.6
Investment	15.8	18.2	27.6	16.2
Exports	35.3	17.7	17.7	17.7
Imports	15.5	5.6	4.3	3.1
GDP	10.6	8.5	7.6	6.9
Ratios to Base Run (percent) (Cumulative for 1963-73 period)				
Consumption	100.0	90.2	77.2	85.6
Investment	100.0	100.1	99.7	70.1
Export	100.0	36.8	36.8	36.8
Imports	100.0	60.8	51.5	51.3
GDP	100.0	91.2	82.5	83.3

Notes: a/ Domestic supply = domestic production + imports
b/ Defined for gross output.

consumption-investment balance because the economy is forced to undertake activities with rapidly increasing domestic resource costs and ICORs. The impression that import substitution is costly is confirmed by the cumulative figures reported in the table. In A-1 and A-2, where cumulative investment is equal to that in the base run, cumulative consumption for the period falls to 90.2 and 77.2 percent of the base run total. In A-3, when cumulative investment is itself reduced, consumption still represents only 85.6 percent of the base run total. Cumulative imports are 50-60 percent of the base run in all three experiments.

Figures 4.1 and 4.2 show the time profiles of foreign capital inflow and investment in the base run and the three experiments. There is a considerable flattening out of the foreign capital inflow profile in all three experiments compared to the base run. In the base run, the high growth of exports required large foreign capital inflows in the early years, with export earnings catching up only in the latter part of the period. In the experiments, with the export growth rates cut in half, the economy spreads its use of foreign capital more evenly. This observation supports the view that an export-led growth strategy may crucially depend on concentrated capital inflows in the early stages. On the investment side, experiments A-1 and A-2 indicate a marked acceleration in the investment rate towards the end of the period compared to the base run. Since the costs of import substitution rise at an increasing rate (as reflected in sectoral ICORs), more investment is needed during the latter part of the period, which results in an acceleration in investment growth compared to the base run. In experiment A-3, with cumulative investment lowered, the acceleration effect disappears and the investment time profile more closely resembles the base run profile.

FIGURE 4.1

FOREIGN CAPITAL INFLOW PROFILE

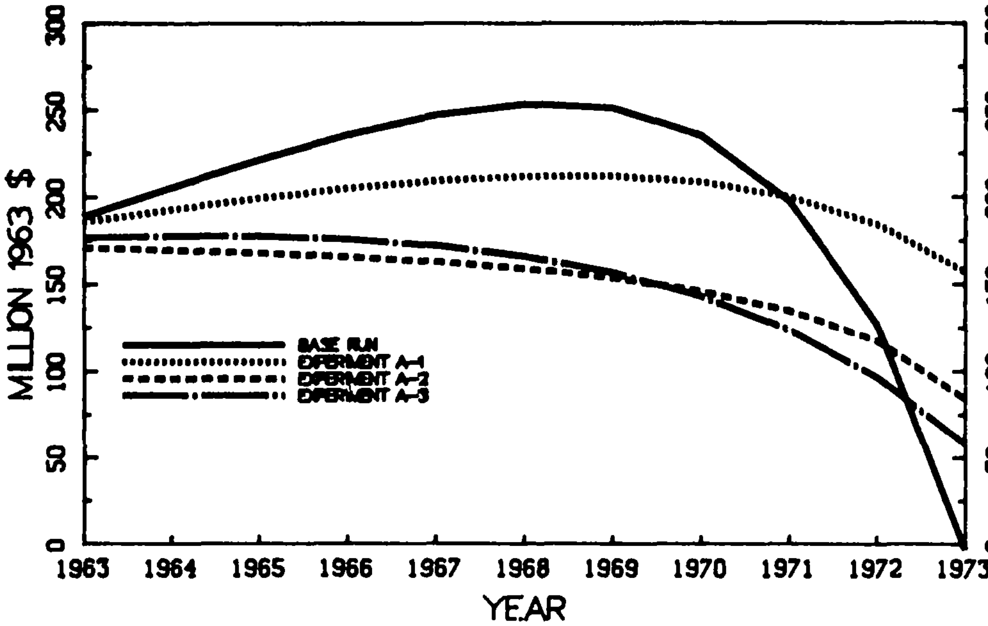
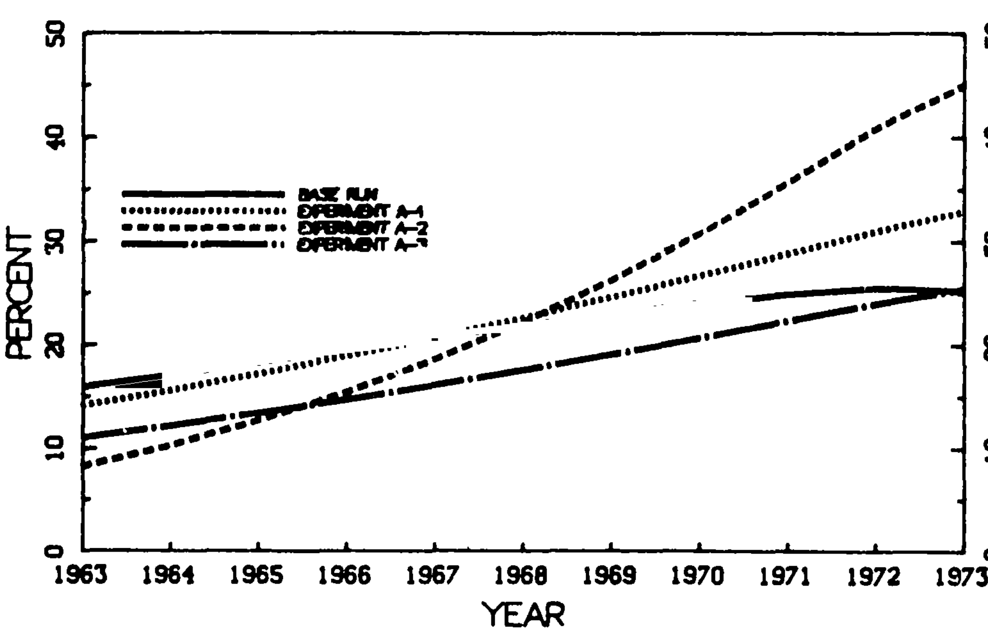


FIGURE 4.2

INVESTMENT/GDP RATIO PROFILE



Some microeconomic results from the experiments are presented in Table 4.4, which compares the structure of production, investment by destination, and imports in the terminal year between the base run and experiment A-3, which is the most "reasonable" of the three inward-looking experiments undertaken. The main structural shifts in production caused by the decline in export growth are a concurrent decline in the share of consumer goods and a rise in the share of intermediate and capital goods, due to the need to reduce reliance on imported goods. Note, however, that the inward-looking strategy is not entirely successful in terms of its objectives. Even though import ratios are lower in all sectors (except agriculture) in A-3 than in the base run, imports are still heavily concentrated in the intermediate and capital goods sectors.

Table 4.4

Structure of Production, Investment and Imports: 1973

Sector	Production Structure		Investment Structure		Import Structure	
	Base Run	Exp.A-3	Base Run	Exp.A-3	Base Run	Exp.A-3
Agriculture	13.3	17.5	6.3	5.4	14.8	25.7
Mining	1.0	1.1	0.1	0.1	1.4	1.2
Food	10.5	9.7	2.0	1.4	2.9	2.2
Consumer goods	21.9	16.6	7.8	4.0	16.1	11.8
Intermediate goods	14.7	17.0	13.3	19.1	29.1	24.6
Capital goods	7.9	11.5	3.0	8.8	34.4	33.4
Social overhead	13.2	11.2	45.0	47.8	1.2	0.9
Services	17.5	15.4	22.5	13.4	0.3	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

The experiments presented here have indicated how the modified dynamic input-output model can be used for counterfactual analysis. Of course, the results obtained depend crucially on the mechanisms chosen to capture the increasing costs of import substitution. Even with its limitations, however, the input-output model provides a useful simulation laboratory for analyzing the nature and structure of growth under different development strategies. The next section illustrates how the CGE model can be used to extend the study of alternative strategies through its focus on relative prices and the exchange rate.

4.3 Simulations with the Dynamic CGE Model

All experiments with the CGE model start by eliminating the exogenous trends in the import demand and export supply functions. In the absence of changes in relative prices, import coefficients and export supply ratios would remain at their initial year values throughout the period. The other changes in assumptions made in the two CGE experiments involve the time profile and cumulative level of foreign capital inflow. In experiment B-1, the cumulative foreign capital inflow has been left equal to that in the base run, but the time profile is changed to allow smooth yearly changes in the real exchange rate in response to changes in export and import flows. In experiment B-2, it is assumed that an inward-looking strategy would be accompanied by smaller inflows of foreign capital (38 percent lower) and changes in their time phasing. Table 4.5 below gives the foreign capital inflow pattern over the period for the base run and the two experiments.

Table 4.5

Foreign Capital Inflows, 1963-73
(Billion 1963 $)

Experiment:	Year: 1963	1965	1967	1969	1971	1973	Annual Average
Base Run	1.6	2.0	2.4	2.6	2.5	0.7	1.97
B-1	1.6	2.0	2.0	2.0	2.0	2.0	1.93
B-2	1.6	1.5	1.5	1.2	1.0	0.9	1.22

Table 4.6 presents the macroeconomic results from the two experiments. The dramatic impact on trade is immediately evident, and similar to that obtained with the dynamic input-output model. The rates of growth of exports and imports are under half those in the base run and the ratios of exports to total production and of imports to domestic demand are both much lower by the terminal year. Yet, in comparison with many developing countries, the export performance in the two experiments is quite respectable; the growth rate of exports is about double that of GDP, albeit starting from a very low base. On the import side, by the terminal year, the import share declines from 14.2 percent in the base run to 10.1 and 8.1 percent in B-1 and B-2, seriously constraining the economy.

Given that the exogenous trends in exports and imports were removed in formulating the two experiments, the observed changes in trade ratios are due to changes in relative prices alone. To achieve rising export and declining import shares, import and export prices must have risen relative to the prices of domestically produced goods sold on domestic markets.

Table 4.6

CGE Model: Macroeconomic Performance in Alternative Simulations

	Base Run	Experiments Exp.B-1	Exp.B-2
Terminal Year Ratios (Percent)			
Investment/GDP	27.9	20.1	16.6
Exports/output	16.3	4.2	4.9
Imports/domestic demand [a]	22.9	10.1	8.1
Real Growth Rates (Percent)			
Consumption	6.5	7.4	6.2
Investment	17.7	13.1	9.9
Exports	35.1	16.9	17.7
Imports	15.4	6.7	3.5
GDP	9.9	9.1	8.1

Ratio to Terminal Base Run Level (Percent)

	Base Run Level	Ratios to Base Run B-1	B-2
Exchange rate[b]	130.0	203.8	270.8
Investment goods deflater (1963=100)	91.6	119.4	138.3
Capital stock [b]			
Physical	5475	91.5	81.7
Effective	6454	88.8	77.3
Embodiment effect	979	73.6	53.2

Notes: a/ Domestic demand = total production - exports
b/ Exchange rate is in 1963 won per dollar. Capital stock figures are in million 1968 won.

With constant world prices in all experiments, these price increases come about through changes in the equilibrium exchange rate which changes dramatically in both experiments, rising steadily to 203.8 and 270.8 percent of the base run value in the terminal year in the two experiments.

The rate of growth of GDP is lower by 1-2 percentage points, so that by the terminal year, the economy is significantly worse off compared to the base run. In the two experiments, investment is much more severely affected than consumption; terminal-year real investment is 33-50 percent lower than in the base run, while real consumption grows only slightly more slowly in B-2 and actually expands faster in B-1 than in the base run. The terminal-year effective capital stock (which includes embodied technical change) is 11-23 percent lower. Thus, as with the dynamic input-output model, the inward-looking development strategy imposes serious costs on the economy.

The asymmetric impact on consumption and investment in the two experiments merits further comment. The economy depends heavily on imported capital goods - as do most developing countries - and the devaluation raises their domestic durrency price. This effect can be seen in the movements in the investment goods deflater in Table 4.6. In the base run, investment became cheaper as the deflater fell to 92 in the terminal year; in experiments B-1 and B-2, the average relative cost of investment was 19-38 percent higher than in the base run. The result is that the same nominal savings buys quite different amounts of real capital goods in the three runs. The increase in price leads to lower real investment.

A large portion of the change in the investment goods deflater can be traced to price changes in the capital goods sector, which in the base year constitutes about a third of a unit of sectoral investment, with construction accounting for most of the rest. In the capital goods sector, the dependence on imported sources of supply is extremely high; the ratio of imports to domestic demand is over 100 percent in the initial year. Since the elasticity of substitution between domestically produced and imported capital goods is low, imports cannot be easily replaced by domestic production, and import substitution dramatically increases the "average" price of capital goods.

In experiment B-1, the decline in real investment is matched by a corresponding rise in consumption which outweighs the fall in GDP, so that real consumption increases compared to the base run. In experiment B-2, further expenditure reduction is forced on the economy by the decrease in foreign capital inflow. While, relatively, this is a less severe shock to the economy in terms of lost foreign exchange than the shift to an inward-looking strategy in experiment B-1, the impact of the fall in foreign capital inflow is substantial. In GDP growth terms, the incremental effect of experiment B-2 is roughly comparable to that of experiment B-1. As in the input-output model, this result can be traced to the fact that the incremental costs of additional reductions in foreign exchange inflows rise rapidly.

While this real investment effect is undoubtedly important in LDC's, the CGE model probably overstates its magnitude. The small supply response of domestic producers in the face of enormous price increases is probably unrealistic. There are examples of countries such as Turkey and Mexico which have followed inward-looking development strategies for long periods and managed to expand domestic capacity to produce capital goods. Questions of economies of scale, learning by doing, and X-efficiency arguments--which are ignored in the CGE model--become important and might partially offset the results obtained with our particular model specification. In addition, the macroeconomic specification whereby consumption suffers the least from the change in development strategy is also probably overstated. The contrast with the dynamic input-output model is especially interesting since, in the first two experiments with that model, it was consumption which suffered the most.

In the CGE model, there is no direct link between export performance and productivity growth in exporting sectors. Factors such as economies of scale in exporting sectors and increased efficiency arising as a response to foreign competition are often cited as justifying the assumption of such a link--for example, see Balassa (1975). By neglecting such effects, the two experiments probably understate the costs associated with switching to an inward-looking development strategy. While the decline in the growth rate of GDP of one to two percentage points is thus a very optimistic estimate of the impact of switching strategies, it does indicate the strength of the indirect links which are currently included in the model.

As might be expected from the macroeconomic analysis, the inward-looking development strategy involves significant changes in the sectoral structure of growth. Table 4.7 presents the growth rates of sectoral output in the base run and the two experiments. Predictably, the major export sectors, especially consumer goods, suffer and - with the fall in aggregate investment - capital goods and construction also grow much more slowly than in the base run. Agriculture, food, social overhead and services are much less affected.

These sectoral results are largely comparable to those obtained from the dynamic input-output model. In both models, given that the experiments largely affect the role of foreign trade, the final impact on the industrial sectors depends crucially on their dependence on imported intermediate inputs and on their orientation toward the internal or export market. However, the mechanisms at work in the two models are quite different. In the CGE model, sectoral demand does not directly determine supply, but affects it only through the price mechanism--increased demand leads to higher prices in the product markets. From the supply side, the response depends on what happens to input costs and on the production function which determines the sector's ability to change output in response to price signals. The supply elasticities of the agriculture, services, and social overhead sectors are quite low, and there is thus little change in their output growth rates even through there are significant changes in their relative prices. In the other sectors, supplies are more responsive to changes in prices and hence market interactions have more effect on the final outcome.

Table 4.7

CGE Model Simulations:
Growth Rates of Sectoral Output
(Percent)

	Base Run	Experiment B-1	Experiment B-2
Agriculture	3.7	3.7	3.4
Food	13.6	14.2	13.3
Consumer goods	14.7	11.4	10.3
Intermediates	18.7	18.0	17.4
Capital goods	21.9	15.4	12.4
Construction	14.8	11.9	9.5
Social overhead	14.2	14.0	13.5
Services	10.2	10.3	9.9
Total	11.7	10.6	9.8

Table 4.8 shows the evolution of relative gross domestic prices and net prices in the base run and in the two experiments. With the exception of consumer and intermediate goods, relative prices do not change much in the base run.33/ The reason for the rise in the domestic price of consumer goods is, of course, their phenomenal export growth. In the base run, consumer good

exports grow at 42 percent a year.34/ For intermediate goods, the high trend growth rate of imports keeps the demand for domestic substitutes low and hence leads to a decrease in the domestic price. A similar trend in imports of capital goods prevents their price from rising. Thus, the export-led development strategy, by making it possible to maintain a low value of the real exchange rate, allowed for the ample provision of intermediate and capital goods at low domestic prices.35/

Table 4.8

CGE Model Simulations:
Structure of Terminal Sectoral Relative Prices

	Base Run Values		Ratios to Base Run (percent)			
			Exp. B-1		Exp. B-2	
Sector	PD	PN	PD	PN	PD	PN
Agriculture	0.98	0.68	112	118	97	100
Food	0.92	0.18	92	78	83	78
Consumer goods	1.25	0.39	66	56	66	64
Intermediates	0.86	0.31	90	71	98	87
Capital goods	0.98	0.37	106	43	127	43
Construction	0.89	0.24	94	63	101	54
Social overhead	0.95	0.44	74	70	64	68
Services	0.93	0.65	87	91	73	74
Average	0.98	0.44	90	88	85	83

Notes: PD is the domestic price. In the base year, PD equals one for all sectors.
PN is the net price or value added per unit of output, and hence PN/PD is the value added ratio.

The last four columns in Table 4.8 give the ratios of domestic and net prices in the terminal year in the two experiments to the values in the base run. First, note that there is a general decline in domestic prices. Given a constant overall price index of domestic and imported goods, a devaluation which increases the domestic-currency prices of all imports must lead to a compensating fall in average domestic prices, although this may be accompanied by major changes in relative domestic prices as well. In particular, the relative prices of the sectors in which there is little trade (social overhead and services) fall a lot. Construction is a special case since its price is linked to aggregate investment. Consumer goods prices collapse because the decline in exports leads to a glut in the domestic market.

In import-competing sectors such as capital goods, with less foreign exchange available, there is a strong upward pressure on relative prices. Note, however, that the net price of capital goods falls to 43 percent of its base run value in the two inward-looking experiments. The reason is that the sector is dependent on imported intermediate inputs whose costs are rising, thereby squeezing value added. The construction sector is similarly dependent on imported intermediates. In the terminal year in the base run, imported intermediate inputs account for 29 and 18 percent of the total costs of production in the capital goods and construction sectors, higher than in any other sectors. In the two experiments, these costs soar to 48 percent (B-1) and 64 percent (B-2) in the capital goods sector and to 27 percent (B-1) and 33 percent (B-2) in construction. It is obvious why these two sectors suffer under the inward-looking development strategy.

The sectoral analysis indicates that there are many mechanisms at work which affect the structure of growth. While it is straightforward to trace out the particular linkages which determine the net impact in a given sector, it is much more difficult to predict the final effect a priori. The linkages are well understood theoretically, but an empirical model is required to determine the relative magnitudes of the different effects and to give quantitative measures of the impact of different strategies on sectoral growth and structural change.

5. Conclusion

The analysis of growth and structural change in the medium term, and of the impact of different choices of development strategy, requires consideration of direct and indirect linkages that can only be captured within the framework of a multisector model. Within the multisector framework, there are many different approaches to modeling the important relationships that are fundamental to an understanding of how different development strategies "work" in an economy. The two models discussed in this paper are at opposite ends of the spectrum in terms of behavioral assumptions, specification of technology, institutional detail, and representation of market interactions. However, both models are flexible enough to provide good simulation laboratories for exploring the quantitative effects of different development strategies, and both capture the inter-industry linkages that are a crucial part of the story.

The parallel application of the two models to analyze the same issue - the choice of an outward-looking versus an inward-looking development strategy - brings out clearly the nature of the differences in behavioral assumptions and model structures. While the empirical results indicate that the two models are in broad agreement, there are significant differences in the mechanisms by which the results are generated. The dynamic input-output model focuses on real variables alone, and does not embody the links between real outcomes and policy instruments that work through their effect on market incentives. The CGE model, which explicitly incorporates market interactions, can provide a framework for the analysis of policy choices in a mixed-market economic system in which incentives are important.

Footnotes

1/ See Kuznets (1966), Chenery and Syrquin (1975), and Chenery (1979).

2/ See Adelman and Westphal (1979) for a discussion of the evolution of planning in Korea.

3/ For such a survey, the reader is referred to Dervis, de Melo and Robinson (1982), which also provides a more detailed discussion of the equations of the two types of models used in this paper.

4/ While the small country assumption is usually appropriate on the import side, there are examples on the export side where it is more realistic to specify downward sloping export demand curves.

5/ The chosen functional form in the application below implies that the ratio of exports to domestic production in each sector is an increasing function of the ratio of the export to the domestic price. Note that the treatment of exports and imports in the CGE model precludes the complete specialization that would be predicted by trade theory for a small open economy. With the functional forms selected, there will always be a demand for imports, while exports in a given sector can neither disappear nor include all production. While somewhat restrictive, this specification is certainly plausible for an empirical model, especially at a relatively high degree of aggregation where two-way trade is observed in nearly all sectors.

6/ While the composite input-output coefficients are fixed, the import ratios and hence the domestic input-output coefficients (A_{ij}^d) are determined endogenously.

7/ In cases where there is a labor surplus, one can alternatively fix the real wage, in which case the model determines employment.

8/ In the application below, no attempt is made at modeling consumption demand for different socioeconomic groups; there is one representative consumer and demand functions have fixed expenditure shares.

9/ There is an extensive literature on alternative macroeconomic specifications in these models. See Dervis, de Melo and Robinson (1982) and Taylor (1979).

10/ If the exchange rate is fixed, then the model determines capital inflows endogenously. Other equilibrating mechanisms have also been modeled.

11/ Finding such a solution numerically requires an appropriate computer algorithm. For a survey of such algorithms, see Dervis, de Melo and Robinson (1982), Appendix B.

12/ For a discussion of the problems of integrating macroecronomic concerns in a CGE model, see Robinson and Tyson (1981).

13/ There are also exogenous trends imposed in the CGE model on the size of the pool of migrant labor over time. The total labor force is assumed to grow at an annual rate of 4.5 percent.

14/ The sectoral rates of disembodied technical change are: agriculture (3%), services (3%), construction (6%), and social overhead (6%). The rates of embodied technical change in all the manufacturing sectors are the same (8%).

15/ This discussion finesses a great deal of mathematics, especially regarding the stability properties of the solution. Suffice it to say that we have successfully dealt with the notorious instability problem of the dynamic input-output model. Mathematically, the "target equilibrium" is termed the "particular solution" or "particular integral." For a complete discussion and justification of our approach, see Dervis, de Melo and Robinson (1982), Chapter 2.

16/ Mathematically, the initial-year production vector in the model solution is required to have the same Euclidean norm as that of the corresponding actual output vector in the base year.

17/ Import ratios by sector in any year are determined by interpolating between initial and terminal-year values. Thus, changing the average ratio in the terminal year also changes the ratios in all but the initial period. Fixing agricultural output in the model requires separate adjustment of the agricultural import ratio.

18/ Formally, the function is:

$$k_{i,T} = k^{o}_{i,T}(\hat{\mu})^{-\alpha m^{o}_{i,T}}$$

$k^{o}_{i,T}$ = the actual incremental capital-output ratio for sector i in the terminal year,

$m^{o}_{i,T}$ = the actual ratio of imported to total intermediate inputs in sector i in the terminal year,

$1-\hat{\mu}$ = import substitution expressed as a fractional reduction in all terminal-year import coefficients,

α = a response parameter, and

$k_{i,T}$ = terminal year incremental capital-output ratio for sector i.

19/ For a description of the solution algorithm, see Powell (1970).

20/ Contrast this treatment with the model described in Dervis, de Melo and Robinson (1982), Chapter 4, in which all the technical coefficients were assumed to be constant over time. The model here is much more difficult to solve, but is much more realistic.

21/ This summary of Korea's economic performance draws heavily on Westphal (1978).

22/ The effective exchange rate is the number of units of local currency actually paid or received for a one-dollar transaction; the purchasing power parity adjusted effective exchange rate (PPP-EER) is the effective exchange rate multiplied by the ratio of the foreign price level to the domestic level.

23/ Between 1955 and 1975, Korea's domestic price index rose at an annual average rate of 13.5%, while the world price index rose at an average of 2.7% (Kim (1980)). Over the period 1965-75 (excluding 1973), the PPP-EER for exports varied between 250 and 285 and the PPP-EER for imports varied between 250 and 290 1965 won per dollar (Westphal (1978), Table 2).

24/ For further discussion, see Westphal (1978), pp. 375-6.

25/ Williamson (1979), Table 2.

26/ Christensen and Cummings (1981), Table 10, p. 298.

27/ Kim and Roemer (1979), Table 37, p. 73, using 1962-65 and 1972-75 averages.

28/ The data were prepared by K.S. Kim under the auspices of the World Bank research project, "A Comparative Study of The Sources of Industrial Growth and Structural Change," (RPO 671-32). The deflation procedure used in compiling this data set evaluated all goods and services, including imports and exports, in protected domestic prices of 1968. Thus, the changes in the rates of protection between 1963 and 1973 resulted in an average GDP growth rate of 13.7 percent per year as compared to a national income growth rate of 10.4 percent. In order to base our discussion on the more commonly accepted growth rate from national income statistics, we have adjusted the 1963 input-output flows upward proportionately to achieve an average GDP growth rate of about 10 percent. The intersectoral structures of production, demand, and trade, however, are kept unchanged.

29/ In the dynamic input-output model, the original estimated sectoral incremental capital-output ratios for both the initial and terminal years were adjusted proportionately in order to approximate actual aggregate investment in the two years in the base run.

30/ The matrix is estimated for 1968 by Adelman and Robinson (1978).

31/ One can also argue that the validation of econometric models is not as straightforward as classical statisticians would have us think. For an interesting discussion of validation issues, see Powell (1981).

32/ The attenuation of the increased costs of import substitution through shifts in the structure of production was explicitly analyzed by Domar (1957) in a two-sector model. Our particular specification only roughly models the effects of these costs. More empirical work is required at the sectoral level to estimate them properly.

33/ All domestic prices in the base year equal 1.0.

34/ By the terminal year, consumer goods represent well over half of the total dollar value of merchandise exports in the base run.

35/ See Balassa (1975) for a discussion of the impact of alternative real exchange rates in inward and outward-looking development strategies.

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