International Linkages of the Korean Economy: Simulations with the Korean Global Model

Peter Boone, Jong-Wha Lee, and Jeffrey Sachs*

This paper introduces a dynamic general equilibrium model of the Korean economy. The Korean economy has nine producing sectors and is linked to other blocks in the world, which consists of the U.S., Japan, Rest of the OECD, OPEC, and other economies. Some simulation results are presented to show the functioning of the Korean economy and its linkages to the world economy given internal and external policy changes.(*JEL* Classification: C50, E17)

I. Introduction

The Korean economy has grown at remarkable rates over the last two decades. Between 1967 and 1987 real GNP grew by over five fold and real exports grew by fifty-one fold. This performance has raised Korea's income per capita, placing her above most of the resource rich Latin American countries. Her current performance suggests that if this trend continues, she can catch up members of the G-7, such as Canada, over the next few decades.

This rapid growth has precipitated calls for economic change both internally and externally. There have been discussions of the need for structural adjustment in domestic financial markets in order to provide a more mature economy with its financing needs. And there have been external calls for structural adjustment. Industries which have been historically protected are finding their tariff barriers threatened as the government succumbs to external pressure to dismantle trade restric-

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tions. And the policy of export orientation, a key aspect of Korean success in the past, can no longer be carried out without some cooperation with other industrialized countries.

This increased Korean integration in the world economy and world politics has made it essential that Korean policy makers have excellent knowledge of the linkages between their own economy and their trading partners. In order to cooperate with foreign countries, and to analyze the effects of structural adjustment, Koreans must have available careful studies of the functioning of the Korean economy and its linkages to the world economy.

In this paper we introduce a model of the Korean economy which aims at both specifying these linkages, and at making empirical estimates of the importance of these linkages. The model, which we call the Korean Global Model (KGM), is a carefully specified, computable general equilibrium model of the Korean economy. The model consists of a Korean block which is linked into a global framework, and includes other blocks modeling the U.S., Japanese, OECD, OPEC and other economies. We have modeled nine separate producing sectors in the Korean block. Thus the model can be used to analyze both the effects of domestic policies which affect structural adjustment, and the effects of shocks originating in foreign countries, on the Korean economy.

In order to specify the Korean block of the model we have examined many of the traditional macroeconometric models found in the literature. These include Bank of Korea (1984a, 1984b), Park (1987), Park and Ro (1988) and the computable general equilibrium models by Kwack (1983), Kubo et al. (1983) and Lee (1989). We have also examined multi-country CGE models such as the Federal Reserve Board's Multi-Country Model (MCM) and the Economic Planning Agency's (EPA) World model.

We believe our model has a number of advantages over these other models for the type of analysis we wish to consider. First, unlike the models mentioned above, this model permits the incorporation of rational expectations and forward looking intertemporal behavior on the part of individual agents. This implies that decisions based on profit maximization can be properly specified. For example, such considerations are particularly important in determining exchange rate movements and international capital flows when there is free capital mobility. Second, we carefully take into account stock-flow relations and budget constraints. We are careful to guarantee that net world trade flows add to zero. and that current account imbalances are reflected in

changes in net foreign indebtedness. We also take into account the government budget constraint so that fiscal multipliers can be properly determined in conjunction with the financing decisions of the government.

A third advantage of this model is our careful specification of the supply-side of the Korean economy. Most large CGE models in operation today have not properly specified aggregate supply and they often effectively assume a flat supply curve. One implication of this is that fiscal multipliers are often quite high as they reflect only the standard Keynesian multiplier with no supply constraint. By specifying a supply side of our model, and by estimating equations for the supply of labor, we are able to incorporate the important role of relatively rapid adjustment of labor markets in the Korea economy.

A final, and more technical advantage of this model is its relative ease of use and flexibility. It is a simple procedure to change the model structure in order to examine how regime shifts affect the standard multipliers. For example, below we discuss how the impact of fiscal policy upon the Korean economy changes when she has a regime of perfect capital mobility and flexible exchange rates, in comparison to a regime with the Won fixed to the U.S. dollar. And the manpower and machinery required to operate and simulate the model is limited. One person can simulate the model using a personal computer. And to restructure the model and run a half dozen policy experiments takes roughly two hours. This implies that sensitivity analysis, and a comparison of various policy scenarios can be carried out quickly and with little cost.

The current version of the model is very preliminary, and part of the aim of this paper is to promote comments from readers which will improve the structure and parameterization of the model. While many of the behavioral relationships have been carefully specified and estimated econometrically, there are certain key relationships which we are not yet satisfied with, and which in the future we will modify. For this reason the simulation results must be treated as illustrative of model structure but preliminary. While the Korean block of the model is new, the specification of the blocks representing other countries and regions represents a hybrid of previous work (see e.g. McKibbin and Sachs 1986, 1989; McKibbin 1987; Sachs and Roubini 1987).

The paper is divided into three sections and one appendix. In the first section we give a brief overview of the model and discuss the key underlying behavioral assumptions. A more complete and detailed

account of the Korean block of the model is given in the appendix. And a discussion of the structure of the remaining blocks can be found in Sachs and Roubini (1987). In section two we present some simulation results from the model. We divide this section into three sub-sections. The first subsection examines the impact of Korean policies upon Korea and the rest of the world. Here we illustrate how changes in Korean fiscal, exchange rate, and credit policies affect domestic macroeconomic indicators, the structure of production, and international balances. The second section examines how foreign policy disturbances impact upon the Korean economy. Here we examine U.S. monetary policy, and contrast the effects of U.S. and Japanese fiscal policy. Finally, in the third subsection we examine how changes in policy regimes affect the simulation properties of the model. The changes we consider are the change from an exchange rate rule which fixes the Won in terms of the dollar to one which fixes the Won in terms of the Yen, and secondly a complete liberalization of capital markets and the imposition of a flexible exchange rate regime. We use both experiments to illustrate the flexibility of the KGM in dealing with a range of policy regimes.

II. An Overview of the KGM

A. The Korean Block in the KGM

A full description of the Korean block of the model is given in the appendix. In this section we outline the basic structure of the model and we highlight the key relationships which determine the simulation properties of the model. We also point out the strengths and weaknesses underlying our assumptions, and discuss areas where more econometric work is needed to specify these relationships.

There are nine produced goods in the Korean block along with one imported good: oil. The produced goods are defined as the nine sectors: agriculture, textiles, other light industry, metals and machinery, transportation equipment, other heavy industry, construction, services, and housing. The model structure is based upon the relations found in a consolidated Input-Output table for Korea from 1983. The goods from each sector are used as intermediate inputs in production in the other sectors, and in final demand for private and public consumption, investment and trade.

Aggregate consumption is currently specified as an *ad hoc* function

of disposable income and wealth. This is perhaps the most problematic behavioral relationship in the current version of the model. A low marginal propensity to consume is assumed to reflect the high Korean savings rate and a high propensity to save out of additional income. The wealth term captures a small effect of wealth on aggregate consumption, and also an indirect effect from changes in interest rates. As interest rates rise the present value of assets such as stocks tend to fall, and this will increase savings through the wealth term.

Having determined aggregate consumption, we allocate consumption across sectors according to a system of linear demand equations which we have econometrically estimated. The choice of a linear demand system was made so as to permit the income elasticity of demand for each product to differ from its expenditure share in total consumption. Such a specification will capture the long-run trend of declining expenditure shares in non-luxury goods such as food and clothing.

Gross investment by each sector is determined as a linear function of a variable measuring the future profitability of new investment (Tobin's Q), and a variable capturing the ability of firms to finance current investment as determined by their cash flow. Tobin's Q is the present discounted value of the future returns on a dollar of additional investment, while the cash flow term is simply the gross revenues of the firm less the payments to factor inputs. Adjustment costs to changing capital cause investment to respond gradually to changes in the profitability of new investment as discussed in Hayashi (1979).

Ideally we would like to econometrically estimate the relative importance of each of these terms in determining total investment, but the empirical difficulties have proven difficult to overcome. The usual difficulty of measuring Q is exacerbated in Korea by the lack of a good measure of the market value of capital. And we have been unable to find alternative variables which will proxy for Tobin's Q. And while a simple regression of investment on cash flow terms does give a significant role to cash flow, we suspect this is partially due to a simultaneity bias with the omitted measures of the true future profitability of investment. We have chosen therefore to weight each variable according to what we consider to be plausible parameter values, and in the future we hope to get better estimates of these weights.

The investment good is assumed to be common to all sectors and is constructed using a fixed coefficient technology from imports and domestic goods. This allows us to allocate investment demand across sectors and to imports. The relevant price index is then calculated as

the cost of these inputs.

Government expenditures in each sector are treated as policy variables which are exogenous in the model and fixed in terms of the GDP deflator. Export demand equations have been carefully estimated for six of the nine sectors. Korean exports in all sectors *except* construction, services and housing, to the United States and Japan are functions of the receiving country's income and their relative price. We also model third party competition by including the competing country's price (either the U.S. or Japan) in the demand equations. The results are described in the appendix and reflect a fairly high degree of price sensitivity of exports. When the Korean price of the good rises, or when the competitor's price of the good falls, Korean exports are reduced. The income elasticities of demand vary from 0.5 to 3 depending on the country and good.

Exports to the OECD and the rest of the world, and for the remaining three sectors for which we have not estimated equations, are assumed to have price elasticities of demand equal to –2, and income elasticities of demand equal to 1.5. These parameter choices reflect roughly the mid-points in the range of the estimates found for the U.S. and Japan.

To determine Korean imports from the rest of the world, we first sum up the demand for each of the intermediate inputs by type of good. Next we allocate this demand to either imported goods, or the domestic version according to a CES production function. Having determined imports of intermediate inputs, we then add the imports from the remaining final demand sectors (consumption, investment and government) to determine aggregate imports by sector. The imports by sector are then allocated to each country assuming that the share of expenditures on imports from each region in the world, by sector, is held fixed. These sectoral shares are determined from the direction of trade statistics. The imports from the rest of world sector and the OPEC sector are assumed to have fixed prices in terms of U.S. dollars.

The supply side of the model is structured according to an Input-Output table. Each sector produces a good using as inputs the goods of all other sectors, along with capital, labor and oil. The production function is Leontief, with output being created using fixed proportions of each of the intermediate inputs and value added. The value added bundle is a Cobb-Douglas function of labor and capital. The required proportions of each input are determined directly from the actual inputs used in our Input-Output table. These are given in the appendix.

The financial sector in the model remains very crude and will be structured more carefully in the future. We specify a Goldfeld money demand equation to determine aggregate money demand, and the evolution of the money supply is determined in conjunction with the choice of the exchange rate regime. When exchange rates are fixed, the monetary authorities purchase or sell reserves for domestic currency in order to guarantee monetary equilibrium. When the exchange rate is flexible, the money supply and reserves are held fixed while the exchange rate adjusts to clear the money market. In both cases the authorities control the purchase and sale of foreign assets so that net foreign indebtedness is held exogenous.

We have made no attempt as of yet to model public finance in the model. Taxation is lump-sum, and there are currently no distortionary taxes. To impose the government budget constraint we model lump sum taxes as being equal to the real interest payment on government debt.

The block is closed by specifying that prices adjust so that supply equals demand for each of the nine goods. Wages are determined according to a Phillips curve equation which we estimated, and labor supply is perfectly elastic at the given nominal wage. Nominal wages are partially indexed to inflation and are very sensitive to unemployment. This sensitivity to unemployment causes wages to adjust quickly so that the economy returns to full employment within a few years of any shock. Such rapid adjustment in labor markets is characteristic of many east Asian countries but is not characteristic of North American or European labor markets.

The stock-flow relationships are carefully specified. Each period net investment is added to the existing capital stock to determine the level of the capital stock for the next period. The government issues bonds equal to the public sector deficit. Exports and imports along with debt service payments are added to determine the current account balance, and the stock of foreign reserves is adjusted for changes in the current account and exogenous capital account balance. The counterpart to the change in reserves is a change in the domestic money supply.

B. The U.S., Japanese, Rest of the OECD, OPEC and Rest of World Blocks

The remaining five regions in the model account for Korea's major trading partners, and a rest of world block. The blocks representing OECD countries are carefully specified structural models, though they

are less detailed than the Korean block and they only produce one good. The OPEC block imports and exports oil to the other countries, and the rest of world block acts an initial accounting identity used to guarantee that world assets and liabilities are initially equal, and that world trade flows add up. These latter two blocks, in this version of the model, are assumed to be liquidity constrained in international capital markets so that their current account balances in each period must be zero. This is achieved by assuming they import exactly their earnings once adjusted for service payments on outstanding debt. We shall briefly describe the three OECD blocks here and refer the reader to Sachs and Roubini (1987) for a more detailed description of a similar version of these blocks.

The three OECD blocks have a similar structure, and we will describe the specification of the U.S. block making clear the differences between the U.S. and other countries when they are important. Each country produces one good which is used for private and public consumption, investment, and exports and imports. Total consumption is determined assuming there are a mix of forward looking and myopic consumers. Forward looking consumers consume a fraction of their permanent income while the myopic consumers spend their disposable income. This view of consumption behavior has been justified in a number of studies of which the most recent is Campbell and Mankiw (1989) in the U.S.. Investment by firms also is determined by a mix of forward looking and myopic behavior which is justified by the existence of credit constraints in capital markets. We use the standard Tobin's Q equation augmented with a cash flow effect to determine aggregate investment demand. The cash flow term is argued to capture the role of liquidity constraints in affecting aggregate investment.

Government expenditure is exogenous. Exports and imports are determined using Cobb-Douglas production/utility functions to allocate the aggregate expenditures of each component of final demand between domestically produced goods and foreign goods. The parts which are purchased from foreigners are then further allocated using Cobb-Douglas functions amongst the other regional blocks. But the allocation of Korean exports and imports is done differently and is described below.

Aggregate supply is a Cobb-Douglas function of capital, labor, raw materials and energy. By setting marginal products equal to marginal costs by factor we can derive the demand for each factor input in total production.

Money demand is determined using a Goldfeld demand equation, and the supply of money is held fixed. To determine nominal interest rates we invert this equation in each country. With the money supply held exogenous, this guarantees money market equilibrium.

The government finances her expenditures using proportional labor income taxes, lump sum taxes, seignorage and bond financing. The lump-sum tax is set equal to interest payments on bonds in order to guarantee that the intertemporal government budget constraint is satisfied.

To close each block the domestic price is permitted to adjust until supply is equal to demand. All exchange rates are assumed to adjust under the assumption of perfect capital mobility. As in the Dornbusch (1976) model the exchange rate is therefore a jumping variable which must satisfy the arbitrage condition that all assets earn equal returns when measured in a common currency along any adjustment path for the economy.

Apart from the initial parameterization, perhaps the most important source of differences across these three regional blocks is found in the wage determination process. Wages in the U.S. and the rest of the OECD block are determined by a Phillips curve which includes partial indexation of wages to lagged inflation and a slow adjustment of nominal wages to unemployment. But in Japan, the wage adjusts so that there is full employment within one year of any shock. In all cases the nominal wage is assumed to be fixed in the first year and the labor supply is perfectly elastic at the given nominal wage. This implies that, through the propagation mechanism of wage adjustment, shocks tend to persist longer in the U.S. and the ROECD than in the other countries.

The stock-flow relationships are carefully accounted for. Exports and imports for each block are added, and these determine the current account. We then determine next period's stock of net foreign debt by adjusting the necessary capital flows. All capital stocks are adjusted for current net investment, and government bonds increase with the contemporaneous public deficit.

The OPEC block of the model has been included to allow for a proper treatment of exogenous changes in energy prices in simulations. In the current paper we do not consider these energy price shocks. For the following simulations, we assume that OPEC spends its current income, so that its current account balance is always identically zero.

C. Integrating the Korean Block in the World Model

To close the world model we must equilibrate exports with imports and adjust wealth variables for the resulting capital flows across countries. To do this we must treat the exports and imports of the Korean economy specially for two reasons. First, they are disaggregated into demands for various goods rather than one single good, and second, because the Korean exports have not been determined from nested demands as in the other blocks, but rather they have been econometrically estimated separately as export demand equations.

To aggregate the imports and exports we simply add the nominal expenditures measured in Won, and then convert this to the foreign currency values using the appropriate exchange rates. We then subtract the Korean exports to each region from that region's derived imports of goods for consumption, and then allocate the remaining imports to the other regions.

Having determined aggregate exports and imports of each region in a common currency, we then determine net capital flows and adjust net foreign assets of each country accordingly.

D. Parameterization and Solving the Model

The various blocks of the model combine to form a set of non-linear behavioral equations. There are state variables, such as the capital stock, jumping variables such as the exchange rates, and exogenous variables such as government expenditures. The solution to the system of differential equations exhibits a multi-dimensional equivalent of saddle path stability. We must solve the model for the stable manifold which is consistent with the economy eventually reaching the steady-state. Initially the jumping variables will "jump" so that the economy reaches the unique stable manifold, and then the dynamics of the model determine the path of the economy over time. The model and solution can be thought of as a straightforward, multi-dimensional version of models such as that found in Dornbush (1976).

We begin by parameterizing the model according to actual data from Input-Output tables for Korea, and for the rest of the world we use various sources for each of the relevant variables. All flow and stock variables are expressed in terms of U.S. GNP, and price variables are written in terms of their level. We then solve the model using this parameterization for the steady-state under the assumption that each econo-

my will grow at a steady-state rate of three percent in he future. The equations are then linearized around these steady-state values using standard numerical techniques.

Having linearized the model we can solve for the stable minifold given any shock using the techniques presented in McKibbin (1985) and McKibbin and Sachs (1989). The whole procedure takes less than ninety minutes, and each policy shock can be simulated in under ten minutes.

III. Simulation Results

In this section we examine the response of the model to various international and domestic policy shocks, and we discuss the mechanisms which give rise to our simulation results. We also examine the role of policy regimes, and in particular the rules determining the exchange rate, to show how the response of the economy to various shocks differs across exchange rate regimes. We remind the reader that the results here are not in any sense final, and they are only illustrative of the mechanisms and structure currently imbedded in the model. As we complete the specification of the financial sector, and improve our specification of consumption and investment we expect that the multipliers, and perhaps some of the qualitative results, will change.

The sheer size of the model gives the impression that the simulation properties will be difficult to interpret. But in fact this is not the case. Each block in the model has a mixture of standard Keynesian and classical properties, with the Keynesian properties being reflected in the short-run and the classical properties being reflected in the long-run. For example, an exogenous increase in U.S. fiscal expenditures causes U.S. demand to rise through the fiscal multiplier, and with nominal wages being rigid, prices rise and real wages fall, while the real interest rate rises. This induces an increase in employment and output, and a crowding out of investment. Over time the high employment results in upward pressure on wages and this in turn reduces the demand for labor. The short and medium run impact of policy has a very Keynesian flavor. But in the long-run the model returns to having full employment, and the only effect upon output is determined through the crowding out of the capital stock.

In the subsections below we outline the properties of the model in three parts. In the first subsection we examine the impact of Korean policy changes upon the Korean and world economy. The first shock is

an increase in Korean fiscal expenditures which are bond financed. The second shock is an increase in permitted foreign borrowing, and the third is an appreciation of the Korean Won. In the second subsection we examine the impact of foreign policy changes upon the Korean economy. Here we examine expansionary U.S. monetary policy, and we compare the effects on Korea of expansionary U.S. and Japanese fiscal policy. In the final subsection we show how these results vary depending upon the policy regime chosen by the Korean government. This subsection illustrates how changes in the exchange rate regime chosen by the Korean government. This subsection illustrates how changes in the exchange rate regime, and capital mobility affects multipliers and the impact of foreign disturbances in the Korean economy.

The reported results, particularly those for variables such as real GNP, vary depending upon the choice of units in which we express them. While in general the choice of units does not make too large a difference, in cases where there are significant relative price changes, such as for the exchange rate revaluation, there can be substantial differences. In these tables we always show consumption and investment measured in terms of real units and summed at their initial prices, while government expenditure which is held fixed in terms of the GDP deflator is reported in terms of the GDP deflator. The trade balance is expressed in real dollars, and real GDP is then determined as the sum of each of these components. Real GDP will therefore only be a proxy for the level of activity in the economy. An alternative measure is the level of employment. With the capital stock fixed initially, value added measured at initial factor prices will only change when employment changes in the first period.

A. Domestic Policy Experiments

A) Korean Fiscal Policy

Table 1a shows the impact of a permanent bond financed increase in Korean fiscal expenditures equal to one percent of her GNP. A rise in government expenditures raises aggregate demand through the direct effect upon expenditures, and indirectly through the fiscal multiplier. The incipient excess demand causes relative prices to change, and through a number of channels these changes induce a decrease in demand and an increase in supply.

The most important channel to reduce demand comes through the real balance effect. With excess demand nominal prices rise and this

TABLE 1a

PERMANENT INCREASE IN KOREAN FISCAL EXPENDITURES EQUAL TO 1% OF GNP

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	0.10	–0.08	–0.22	–0.33	–0.42
Consumption	–0.08	–0.22	–0.36	–0.48	–0.58
Investment	–0.81	–0.76	–0.73	–0.71	–0.68
Government	1.00	1.00	1.00	1.00	1.00
Exports:					
Goods and services	–0.15	–0.26	–0.32	–0.36	–0.38
Imports:					
Goods and services	–0.14	–0.17	–0.20	–0.22	–0.23
Trade Balance	–0.01	–0.09	–0.13	–0.14	–0.15
Labour demand	0.07	0.01	–0.02	–0.02	–0.02
Interest rate real	0.63	0.57	0.55	0.53	0.52
Nominal wage	0.38	0.48	0.48	0.44	
Prices (GNP deflator)	0.31	0.47	0.54	0.58	0.60
Real Exchange Rates:					
Won/$	–0.31	–0.47	–0.54	–0.58	–0.60
Won/Yen	–0.33	–0.48	–0.55	–0.59	–0.62
Won/Ecu	–0.32	–0.47	–0.55	–0.59	–0.61
Real Value Added by Sector					
Agriculture	–0.01	–0.04	–0.06	–0.07	–0.09
Textiles	–0.01	–0.03	–0.03	–0.04	–0.04
Other light ind.	–0.00	–0.02	–0.03	–0.04	–0.04
Metal & mach.	–0.03	–0.05	–0.06	–0.08	–0.08
Transport	–0.01	–0.02	–0.03	–0.03	–0.03
Other heavy ind.	–0.02	–0.04	–0.05	–0.06	–0.07
Construction	–0.05	–0.04	–0.04	–0.04	–0.03
Services	0.18	0.13	0.09	0.06	0.04
Housing	–0.00	–0.02	–0.03	–0.05	–0.06
International:					
Exchange Rate					
$/Ecu	–0.01	–0.01	–0.01	–0.01	–0.01
$/Yen	–0.02	–0.02	–0.02	–0.02	–0.02
U.S.: Output	0.00	0.00	0.00	0.00	0.00
Trade Bal.	–0.00	0.00	0.00	0.00	0.00
ROECD: Output	–0.00	–0.00	–0.00	–0.00	–0.00
Trade Bal.	0.00	0.00	0.00	0.00	–0.00
Japan: Output	–0.00	–0.00	–0.00	–0.00	–0.00
Trade Bal.	–0.00	–0.00	–0.00	–0.00	–0.00

Note: See notes at end of Table 1b for definitions of variables.

reduces real balances. The reduction in real money results in a rise in real interest rates, and this causes Tobin's Q to fall. In response investment falls, and consumption tends to fall due to the decline in the market value of capital.

The rise in prices, with a fixed exchange rate also results in an appreciation of the Won. This cause Korean exports to be less competitive in world markets, and Korean imports tend to rise. Thus the trade balance tends to worsen and aggregate demand falls. But opposing this is an "expenditure switching" effect. The governments average propensity to import is near to zero, whereas private investors spend roughly twenty percent of their total expenditures on imports. When investment is crowded out in favor of government spending, this "expenditure switching" effectively results in a decline in the average propensity to import for the economy as a whole. The result of this is that imports decline even in face of the appreciation of the currency. Further, the distribution of effects varies by country. The Japanese export far more to Korea than they import from Korea, so on net the drop in imports outweighs the improvement in exports, and their bilateral trade balance with Korea actually worsens. On the other hand the U.S. imports from Korea far more than it exports, so that the U.S. on net shows an improvement in her bilateral trade balance.

With the capital stock fixed in the first period, an increase in aggregate supply can come only from an increase in employment. When the price level rises, with sticky nominal wages, real wages fall and employment rises. But given the relatively rapid adjustment of nominal wages to variations in employment in Korea, the underlying supply curve is very steep. With wages adjusting so that employment remains near the full employment level, output in the model increases only slightly while most of the government expenditures increase is crowded out via lower investment. This is perhaps the most striking structural difference between our model and many of the other CGE models of the Korean economy, and while we are not yet satisfied that the supply-side is correctly structured in this version of the KGM, we present these results to show the potential importance of supply factors in determining the impact of fiscal policy.

The sectoral impact of the shock shows that the services sector benefits most and there are relatively small impacts, and all negative, upon the remaining sectors. The rise in services is due to the fact that a large proportion of government spending is recorded in this sector. The other sector where the government spends heavily is construction, but here

TABLE 1b

PERMANENT INCREASE IN KOREAN FISCAL EXPENDITURES EQUAL TO 1% OF GNP
CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	59.6	8.9	-6.0	-9.9	-10.4
United States	-19.0	14.4	28.5	35.6	39.7
Japan	-36.0	-26.9	-25.4	-25.4	-25.5
Rest of World	-4.6	3.6	2.9	-0.3	-3.9
Trade Balances:					
Korea	58.7	5.6	-9.3	-12.5	-12.3
United States	-20.9	15.2	29.3	35.1	37.5
Japan	-31.3	-23.3	-21.3	-20.3	-19.2
Rest of World	-6.5	2.5	1.3	-2.3	-6.1
Bilateral Korean Trade Balances:					
United States	-3.3	-44.0	-63.7	-74.5	-80.9
Japan	60.0	46.8	41.5	37.7	33.8
Rest of World	1.9	2.8	12.9	24.4	34.8

Note: 1. All variables are reported as deviations from baseline. GDP is shown in percentage deviation from baseline. Other flow and stock variables are expressed as deviations from baseline measured as a percentage of Korean GDP. All prices (except interest rates) are expressed as percentage deviation from baseline. The interest rate is measured in basis points.

2. Consumption and investment are calculated by taking real units, as measured by initial prices, and summing for each of the components which makes up the aggregate value. Government expenditures are deflated by the GDP deflator. Exports and imports in Table 1a are measured in terms of real units at initial period prices. In Table 1b they are measured in dollars. The real exchange rate for Korea is calculated using the Korean GDP deflator as the price index for Korea.

the decline in investment in other sectors offsets the potential positive impact upon this sector.

A common finding illustrated here is that there is very little impact of Korean policy upon the world economy. The reason is that the Korean economy is relatively small compared to other countries, and thus in the international economy an increase in Korean expenditures represents only a small increase in world spending.

Table 1b shows the estimated impact in dollars upon the current account of the other major blocks. The values here are reported in dollars. With the appreciation of the Won the dollar value of the trade balance shows an improvement initially even while the trade balance mea-

sured in real units declines. This improvement is due to the large "expenditure switching" effect which reduces imports and offsets what would otherwise be a deterioration of the trade balance. The importance of Japan as a supplier of import goods, but not as a large purchaser of exports is reflected in the bilateral trade balances and the overall impact upon these nations trade balances. The reduction in Korean imports causes Japanese exports to fall sharply, whereas the appreciation of the Korean won reduces exports to Japan, but given that these are initially small relative to imports, the Japanese trade balance is worsened Overall. On the other hand the U.S. trade balance is improved as the U.S. tends to import relatively heavily from Korea but exports relatively little to Korea. These diverse effects again derive from the role of "expenditure switching" in reducing Korean imports.

The magnitudes illustrated here are small. The call for the Koreans to expand domestic demand in order to worsen their trade balance clearly do not have the expected impact upon the Korean trade balance until the third year of the change. Even if we allow for a greater propensity to import by the government, the overall magnitude of the worsening of the balance would be small relative to the existing surplus, and the effect would be mostly shown in changes in the bilateral balance with Japan, as Japan supplies Korea with the greatest portion of her imports. Our model predicts that any change in the Korean trade surplus cannot be realistically expected to come solely from an expansion of domestic demand.

B) An Increase in Net Foreign Borrowing

In this experiment we consider the effects of a permanent increase in foreign borrowing equal to one percent of Korean GNP. Each period the interest on the accumulated debt is serviced but no principal repayments are made. The results are shown in Table 2a.

The rise in foreign borrowing is equivalent to an exogneous increase in savings in the economy and results in a fall in the domestic real interest rate. This induces a rise in investment and aggregate demand, and through the multiplier consumption rises also. The rise in demand raises Korean prices and effectively causes an appreciation of the currency. The income and price effects lead to a rise in Korean imports and a fall in exports, with the trade balance being reduced by almost the full amount of the increased foreign financing by the end of the fifth year. In the intermittent years the expansion in foreign financing leads to a partial increase in foreign reserves held by the monetary

TABLE 2a

PERMANENT INCREASE IN KOREAN FOREIGN BORROWING EQUAL TO 1% OF KOREAN GNP EACH YEAR

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	0.20	0.32	0.44	0.57	0.68
Consumption	0.37	0.44	0.47	0.49	0.51
Investment	0.73	0.94	1.02	1.07	1.09
Government	0.00	0.00	0.00	0.00	0.00
Exports:					
Goods and services	–0.51	–0.57	–0.51	–0.43	–0.33
Imports:					
Goods and services	0.39	0.49	0.54	0.57	0.59
Trade Balance	–0.90	–1.06	–1.05	–0.99	–0.92
Labour demand	0.14	0.09	0.05	0.03	0.02
Interest rate real	–0.01	–0.36	–0.50	–0.55	–0.58
Nominal wage	1.00	1.29	1.36	1.35	
Prices (GNP deflator)	1.06	1.16	1.05	0.88	0.70
Foreign debt	0.00	1.00	1.97	2.91	3.82
Real Exchange Rates:					
Won/$	–1.06	–1.15	–1.04	–0.86	–0.69
Won/Yen	–0.99	–1.08	–0.97	–0.80	–0.62
Won/Ecu	–1.04	–1.14	–1.02	–0.85	–0.67
Real Value Added by Sector					
Agriculture	–0.01	0.00	0.02	0.04	0.06
Textiles	–0.03	–0.03	–0.03	–0.02	–0.01
Other light ind.	0.00	0.01	0.02	0.03	0.03
Metal & mach.	0.00	0.01	0.03	0.04	0.06
Transport	0.00	0.01	0.02	0.03	0.03
Other heavy ind.	–0.03	–0.02	–0.01	0.00	0.02
Construction	0.14	0.18	0.20	0.21	0.22
Services	–0.01	–0.00	0.01	0.04	0.07
Housing	0.00	0.02	0.03	0.05	0.06
International:					
Exchange Rate					
$/Ecu	0.01	0.02	0.02	0.02	0.02
$/Yen	0.07	0.08	0.08	0.08	0.08
U.S.: Output	–0.01	–0.01	–0.01	–0.02	–0.02
Trade Bal.	0.01	0.01	0.01	0.01	0.01
ROECD: Output	–0.00	–0.00	–0.00	–0.01	–0.01
Trade Bal.	0.01	0.01	0.01	0.01	0.01
Japan: Output	0.00	0.01	0.01	0.01	0.01
Trade Bal.	0.01	0.01	0.01	0.01	0.01

Note: See notes at end of Table 1b for definitions of variables.

TABLE 2b

PERMANENT INCREASE IN KOREAN FOREIGN BORROWING EQUAL TO 1% OF KOREAN GNP CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	-849.2	-1061.6	-1130.3	-1152.1	-1158.8
United States	471.4	561.1	587.6	593.2	592.5
Japan	182.1	243.4	262.8	268.3	269.0
Rest of World	195.7	257.2	280.0	290.6	297.3
Trade Balances:					
Korea	-852.7	-1019.5	-1033.8	-999.8	-951.6
United States	455.1	531.6	535.8	516.4	490.0
Japan	194.9	230.0	230.8	220.9	207.6
Rest of world	202.8	257.9	267.2	262.6	254.0
Bilateral Korean Trade Balances:					
United States	-285.4	-333.3	-324.2	-297.6	-266.8
Japan	-279.2	-336.8	-345.4	-337.4	-323.3
Rest of World	-288.1	-349.4	-364.1	-364.8	-361.5

Note: See notes at end of Table 1b for definitions of variables.

authorities. This induces an increase in the domestic money supply.

Output increases in each of the five years as the capital stock rises with investment. The pattern of employment again reflects the wage adjustment process which initially lags the change in prices. The long-run effect of the borrowing is a rise in the domestic capital stock and output.

The impact of the shock on the other blocks is again small. The increase in foreign borrowing represents only a small proportion of world GNP, so world interest rates and other variables are not significantly affected. The impact on world current account balances measured in dollars are shown in Table 2b.

All foreign blocks experience an improvement in their overall trade balances, and in their bilateral balance with Korea. The U.S. trade balance with Korea improves by 285 million dollars, and the increase in expenditures by the rest of the world on U.S. goods further induces an improvement in her trade balance, so the overall improvement is 455 million dollars.

C) A 10% Nominal Revaluation of the Won

The model is designed such that all nominal shocks will be reflected fully in changes in prices in the long-run, and they will have no real

impact. But in the short-run a number of mechanisms cause nominal shocks to affect output. On impact, the partial adjustment of nominal wages to inflation and unemployment implies that any price changes will induce changes in real wages, and these in turn cause changes in employment and output. Further, a real appreciation will induce a corresponding fall in prices in the long-run, and this implies that individuals will want to reduce their nominal money balances. To achieve this, individuals spend their money balances and the country runs a trade deficit which contracts reserves. During adjustment there is a shift in production towards non-tradeables and away from tradeables. These effects are propagated through the accumulation of capital and the dynamics result in a cyclical response of the economy.

Table 3a shows the effect of a 10% revaluation of the Won in terms of the dollar. Initially exports contract sharply and imports rise. The fall in import prices and the contraction of demand for domestic goods induces a fall in domestic prices, and this causes real wages to rise and employment and output to fall in the first year. On the other hand investment rises sharply. This is because the decline in prices and demand reduces the demand for real balances, to equilibrate the money market interest rates must fall, and this in turn promotes investment. Further, a large component of investment expenditures is spent on imports, and the real appreciation of the Won causes the relative price of investment goods to fall, further causing investment to rise.

In the second year and onwards total investment actually declines. The reason is that the loss in reserves causes the money supply to fall sharply, and this in turn causes interest rates to rise over time. The future rise in borrowing costs reduces current investment through Tobin's Q, and the reduction in employment, income and wealth also causes aggregate consumption to fall. The fall in domestic prices now more than offsets the nominal appreciation so the relative costs of investment goods rises in the second period. But the propagation channels of a higher capital stock, and lagged adjustment of wages causes the output effects of the revaluation to be long-lived.

The sectoral impact of the policy change is shown at the bottom of the table and reflects a mixture of forces. The expenditure switching away from exports and traded goods towards domestic investment initially benefits the construction sector most. The services sector fares relatively badly due to the inclusion of "trade services" in this category which are hurt as exports fall.

TABLE 3a

PERMANENT 10% REVALUATION OF THE KOREAN WON IN TERMS OF THE DOLLAR

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	-0.79	-0.72	-0.75	-0.85	-0.98
Consumption	-0.21	-0.67	-0.84	-0.93	-1.01
Investment	1.00	-0.22	-0.64	-0.82	-0.91
Government	0.00	0.00	0.00	0.00	0.00
Exports:					
Goods and services	-1.04	0.14	0.50	0.57	0.55
Imports:					
Goods and services	0.54	-0.03	-0.24	-0.33	-0.39
Trade Balance	-1.57	0.17	0.73	0.90	0.94
Labour demand	-0.86	-0.52	-0.26	-0.13	-0.07
Interest rate real	-3.23	-0.99	-0.24	0.03	0.14
Exchange rate	-10.00	-10.00	-10.00	-10.00	-10.00
Nominal wage	0.00	-7.51	-10.27	-11.40	-11.86
Prices (GNP deflator)	-9.02	-11.37	-12.11	-12.29	-12.27
Real Exchange Rates:					
Won/$	-0.96	1.39	2.13	2.30	2.28
Won/Yen	-0.84	1.43	2.14	2.31	2.30
Won/Ecu	-0.88	1.45	2.17	2.34	2.33
Real Value Added by Sector					
Agriculture	-0.15	-0.10	-0.10	-0.11	-0.13
Textiles	-0.03	0.07	0.10	0.11	0.11
Other light ind.	0.05	0.07	0.08	0.07	0.06
Metal & mach.	-0.06	-0.02	-0.01	-0.02	-0.03
Transport	-0.03	-0.01	-0.01	-0.02	-0.03
Other heavy ind.	-0.16	-0.07	-0.05	-0.05	-0.06
Construction	0.19	-0.03	-0.10	-0.14	-0.16
Services	-0.23	-0.01	0.08	0.10	0.09
Housing	-0.00	0.01	0.00	-0.01	-0.03
International:					
Exchange Rate					
$/Ecu %	0.08	0.07	0.06	0.06	0.05
$/Yen %	0.12	0.05	0.03	0.02	0.02
U.S.: Output %	-0.00	-0.02	-0.02	-0.02	-0.02
Trade Bal. % GNP	0.02	0.01	0.00	0.00	0.00
Japan: Output %	0.05	0.01	0.00	-0.00	-0.00
Trade Bal. % GNP	0.02	0.01	0.00	-0.00	-0.00
ROECD: Output %	0.02	0.01	0.01	0.01	0.01
Trade Bal. % GNP	0.01	0.01	0.00	0.00	0.00

Note: See notes at end of Table 1b for definitions of variables.

TABLE 3b

PERMANENT 10% REVALUATION OF THE KOREAN WON IN TERMS OF THE DOLLAR
CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	-2464.3	-1009.5	-532.1	-377.4	-328.0
United States	1051.7	389.7	165.5	90.8	66.5
Japan	635.7	227.3	98.0	57.6	45.3
Rest of World	776.9	392.5	268.7	229.0	216.1
Trade Balances:					
Korea	-2437.5	-873.0	-361.5	-196.3	-143.5
United States	1130.5	376.9	120.8	38.3	16.0
Japan	475.1	136.1	32.0	0.6	-8.7
Rest of World	831.9	360.0	208.8	157.3	136.2
Bilateral Korean Trade Balances:					
United States	-496.7	105.9	301.9	358.6	368.6
Japan	-504.0	-41.3	105.9	151.0	163.2
Rest of World	-1436.7	-937.6	-769.4	-705.9	-675.3

Note: See notes at end of Table 1b for definitions of variables

The impact of the shock upon world balances is shown in Table 3b. We predict that the policy initially causes a 2.5 billion dollar decline in the overall Korean trade balance, of which 500 million dollars is directly attributed to the U.S.. The overall impact upon the U.S. trade balance is somewhat higher as the improvement in other country's balances further cause an increase in U.S. exports. But the effects on world balances are not long-lived. The adjustment of the Korean economy to the nominal shock is fairly rapid, so within five years the overall decline in the Korean trade balance is less than 150 million dollars, and the U.S. improvement has fallen to less than 20 million dollars.

It must be noted that in determining the effects of the revaluation, the flexible wage adjustment assumption is crucial. The wage and price drop have offsetted the effects of nominal appreciation on real exchange rates, and made the trade balance deterioration short-lived in the economy. However, different wage settings result in major differences in persistence of the external shock. For instance, if nominal wage rate is assumed to be fixed in the simulation, a 10 percent revaluation causes an additional decline in the overall trade balance by 450 million dollars over five years.

B. Shocks Originating Outside of Korea

The transmission of shocks across countries depends both upon the nature of their policy regimes, in particular the exchange rate regime and the degree of capital mobility, and upon the relative importance of various opposing channels. In this section we consider the impact of U.S. monetary policy on the Korean economy, and we contrast the impact of U.S. and Japanese fiscal policy.

The key variables determining international transmission are the exchange rate, interest rates and the trade balance. the U.S., Japan and ROECD are assumed to have flexible exchange rates and perfect capital mobility, so real interest rates are equalized in these blocks. But in Korea the assumption of no capital mobility and an exchange rate which is tied to the dollar has important implications for how changes in world interest rates and relative exchange rates impact upon her economy. In the next section we discuss how the results we find here are affected by changing these assumptions.

A) U.S. Monetary Policy

Here we consider an increase in base money in the U.S. which induces a permanent, one percent rise in the M1 money supply. In the long-run this will result in a one percent rise in U.S. prices, but in the short-run due to the rigidity of nominal wages in the U.S., the policy will have real affects. The rise in money causes interest rates to fall, prices to rise, and real wages to fall. This induces a rise in investment and employment, and output is temporarily increased. These effects are propagated through the increase in the capital stock and so the effects are felt for many years. Table 4a shows these results.

The impact of this policy upon foreign countries depends on the relative effects of various factors. The rise in U.S. income leads to an increase in demand for foreign goods and would tend to encourage exports to the U.S. But on the other hand the fall in U.S. interest rates, and the expected rise in U.S. prices, reduces the attractiveness of the U.S. dollar and leads to a real depreciation of the currency. This tends to reduce U.S. imports and raise U.S. exports. The net overall effect upon Japan and ROECD is shown to be small.

For Korea, because her currency is tied to the dollar, U.S. monetary policy has an initial positive impact. The Korean Won depreciates relative to Japan and the ROECD, so her exports become more competi-

TABLE 4a

PERMANENT INCREASE IN U.S. MONEY SUPPLY EQUAL TO 1% OF U.S. GNP

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	0.06	0.04	0.04	0.04	0.05
Consumption	0.11	0.09	0.08	0.08	0.08
Investment	–0.05	0.03	0.05	0.06	0.06
Government	0.00	0.00	0.00	0.00	0.00
Exports:					
Goods and services	0.02	–0.03	–0.03	–0.03	–0.02
Imports:					
Goods and services	0.02	0.05	0.06	0.06	0.07
Trade Balance	0.00	–0.08	–0.09	–0.09	–0.09
Labour demand	0.05	0.03	0.01	0.00	0.00
Interest rate real	0.24	0.06	0.01	–0.00	–0.01
Nominal wage	0.47	0.58	0.61	0.61	
Prices (GNP deflator)	0.55	0.64	0.64	0.63	0.62
Real Exchange Rates:					
Won/$	–0.27	–0.22	–0.16	–0.12	–0.10
Won/Yen	0.24	0.12	0.10	0.11	0.11
Won/Ecu	0.20	0.09	0.08	0.09	0.10
Real Value Added by Sector					
Agriculture	0.01	0.00	0.01	0.01	0.01
Textiles	0.00	–0.00	–0.00	–0.00	–0.00
Other light ind.	0.00	–0.00	–0.00	–0.00	–0.00
Metal & mach.	0.00	0.00	0.00	0.00	0.01
Transport	–0.00	–0.00	–0.00	–0.00	–0.00
Other heavy ind.	0.01	0.00	0.00	0.00	0.00
Construction	–0.01	0.00	0.01	0.01	0.01
Services	0.02	–0.00	–0.01	–0.01	–0.01
Housing	0.00	0.00	0.00	0.00	0.00
International:					
Exchange Rate					
$/Ecu %	0.77	0.75	0.74	0.73	0.72
$/Yen %	0.80	0.77	0.75	0.74	0.74
U.S.: Output	0.38	0.24	0.18	0.15	0.13
Trade Bal.	–0.01	–0.01	–0.00	–0.00	–0.00
ROECD: Output	0.01	0.02	0.02	0.02	0.01
Trade Bal.	0.01	0.00	0.00	–0.00	–0.00
Japan: Output	0.00	0.01	0.01	0.01	0.01
Trade Bal.	–0.00	–0.00	–0.01	–0.01	–0.01

Note: See notes at end of Table lb for definitions of variables.

TABLE 4b

PERMANENT INCREASE IN U.S. MONEY SUPPLY EQUAL TO 1% OF U.S. GNP
CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	152.8	45.1	19.0	14.1	13.8
United States	-81.2	-34.6	-11.6	2.4	12.4
Japan	284.8	187.9	141.5	117.3	103.1
Rest of World	-356.4	-198.4	-148.9	-133.8	-129.3
Trade Balances:					
Korea	27.7	-21.2	-23.0	-17.9	-13.9
United States	-542.9	-256.0	-139.1	-87.6	-62.2
Japan	431.1	241.9	157.1	115.6	92.4
Rest of World	84.1	35.3	5.0	-10.1	-16.3
Bilateral Korean Trade Balances:					
United States	64.4	31.6	25.1	24.9	25.7
Japan	-15.7	-5.8	4.2	10.9	15.2
Rest of World	-21.0	-46.9	-52.4	-53.7	-54.7

Note: See notes at end of Table 1b for definitions of variables.

tive. And the direct impact of higher U.S. demand for her exports as a result of higher U.S. income further raises export demand. With the fall in U.S. interest rates, the service payments on Korean debt also fall, and this induces an increase in consumption. The increases in demand causes prices to rise, and due to the stickiness of nominal wages temporarily raises employment. But Korean wages rise rapidly in response so that employment remains near the full employment level, and Korean prices rise offsetting her competitive advantage. The overall effect upon the Korean economy is small.

The effects upon international current account balances, when measured in dollars, are shown in Table 4b. The U.S. balance initially worsens, and this is reflected in an improvement in the trade balance in all other countries, but the overall size of these improvements is small. The bilateral balance of Korea with the U.S. improves by 65 million dollars initially, due to the increase in income in the U.S. and the ensuing increase in Korean exports to the U.S.. But this improvement rapidly declines as prices adjust to the increased money supply and the economy returns to the former equilibrium.

B) U.S. Fiscal Policy

Here we consider a bond financed, permanent increase in U.S. fiscal

TABLE 5a

PERMANENT INCREASE IN U.S. FISCAL EXPENDITURES EQUAL TO 1% OF U.S. GNP

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	0.02	0.06	0.10	0.12	0.15
Consumption	0.04	0.07	0.08	0.09	0.09
Investment	0.27	0.23	0.23	0.25	0.26
Government	0.00	0.00	0.00	0.00	0.00
Exports:					
Goods and services	0.11	0.16	0.18	0.19	0.21
Imports:					
Goods and services	0.41	0.40	0.40	0.41	0.41
Trade Balance	–0.29	–0.23	–0.22	–0.21	–0.20
Labour demand	–0.02	–0.01	–0.00	–0.00	–0.00
Interest rate real	–0.19	–0.06	–0.04	–0.05	–0.06
Nominal wage	–0.33	–0.42	–0.47	–0.51	
Prices (GNP deflator)	–0.47	–0.58	–0.65	–0.71	–0.76
Real Exchange Rates:					
Won/$	0.41	0.52	0.65	0.81	0.96
Won/Yen	–2.10	–1.97	–1.90	–1.84	–1.78
Won/Ecu	–1.92	–1.68	–1.52	–1.39	–1.26
Real Value Added by Sector					
Agriculture	–0.01	–0.01	–0.00	0.00	0.01
Textiles	0.01	0.02	0.02	0.03	0.03
Other light ind.	–0.00	0.00	0.01	0.01	0.01
Metal & mach.	0.00	0.01	0.02	0.02	0.03
Transport	0.00	0.00	0.01	0.01	0.01
Other heavy ind.	–0.04	–0.03	–0.03	–0.03	–0.02
Construction	0.05	0.05	0.05	0.06	0.06
Services	–0.03	–0.01	–0.00	0.00	0.00
Housing	–0.00	0.00	0.01	0.01	0.01
International:					
Exchange Rate					
$/Ecu	–2.46	–2.41	–2.39	–2.36	–2.33
$/Yen	–2.65	–2.66	–2.69	–2.71	–2.74
U.S.: Output	0.41	0.38	0.26	0.12	–0.02
Trade Bal.	–0.23	–0.22	–0.22	–0.21	–0.20
ROECD: Output	–0.12	–0.23	–0.30	–0.36	–0.42
Trade Bal.	0.21	0.21	0.20	0.19	0.18
Japan: Output	–0.06	–0.10	–0.13	–0.17	–0.20
Trade Bal.	0.27	0.27	0.27	0.26	0.26

Note: See notes at end of Table 1b for definitions of variables.

TABLE 5b

PERMANENT INCREASE IN U.S. FISCAL EXPEDITURES EQUAL TO 1% OF U.S. GNP
CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	-122.5	-39.3	-22.3	-20.5	-21.3
United States	-12070.1	-12209.8	-12364.7	-12527.8	-12695.8
Japan	2621.1	2705.0	2727.5	2728.3	2723.2
Rest of World	9571.5	9544.1	9659.5	9820.0	9993.9
Trade Balances:					
Korea	50.1	87.6	100.2	113.6	130.4
United States	-11286.9	-11000.1	-10576.7	-10112.5	-9641.9
Japan	2311.4	2303.9	2182.4	2022.6	1853.6
Rest of World	8925.4	8608.5	8294.2	7976.4	7657.9
Bilateral Korean Trade Balances:					
United States	204.2	218.6	215.2	208.7	202.5
Japan	-96.3	-89.1	-73.2	-51.3	-26.7
Rest of World	-57.8	-41.9	-41.8	-43.8	-45.4

Note: See notes at end of Table 1b for definitions of variables.

expenditures equal to one percent of U.S. GNP. The results are shown in Table 5a. The rise in demand in the U.S. occurs directly through the increase in government expenditures and indirectly through the multiplier effects upon consumption. This induces an increase in prices and money demand in the U.S., and the real interest rate rises. The rise in real interest rates crowds out investment, while the rise in prices lowers the real wage and so employment and output increase. The higher interest rate raises the attractiveness of the U.S. dollar and the currency appreciates.

Here there is an unambiguous improvement in the trade balance in Japan and the ROECD. Both the higher U.S. income and the appreciated dollar induce an increase in exports from these countries to the U. S.. But the overall effect upon demand and output in these countries shows a small, but negative transmission. The reason is that the rise in world interest rates reduces their consumption and investment. These effects dominate the improvement in foreign demand and so output falls.

For Korea, the restriction of capital flows and the fixed exchange rate regime imply the transmission mechanisms will be different. Here the appreciation of the dollar, and hence the Won, implies that Japanese exports now compete more favorably with Korean exports to the U.S.,

and Korean exports to both Japan and the ROECD tend to fall. On the other hand, higher U.S. income tends to improve Korean exports. The appreciation of the currency lowers the relative price of imports, and particularly investment goods, thus tending to encourage imports. The overall effect is shown to be a small improvement in the Korean trade balance when measured in dollars, but in real units the trade balance actually worsens. The appreciation of her currency also reduces overall prices and causes real balances to rise. The rise in real balances induces a fall in real interest rates, and a fall in the relative price of investment goods, and so Korean investment expands. The increased capital stock causes output to continue to rise in the future. This is the opposite effect to that found in Japan and the ROECD and clearly depends upon the restrictions on capital mobility and the exchange rate regime.

Table 5b shows the change in the dollar values of world trade balances. The U.S. trade balance worsens by 11.2 billion dollars while in Japan and the rest of the world the balances improve. The Korean bilateral balance with the U.S. increases by 204 million dollars.

C) Japanese Fiscal Policy

The experiment considered here is a permanent, bond financed rise in Japanese fiscal expenditures equal to one percent of her GNP. The transmission mechanism in this case, and the impact upon the U.S. and the ROECD are similar to the previous case and we will not repeat the arguments. The key difference here is that the Japanese economy is smaller than the U.S. economy so the magnitude of the effects is somewhat smaller.

For Korea, the impact of Japanese fiscal policy is quite different from the impact of U.S. fiscal policy because the price effects are now in her favor. With the Won tied to the dollar, the appreciation of the Yen improves the competitiveness of Korean exports and induces a reduction in demand for imports from Japan. The overall trade balance improves. On the other hand, the depreciation tends to raise Korean prices reducing real balances. This cause real interest rates to rise and investment is crowded out. The fall in wealth also reduces consumption. The overall impact upon the economy is a reduction in measured real GNP, and because investment falls output and the capital stock continue to decline over time. The impact upon international trade balances is shown in Table 6b. The appreciation of the yen, and the income effects cause the Japanese trade balance to worsen by 8.3 bil-

TABLE 6a

PERMANENT INCREASE IN JAPANES FISCAL EXPENDITURES EQUAL TO 1% OF JAPANESE GNP

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	–0.05	–0.10	–0.15	–0.18	–0.21
Consumption	–0.15	–0.18	–0.21	–0.23	–0.25
Investment	–0.33	–0.28	–0.27	–0.27	–0.27
Government	0.00	0.00	0.00	0.00	0.00
Exports:					
Goods and services	–0.03	–0.08	–0.10	–0.12	–0.12
Imports:					
Goods and services	–0.46	–0.44	–0.43	–0.43	–0.43
Trade Balance	0.43	0.36	0.33	0.32	0.30
Labour demand	0.00	0.00	–0.00	–0.01	–0.01
Interest rate real	0.20	0.11	0.09	0.09	0.09
Nominal wage	0.23	0.29	0.29	0.27	
Prices (GNP deflator)	0.38	0.47	0.50	0.50	0.50
Real Exchange Rates:					
Won/$	–0.34	–0.34	–0.33	–0.30	–0.28
Won/Yen	3.69	3.46	3.31	3.18	3.06
Won/Ecu	–0.08	–0.14	–0.15	–0.15	–0.15
Real Value Added by Sector					
Agriculture	0.02	0.01	0.01	0.00	0.00
Textiles	–0.01	–0.02	–0.02	–0.02	–0.02
Other light ind.	–0.00	–0.01	–0.01	–0.02	–0.02
Metal & mach.	–0.00	–0.01	–0.01	–0.01	–0.02
Transport	–0.01	–0.01	–0.02	–0.02	–0.02
Other heavy ind.	0.05	0.04	0.04	0.04	0.04
Construction	–0.07	–0.06	–0.06	–0.06	–0.06
Services	0.03	0.00	–0.02	–0.03	–0.04
Housing	–0.00	–0.01	–0.01	–0.02	–0.02
International:					
Exchange Rate					
$/Ecu %	0.28	0.27	0.26	0.24	0.23
$/Yen %	4.16	4.01	3.87	3.74	3.61
U.S.: Output	–0.21	–0.29	–0.34	–0.37	–0.39
Trade Bal.	0.10	0.10	0.10	0.10	0.10
ROCED: Output	–0.09	–0.13	–0.16	–0.18	–0.20
Trade Bal.	0.06	0.06	0.05	0.05	0.05
Japan: Output	0.47	0.45	0.43	0.40	0.38
Trade Bal.	–0.71	–0.69	–0.67	–0.65	–0.63

Note: See notes at end of Table 1b for definitions of variables.

TABLE 6b

PERMANENT INCREASE IN JAPANESE FISCAL EXPENDITURES EQUAL TO 1% OF GNP
CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	95.4	25.8	6.4	1.2	-0.1
United States	5336.6	5513.4	5655.4	5784.5	5908.2
Japan	-7994.5	-8231.9	-8450.9	-8658.2	-8857.9
Rest of World	2562.6	2692.7	2789.1	2872.4	2949.8
Trade Balances:					
Korea	60.0	22.7	21.6	28.3	35.8
United States	4968.3	5017.0	4967.0	4878.4	4774.2
Japan	-8307.9	-8186.7	-8023.7	-7840.8	-7648.2
Rest of World	3279.6	3147.0	3035.1	2934.0	2838.1
Bilateral Korean Trade Balances:					
United States	-108.2	-135.7	-144.1	-146.3	-146.3
Japan	304.9	307.8	313.5	317.2	318.5
Rest of World	-136.7	-149.4	-147.8	-142.5	-136.3

Note: See notes at end of Table 1b for definitions of variables.

lion dollars. The U.S. trade balance rises by 5 billion dollars, and there is a small improvement in the Korean trade balance equal to 60 million dollars. This reflects sharp improvement in the bilateral balance with Japan, but a smaller deterioration with the rest of the world as the Won appreciates somewhat with a rise in the Korean price level.

C. The Role of the Policy Regime

One of the most attractive properties of the Korean Global model is its potential use to examine variations in the behavior of the economy in response to changes in policy regimes. A movement toward capital mobility, or a change in the exchange rate regime can be easily incorporated into the structure of the model. Such experiments are subject to the critique first made by Lucas, that they would affect the parameters of the model and hence require modifications to behavioral equations. But to the extent that the basic relationships for consumption, investment, labor markets and money demand are not seriously affected, then the results in these simulations should provide good approximations to changes in the nature of the Korean economy's response to internal and external disturbances as a result of regime changes.

Here we briefly examine two experiments: i) how the U.S. fiscal expenditures shock is transmitted differently to Korea under an

exchange rate regime where the Won is tied to the Yen, and ii) how the Korean fiscal policy affects the economy under perfect capital mobility and flexible exchange rates.

A) U.S. Fiscal Policy when the Won Price Is Fixed to the Yen

This experiment has as a similar counterpart to the fiscal shock with Japan where the Won was tied to the dollar. The interpretation is similar and here we will only briefly contrast the results with those in section B. B).

By fixing the Won to the Yen, the effect of U.S. fiscal policy is now more expansionary for Korea than previously. The reason is that the appreciation of the dollar no longer implies that the Won directly appreciates relative to the Yen and the Ecu. The trade balance improves initially in Korea, and while in real units it worsens after the first period, in dollar terms it remains in surplus as shown in Table 7a and 7b.

The increase in demand for Korean goods raises prices, and initially this causes real interest rates to rise and reduces investment. But with time the surplus in the trade balance (measured in dollars) causes the money supply to increase and real interest rates fall, while the appreciation of the Won relative to the Yen (through higher Korean prices) causes the relative price of investment goods to fall. Both these factors encourage investment and output tends to rise over time with the increase in capital.

B) Korean Fiscal Policy under Perfect Capital Mobility and Flexible Exchange Rates in Korea

With perfect capital mobility Korean interest rates will be tied to world interest rates through arbitrage. The rise in government expenditures puts upward pressure on Korean interest rates, this in turn causes an incipient flow of capital towards Korea, and the exchange rate appreciates. The net effect is that interest rates rise by less than in the previous case of zero capital mobility, while the Won tends to appreciate by more. By the interest parity condition the difference between Korean interest rate and world interest rate equals the expected rate of depreciation of the Korean Won. Over time the increase in demand is mitigated by a reduction in the trade balance, and the crowding out effect on investment is much reduced. These results are

TABLE 7a

PERMANENT INCREASE IN U.S. FISCAL EXPENDITURES EQUAL TO 1% OF U.S. GNP WITH THE WON FIXED IN TERMS OF THE YEN

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	0.23	0.26	0.30	0.36	0.42
Consumption	0.08	0.24	0.31	0.34	0.36
Investment	0.01	0.29	0.41	0.47	0.50
Government	0.00	0.00	0.00	0.00	0.00
Exports:					
Goods and services	0.40	0.13	0.05	0.05	0.07
Imports:					
Goods and services	0.26	0.41	0.46	0.50	0.52
Trade Balance	0.13	–0.28	–0.41	–0.45	–0.45
Labour demand	0.21	0.13	0.07	0.04	0.02
Interest rate real	0.65	0.19	0.02	–0.06	–0.10
Exchange rate	2.68	2.68	2.70	2.72	2.74
Nominal wage	1.68	2.32	2.59	2.70	
Prices (GNP deflator)	1.95	2.46	2.61	2.62	2.59
Real Exchange Rates:					
Won/$	0.68	0.14	0.09	0.19	0.35
Won/Yen	–1.87	–2.35	–2.47	–2.46	–2.40
Won/Ecu	–1.68	–2.06	–2.10	–2.02	–1.89
Real Value Added by Sector					
Agriculture	0.03	0.02	0.03	0.03	0.05
Textiles	0.02	0.00	–0.00	–0.00	0.00
Other light ind.	–0.01	–0.02	–0.01	–0.01	–0.01
Metal & mach.	0.02	0.02	0.02	0.03	0.03
Transport	0.01	0.01	0.01	0.02	0.02
Other heavy ind.	0.01	–0.01	–0.02	–0.01	–0.01
Construction	0.01	0.06	0.08	0.09	0.10
Services	0.03	–0.01	–0.02	–0.02	–0.02
Housing	0.00	0.00	0.01	0.01	0.02
International:					
Exchange Rate					
$/Ecu	–2.48	–2.43	–2.40	–2.37	–2.35
$/Yen	–2.68	–2.68	–2.70	–2.72	–2.74
U.S.: Output	0.41	0.38	0.27	0.13	–0.02
Trade Bal.	–0.24	–0.23	–0.22	–0.21	–0.20
ROECD: Output	–0.12	–0.23	–0.30	–0.36	–0.42
Trade Bal.	0.21	0.20	0.20	0.19	0.18
Japan: Output	–0.07	–0.10	–0.13	–0.17	–0.20
Trade Bal.	0.27	0.27	0.27	0.26	0.26

Note: See notes at end of Table 1b for definitions of variables.

TABLE 7b

PERMANENT INCREASE IN U.S. FISCAL EXPENDITURES EQUAL TO 1% OF U.S. GNP WITH THE WON FIXED IN TERMS OF THE YEN

CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	538.4	229.6	124.4	88.5	75.9
United States	-12353.5	-12314.5	-12411.7	-12556.1	-12717.8
Japan	2450.8	2645.0	2700.6	2711.2	2709.1
Rest of World	9363.3	9440.0	9586.8	9756.4	9932.8
Trade Balances:					
Korea	703.8	320.0	201.4	174.0	177.6
United States	-11590.4	-11101.0	-10611.5	-10126.5	-9649.9
Japan	2184.2	2267.7	2172.7	2020.7	1854.1
Rest of World	8702.4	8531.3	8237.4	7931.9	7618.2
Bilateral Korean Trade Balances:					
United States	337.8	190.3	135.6	114.1	104.4
Japan	38.5	-78.6	-100.7	-90.3	-69.0
Rest of World	327.5	208.3	166.4	150.1	142.2

Note: See notes at end of Table 1b for definitions of variables.

shown in Table 8a and 8b.

The sectoral impact shows that services again benefit most, and construction now improves because the direct effect of increased government expenditures in this sector are no longer offset by investment being crowded out. The Korean trade balance worsens by 878 million dollars, much greater than the slight improvement of 50 million dollars which we found in the previous example. And the major benefactor is the U.S., whose trade balance improves by 436 million dollars of which 276 million dollars comes from a direct improvement in the bilateral balance with the U.S..

IV. Conclusion and Summary

Korea's rapid growth over the last two decades has changed Korea's position in the world economy. Increased export's share in the world market has made her directly compete with developed countries on the ladder of international trade and thereby necessitated an emphasis on trade relations. As Korea's trade imbalance with trading partners has persisted and Korean market penetration in their economies has become sizable in certain industries, foreigners are demanding for new

TABLE 8a

PERMANENT INCREASE IN KOREAN FISCAL EXPENDITURES EQUAL TO 1% OF GNP UNDER A FLEXIBLE EXCHANGE RATE REGIME WITH PERFECT CAPITAL MOBILITY

	1989	1990	1991	1992	1993
Korean Economy					
Real GDP	0.16	0.08	0.03	-0.01	-0.05
Consumption	0.17	0.01	-0.12	-0.25	-0.37
Investment	-0.14	-0.14	-0.13	-0.13	-0.13
Government	1.00	1.00	1.00	1.00	1.00
Exports:					
Goods and services	-0.66	-0.63	-0.58	-0.53	-0.47
Imports:					
Goods and services	0.21	0.17	0.13	0.10	0.08
Trade Balance	-0.87	-0.80	-0.71	-0.63	-0.55
Labour demand	0.07	0.02	-0.00	-0.00	-0.01
Interest rate real	0.11	0.12	0.12	0.11	0.10
Exchange rate	-1.23	-1.07	-0.92	-0.79	-0.66
Nominal wage	0.19	0.27	0.28	0.28	
Prices (GNP deflator)	-0.01	0.03	0.06	0.08	0.09
Foreign Debt	0.00	0.75	1.43	2.05	2.61
Real Exchange Rates:					
Won/$	-1.22	-1.10	-0.97	-0.85	-0.74
Won/Yen	-1.18	-1.07	-0.95	-0.83	-0.73
Won/Ecu	-1.20	-1.09	-0.97	-0.85	-0.74
Real Value Added by Sector					
Agriculture	-0.04	-0.04	-0.05	-0.05	-0.06
Textiles	-0.04	-0.04	-0.04	-0.04	-0.03
Other light ind.	0.00	-0.00	-0.01	-0.01	-0.02
Metal & mach.	-0.04	-0.04	-0.04	-0.05	-0.05
Transport	-0.01	-0.02	-0.02	-0.02	-0.02
Other heavy ind.	-0.06	-0.06	-0.06	-0.06	-0.05
Construction	0.08	0.08	0.08	0.08	0.08
Services	0.15	0.12	0.11	0.10	0.09
Housing	-0.00	-0.00	-0.01	-0.01	-0.02

Note: See notes at end of Table 1b for definitions of variables.
International data not reported as it is simiar to Table 1a.

industrial and trade strategies of Korea. With the future leading to more global integration, it is crucial that Korean economists and policy makers have a model of international linkages to analyze the effect of alternative policy scenarios. We hope that the Korean Global Model (KGM) which we present here will help to serve this purpose.

TABLE 8b

PERMANENT INCREASE IN KOREAN FISCAL EXPENDITURES EQUAL TO 1% OF GNP UNDER A FLEXIBLE EXCHANGE RATE REGIME WITH PERFECT CAPITAL MOBILITY
CHANGE IN INTERNATIONAL BALANCES IN MILLIONS OF DOLLARS

Current Account Balances:					
Korea	-879.3	-831.5	-780.9	-728.1	-673.8
United States	433.8	415.0	392.5	367.8	341.8
Japan	197.1	183.4	170.9	158.3	145.7
Rest of world	248.3	233.0	217.5	201.9	186.3
Trade Balances:					
Korea	-877.7	-784.9	-693.5	-603.8	-516.5
United States	436.2	399.6	359.4	317.9	276.5
Japan	182.9	158.6	136.7	116.1	96.3
Rest of World	258.6	226.7	197.5	169.9	143.7
Bilateral Korean Trade Balances:					
United States	-276.8	-257.9	-234.5	-209.3	-183.4
Japan	-210.9	-189.2	-168.3	-147.5	-126.6
Rest of World	-389.9	-337.8	-290.7	-247.1	-206.5

Note: See notes at end of Table 1b for definitions of variabless.

The model has a number of advantages over other CGE models of the Korean economy. It is multi-sectoral, it links the Korean economy with the world economy, it carefully takes into account budget constraints and stock-flow relationships, the supply-side of the model is specified, and it incorporates forward looking behavior by individuals but permits inclusion of myopic behavior where it appears realistic. We have demonstrated the flexibility of the model in this paper, showing how policy analysis can be conducted under assumptions for alternative exchange rate regimes, and for differing degrees of capital mobility. And as we pointed out in the introduction, the model is very easy to use. It can be run by one person on a personal computer, and takes roughly two hours to carry out a half-dozen simulations.

The simulation results in this paper are highly preliminary but already they point to a number of robust results. We find that Korean policy has only minor effects upon the rest of the world, i.e. it is reasonable to assume that Korea is small relative to the rest of the world. But external policies have very important impacts upon the Korean economy. For example, a U.S. fiscal expansion results in a sizable improvement in the Korean trade balance. Second, a Korean revaluation in terms of the U.S. dollar has a fairly small and short-lived impact upon the Korean bilateral trade balance. The reason is that

labor markets in Korea adjust fairly rapidly to unemployment, so nominal shocks tend to have a small impact upon the economy. The flexibility of Korean labor markets has often been stated as a reason for why Korea was able to adjust rapidly to external shocks in the past. Here it provides a rationale for arguing that calls for a devaluation or revaluation of the Won to alter the bilateral trade balance with the U.S. are misdirected. Finally we reiterate that in the future we hope to improve the specification of key sectors in the model. The results presented here are preliminary, and they were aimed to outline the structure and potential of this model, along with to encourage comments and criticisms from economists and policy makers.

Appendix

The Structure of the Korean Global Model

In this appendix we give a formal description of the Korean Global Model and outline the structural equations, and the parameterization of the equations in the Korean block. The structure of the remaining blocks in the model is similar to that described in Sachs and Roubini (1987).

Production and Factor Markets

There are nine producing sectors in the Korean block: agriculture and mining, textiles, other light manufacturing, fabricated metals and machinery, transports equipment, other heavy industry, construction, services and housing. Each sector's production is determined by a two-level production function. The top level is a Leontief-type fixed coefficient function of value added and intermediate inputs, and value added is given by a Cobb-douglas function of labor and capital.

$$x_i^s = \min\left(\frac{V_i}{a_{vi}}, \frac{N_{1i}}{a_{1i}}, \ldots, \frac{N_{10i}}{a_{10i}}\right), \quad i = 1,\ldots,9 \tag{A1}$$

$$V_i = A\, L_i^{\alpha i}\, K_i^{1-\alpha i} \tag{A2}$$

where X_i^s = production in sector i

N_{ji} = intermediate input of good j in producing i (j = 10 is crude oil)

V_i = value added in sector i

L_i = labor input in sector i

TABLE A1

TRANSACTIONS TABLE AT PRODUCER'S PRICE

(Unit: Million Won)

	1	2	3	4	5	6	7	8	9	Total
1 Agri. & min.	1170098	564755	7493282	10717	1143	2030425	117566	339857	814	11728657
2 Textiles	30039	4156007	31039	24303	10835	505132	10935	130051	2308	4900649
3 Other light ind.	1158345	251575	3393635	157345	18073	342899	545957	2127872	8100	8003801
4 metal prod. & mach.	79057	92507	169302	3887187	721885	438906	1323289	1044464	15465	7772062
5 Transport	36274	11531	37724	27920	658411	37389	18378	923188	2649	1753464
6 Other heavy ind.	1009402	1721143	1040259	3147636	873132	10849479	3254371	5885129	44969	27825220
7 Construction	33227	22116	3287	8781	6099	40894	15988	462822	379905	973119
8 Services	597512	1210256	1754529	1917598	463235	3570830	1888874	8357152	224416	19984402
9 Housing	13296	37761	38329	43784	6360	55425	41807	854488	9509	1096676
10 Crude oil	0	0	0	0	0	5294996	0	0	0	5294996
Subtotal	4127250	8067651	13961386	9225271	2759173	23166075	7217165	20125023	688135	89333046
Wage bill	1605353	1430416	1289227	1650787	615452	2113669	2743346	13248431	230941	24927622
Oper. surplus	7201822	515438	793509	926411	367342	2156466	1522467	9053495	1916033	24452983
Total value added	8807175	1945854	2082736	2577198	982794	4270135	4265813	22301926	2146974	49380605
Total	12934425	10013505	16044122	11802469	3741967	27436210	11482978	42426949	2835109	138713651

TABLE A2

FINAL DEMAND FOR DOMESTIC GOODS

(Unit: Million Won)

	C	*GC*	*I*	*GI*	*d INV*	*X*	Total Fin.	Total Prod.
1	3274086	0	153568	17880	765598	651995	4863127	13419893
2	1616351	0	37182	401	132120	4605959	6392013	10455224
3	11224072	0	75327	2087	-303406	628633	11626713	18528787
4	1558497	0	2140124	61978	-45121	3981831	7697309	12643698
5	201016	0	1303172	162328	-404880	1913588	3175224	4129514
6	3070526	0	65280	501	-1251945	4770981	6655343	29411419
7	0	0	8288560	2972304	0	115739	11376603	12348848
8	13638369	7390180	566166	30140	97362	4916183	26638400	45493726
9	2322375	0	389379	0	0	6465	2718219	3810812
Total	36905292	7390180	13018758	3247619	-1010272	21591374	81142951	150241921

Notes: *C* = Private Consumption; GC = Government Consumption; *I* = Private Investment; *GI* = Government Investment; *dINV* = Change in Inventory; *X* = Export

TABLE A3

FINAL DEMAND FOR IMPORTED GOODS

(Unit: Million Won)

	C	*GC*	*I*	*GI*	*d INV*	*X*	Total Fin.	Total Import
1	86896	0	50160	0	71526	0	208582	3380536
2	53068	0	867	0	66452	0	120387	957825
3	249606	0	1439	0	66366	0	317411	1419138
4	87195	0	2645801	70888	145475	0	2949359	5775032
5	1159	0	295963	12916	10184	0	320222	1119396
6	118268	0	4718	0	196858	0	319844	5388988
7	0	0	0	0	0	0	0	874
8	262645	0	0	0	1	0	262646	1391722
9	7399	0	0	0	0	0	7399	11482
10	0	0	0	0	-572904	0	-572904	4722029
Total	866236	0	2998948	83804	-16042	0	3932946	24167022

Note: See Table A2.

K_i = capital stock in sector i.

All parameters which are denoted by lower-case letters or Greek letters are obtained from 1983 Input-Output tables for Korea (Table A1-Table A3), which we have consolidated into nine sectors plus oil.

In the factor markets, the demand for labor arises from profit maximizing behavior of producers. Capital stocks are fixed within each period, implying a declining marginal productivity of labor as production increases.

$$\frac{\partial X_i}{\partial L_i} = \frac{W}{P_i} \tag{A3}$$

where $\partial X_i / \partial L_i$: marginal product of labor in sector i

W: nominal wage rate

P_i: value added deflator in sector i.

Since we assume perfect mobility of labor across sectors, there exists only one nominal wage rate in the economy. The wage is determined by a variant of the expectations-augmented Philips curve which we have econometrically estimated using annual data from 1971 to 1987. According to the estimation results, the nominal wage is highly sensitive to unemployment and expected inflation so that the Korean labor market returns to near full employment equilibrium within a few years of any shock. The estimation results are as follows, with t-statistics in parentheses.

$$\hat{W} = 0.29 - 4.57UN + 0.57\,\hat{CPI} \tag{A4}$$
$$(3.0) \quad (-1.9) \quad (3.4)$$
$$R^2 = 0.81,\ D.W = 2.12,\ \rho = 0.79$$

where $\hat{W}$: percentage change of nominal wage

UN: unemployment rate

$\hat{CPI}$: percentage change of the consumer price index.

Private Consumption

Following results from existing Korean studies, we have specified total private consumption as a function of current disposable income and net wealth. During the last quarter century, the private saving ratio has risen remarkably in Korea, from far less than 10% in the mid-1960s to 26.2% of GNP in 1986. At present we can not find any behavioral equation which is able to track this pattern of savings closely.

Net wealth is defined as the present value of private capital stock

after subtracting the present value of net foreign debt. The wealth term captures an effect of wealth accumulation on private consumption and also incorporates an indirect effect from changes in interest rates. As interest rates rise, private consumption falls due to a decrease in the present value of wealth.

$$C = 0.75\,(Y - T) + 0.02\,W \tag{A5}$$

where C: total private consumption
Y: GNP
T: total tax
W: net wealth.

$$W_t = \sum_i Q_{it} K_{it} \tag{A6}$$

$$Q_{it} = [\sum_{j=t}^{\infty} \left(\frac{\partial X_t}{\partial K_t} P_t \right)_j \{(1+r_j)(1+d)\}^{t-j}] / P_{Iit} \tag{A7}$$

where Q_{it}: the shadow value of a unit of capital (Tobin's Q in sector i in period t)
K_{it}: the capital stock of sector i in period t
d: rate of economic depreciation
r_j: real interest rate (deflated by price of good i) in period j
P_{Iit}: price of investment good i in period t.

The depreciation rate was assumed to be 7% a year in the simulation.

The allocation of total consumption among each sector's output is determined by a linear expenditure system (LES) which allows non-unitary income elasticities of demands. Consumers are assumed to maximize the following Stone-Geary utility function subject to the given budget constraint.

$$U = \prod_{i=1}^{N} (C_i - m_i)^{\beta i}, \tag{A8}$$

where $\sum_{i=1}^{N} \beta_i = 1$.

The β_i are exponent terms and the m_i are minimum requirements of the i goods. If all the m_i equal zero, then the demand function is identical to a Cobb-Douglas function and the β_i will equal the share of expenditures on each good i. The N commodity demand functions are given by

$$C_i = m_i + \frac{\beta_i (C - \sum_{j=1}^{N} Pc_j \cdot m)_j}{Pc_i}, \tag{A9}$$

TABLE A4
ALLOCATION OF PRIVATE CONSUMPTION EXPENDITURE

	Minimum expenditure (mi, billion $)	Share ($\tilde{A}i$)	Income elasticity (= ηi)
Agriculture	99	0.02	0.9
Textiles	39	0.04	0.99
Other Light	255	0.16	0.98
Metals & Machi.	15	0.1	1.02
Transport equip.	2	0.01	1.02
Other Heavy	0	0.11	1.02
Construction	55	0.00001	0.01
Services	265	0.46	1.01
Housing	42	0.1	1.01
Crude oil	0	0	0

where Pc_i: price of consumption good i.
The income elasticities can be calculated using the following formula:

$$\eta_i = \frac{\beta_i}{Pc_i} \cdot C / [m_i + \frac{\beta_i}{pc_i}(C - \sum_{j=1}^{N} Pc_i m_j)]. \quad \text{(A10)}$$

The coefficient m_i and β_i were estimated using nonlinear least square techniques with data from various issues of Input-Output tables. Table A4 shows the estimated coefficients and the calculated income elasticities of demand in the base year.

Private Investment

Gross fixed capital formation in each sector is determined as a function of Tobin's Q and cash flow. Tobin's Q is included to capture the effect of future profitability on investment, measured by the present discounted value of the future returns of one new unit of investment. The cash flow term is considered as an important determinant of private investment in Korea as many firms are liquidity-constrained and unable to borrow or raise money on equity markets.

Ideally we would like to econometrically estimate the relative importance of each of these terms in determining investment, but certain empirical problems have proven hard to overcome. The usual difficulty of measuring Q is exacerbated in Korea by the lack of a good measure of the market value of capital. We have been unable to find any alternative variable which can substitute for Tobin's Q at a disaggregated sectoral level. And while a simple regression of investment on cash flow

terms does give a significant role to cash flow, we suspect this is partially due to a simultaneity bias with the omitted measures of the true future profitability of investment. We have chosen therefore to weight each variable according to what we consider to be plausible parameter values, and in the future we hope to get better estimates of these weights. The current specification of the investment is as follows.

$$I_{it}/K_{it} = 0.05\,(Q_{it} - 1) + 0.05\,CASH_{it} \tag{A11}$$

$$CASH_{it} = (V_{it} - W \cdot L_{it})/P_{Iit} \tag{A12}$$

where I_i: investment in sector i

$CASH_i$: cash flow in sector i

V_{it} : value added in sector i in period t.

The investment good for each sector is assumed to be formed as a fixed coefficient bundle of the goods from each sector. Currently we assume that the investment good is identical across all sectors, and the required input from each sector to the investment good is determined from the Input-Output table according to the listed final demand for investment purposes by sector. This includes a direct demand for imported goods for investment. We can write the derived demand for investment purposes by sector as:

$$J_{it} = s_i \sum_i I_{it} \tag{A13}$$

where J_{it} : derived demand for good i for investment in period t

s_i: sector i's unit input requirement in investment good.

Exports

During the era of export-led growth, the structure of Korean exports has changed dramatically. In 1970, light manufacturing composed 70 percent of total exports while the share of heavy and chemical industry exports was only 13 percent. But in 1985 the latter is more than one half of total exports.

To capture this structural change, we have carefully specified and estimated export demand functions for the Korean economy. We have estimated price and income elasticities for Korean exports using data subdivided into industrial sectors and by importing countries. In our specification of the export demand function, we allowed for competition between Korea and a third country, for example Japan in the U.S. market, by including the competitor's price in the Korean export demand equations. This cross-price elasticity of export demand should give a

TABLE A5

BILATERAL EXPORTS OF KOREA: ESTIMATES OF EXPORT DEMAND EQUATIONS

Importing country	Commodity	Income	Own price	Competitor's price
United States	Agriculture	2.23	-2.49	1.26
	Textiles	3.04	-4.33	0.16
	Other Light	3.54	-2.04	0.63
	Metals & Machi.	1.76	-3.20	0.54
	Other Heavy	3.75	-1.92	0.00
Japan	Agriculture	3.26	-1.58	4.79
	Textiles	2.01	-3.66	0.21
	Other Light	0.45	-1.12	0.70
	Metals & Machi.	0.43	-2.80	1.65
	Other Heavy	0.66	-1.98	3.17

more accurate prediction for bilateral trade, and is important when there are shocks which affect bilateral exchange rates amongst Korea's competitors. The export demand equations are specified as follows:

$$EX_i^k = f\left(FGNP^k, \frac{PEX_i}{FWPI_i^k}, \frac{FWPI_i^1}{FWPI_i^k}\right) \tag{A14}$$

where EX_i^k : export volume of commodity i to country k

$FGNP^k$: real GNP of importing country k

PEX_i: export price deflator of commodity i

$FWPI_i^k$: foreign WPI of commodity i in country k

$FWPI_i^1$: foreign WPI of commodity i in country 1.

All variables are denoted as the U.S. dollar terms by multiplying appropriate bilateral exchange rates. Table A5 presents estimated parameters obtained by OLS using log-linear form. (In all the equations, the R^2 are very high and most of coefficients are statistically significant at the 1 percent level.) The results show that most Korean exports are highly price elastic, and there is a fair degree of competition with exports from the third country. The estimates in the transportation equipment sector were not significant, which we believe is due to the sharp fluctuations and growth in exports of components such as ships and automobiles during the 1980s. We decided to adopt the price and income elasticities from the metals and machinery sector for the transportation equipment sector.

Since the disaggregated wholesale price data were not available for the rest of OECD, OPEC and the rest of world, we could not estimate

their export demand functions. For those regions, we assumed income elasticities were equal to 2.0, and price elasticities were equal to −1.5, which reflects a rough average of the estimates for the U.S. and Japan. These parameters are also used for exports of the service sectors.

Imports

To determine imports by sector we assume that domestic and foreign goods are imperfect substitutes. Producers and consumers determine their demand for imported goods by minimizing the cost of acquiring a composite good which is defined as a CES bundle of imports and the domestic good as follows:

$$N_i = n_0[\mu_1 ND_i^{\rho_{1i}} + (1-\mu_1)NM_i^{\rho_{1i}}]^{1/\rho_{1i}} \tag{A15}$$

$$c_i = c_0[\mu_2 CD_i^{\rho_{2i}} + (1-\mu_2)CM_i^{\rho_{2i}}]^{1/\rho_{2i}} \tag{A16}$$

$$I_i = i_0[\mu_1 ID_i^{\rho_{3i}} + (1-\mu_3)IM_i^{\rho_{3i}}]^{1/\rho_{3i}} \tag{A17}$$

where $NM_i(ND_i)$: imported (domestically produced) intermediate good i
$CM_i(CD_i)$: imported (domestically produced) consumption good i
$IM_i(ID_i)$: imported (domestically produced) investment good i.

The desired ratio of imports to domestic goods will be a function of their price ratio. The elasticity of substitution between domestic and imported products is assumed to be 1.5 in the Korean economy, which implies a slightly higher price elasticity of imports than that estimated by other Korean authors (Park 1987 and Yoo 1984).

The imports for intermediate inputs are determined by first summing the desired input by type of good for all producing sectors, and then allocating these inputs according to the function above between the domestic and imported version. Consumer's demand for imports is determined by directly allocating the aggregate consumption of each good between the domestic and imported version. Having determined imports for each product, we allocate them across region's according to a Cobb-Douglas function, implying that the share of expenditures on imports from each region is held fixed. Table A6 shows each regions share by commodity. For the service sector we applied the aggregate country share because breakdown of imports by region was not available.

The Government and Financial Sector

Total government expenditure is treated as a policy variable which is

a fixed, exogenous share of the Korean GNP and allocated among sectors by fixed shares. Government revenue was not precisely modeled in the present version. Revenues consist of lump sum taxes out of the private income and bond issues. Domestic distortionary taxes, tariff and seignorage revenue will be considered in later versions of this model. To impose the government budget constraint, lum sum taxes are set equal to the real interest payment on net public debt in every period.

$$T_t = r_t \cdot B_t - r_t^{u.s.} \cdot FR_t \tag{A18}$$

where G_t: government expenditure

B_t: outstanding public bond

FR_t: net foreign assets held by the public sector

$r_t^{u.s}$: U.S. interest rate.

In the current model we attempted to capture only essential features of the Korean finahcial market. With capital controls and fixed exchange rates, the monetary authorities purchase or sell reserves for domestic currency.

$$M_t^s = M_{t-1}^s + k\,[DR_t - DR_{t-1}] \tag{A19}$$

where M^s : money supply (M_1)

k: money multiplier

DR_t: foreign reserves held by the central bank.

The money multiplier was assumed to be 2.0 in the model. If there is an inflow of foreign capital, it increases supply of money additionally in equation (A19).

Demand for real money balances is a function of real GNP and the domestic nominal interest rate according to a standard Goldfeld-type money demand equation. Nominal interest rates adjust freely to equilibrate money demand and supply.

$$\frac{M_t}{P_t} = (Y_t)^{\varepsilon} \cdot (1 + i_t)^{-\nu} \tag{A20}$$

where P_t: GNP deflator

i: nominal interest rate

Parameter ε and ν are the income and interest elasticity of money demand, which are assumed to be 1.0 and 0.6 respectively.

Market Clearing and Intertemporal Linkage

In the labor market, the supply of labor is assumed to be perfectly

elastic at the current nominal wage. In goods markets, prices are flexible and adjust freely to equate supply and demand. The goods market equilibrium condition is given by

$$X_t^s = N_t + C_t + J_t + G_t + (EX_t - IM_t), \tag{A21}$$

where IM_t: imports of sector i good.

In our model, stock-flow consistency is carefully maintained. Net investment each period increases the capital stock in the following period. The government issues new bond every year by the amount of fiscal deficit.

The trade balance plus debt service payment determine the current account balance, and the stock of net foreign assets is adjusted to reflect the current account balance each period.

$$K_{i,t} = [K_{i,t-1} \cdot (1 - d)] + I_{i,t} \tag{A22}$$

$$B_t = (1 + r_t)B_{t-1} + (G_t - T_t) \tag{A23}$$

$$FR_t = (1 + r_t^{u.s})\mathrm{FR}_{t-1} + (EX_t - IM_t) \tag{A24}$$

Finally the model is specified with a labor augmenting technological progress. So labor supply increases by exogenous rate of technical progress (μ) and we chose μ equal to 3%.

$$LS_{t+j} = LS(1 + \mu)^j \tag{A25}$$

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