

# **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.