Openness, Growth and Inflation: Evidence from South Korea

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I. Introduction

Until the end of 1997, a rapid growth in South Korea has been accompanied by government intervention in international trade as well as in financial markets. The government intervention in South Korea has encouraged domestic investment along the lines of comparative advantage. Recently, however, the WTO and especially the IMF bailout packages compel South Korea to remove trade barriers, particularly to accelerate removal of import restrictions on foreign products. Financial markets are also induced to open to foreign investors. The impetus for the increasing pressure to open is the 'new' growth theories, which suggest that a country's openness to the world trade improve domestic technology, and hence domestic productivity rises (Grossman and Helpman, 1991; Romer, 1992; Barro and Sala-i-Martin, 1995). While many cross-country studies provide evidence that increasing openness has a positive effect on GDP growth (Barro, 1991; Edwards, 1992, 1993, 1998; Sachs and Warner, 1995; Sala-i-Martin, 1997; Frankel and Romer, 1999, among others), robust positive relationships are difficult to find (Levine and Renelt, 1992; Harrison, 1996; Harrison and Hanson, 1999; O' Rourke, 2000, among others). Increasing openness is also believed to reduce inflation rates, because the harms of real depreciation will be greater if an economy is more open to the world, and hence policy makers may have less incentives to pursue expansionary policies (Romer, 1993). This proposition is well supported by empirical evidence that increased openness generally exerts a significant negative effect on inflation across countries (Romer, 1993; Lane, 1997; Terra, 1998).

Most studies of the macroeconomic role of openness have focused upon the estimation of cross-country averages of many different levels of economies. However, these studies cannot identify country-specific differences among less developed countries (LDCs). Most LDCs are similar to each other, but these countries may have their own trade policies, and their socio-economic characteristics may also be quite different among LDCs. It thus appears that the impact of openness must be studied on a country-by-country basis. One such economy well-suited to the study of the macroeconomic effects of openness is the Korean economy, which has grown rapidly over the last several decades and has simultaneously run government intervention in trade as well as in financial markets that has led to a rapid increase in output and the price level.[1] Although the Korean economy has been characterized by rapid growth of economic activity and government intervention, Lee (1995) and Kim (2000) have conducted even limited studies of the effect of government intervention in Korea. Both studies estimated the effects of tariffs on productivity growth using micro-level data of Korean manufacturing industries and found that high tariffs (and thus protection) have negative, but statistically insignificant effects on productivity.

This paper goes further, by using time-series data and by examining the dynamics of openness-growth and openness-inflation relations simultaneously. The dynamics are examined through computation of variance decompositions (VDCs) and impulse response functions (IRFs), which are based on the moving average representations of the vector autogressive (VAR) model. The variables included in the model are consistent with the reduced form of an aggregate demand-aggregate supply framework, where the IS-LM model underlies the aggregate demand side. Openness, output, the price level, the money supply, and government spending are included in the model as are two external shock variables. The latter two variables measure foreign output and foreign price shocks emanating, respectively, from the output of industrial countries and from world export prices. To check on the robustness of the results, four different measures of openness are employed: two are openness measures in international trade, while another two reflect financial market openness.

The VAR modeling approach is employed since there is little agreement on the appropriate structural model and since few restrictions are placed on the way in which the system's variables interact in the estimation of the system. In the specification and estimation of the model, all variables are treated as jointly determined; no *a priori* assumptions are made about the exogeneity of any of the variables in the system at this stage of analysis. However, in the computation of the IRFs and VDCs, some decisions about the structure must be made. These decisions are discussed in Section IV, but the results are not sensitive to the decisions made about the structure.[2]

Section II reviews the literature on openness and growth and openness and inflation relations. Section III discusses the data and the specification of the model, while basic results are presented and analyzed in Section IV. Section V discusses alternative models to test for the robustness of the results. Conclusions are summarized in Section VI.

II. Literature on Openness-Growth and Openness-Inflation Relations

A. Openness and Growth

Neoclassical growth models assume that technological change is exogenous, and it is unaffected by a country's trade policy (e.g. Solow, 1957). Recently, however, ‘new’ growth theories pioneered by Romer (1986) and Lucas (1988) assume that technological change is endogenous. Particularly, Grossman and Helpman (1991), Romer (1992), and Barro and Sala-i-Martin (1995), among others, argue that technological change can be influenced by a country's openness to trade. Increased openness raises imports of goods and services, which include new technology. The new, foreign technology is then introduced to the domestic economy and will be learned by domestic producers. Thus, a country's openness will improve domestic technology; production process will be more efficient; and hence productivity will rise. Therefore, a domestic economy that is open to world trade may grow faster than protected or closed economies, and thus increased openness is expected to have a positive impact on economic growth.

Openness, however, does not raise economic growth unambiguously. Levine and Renelt

(1992) suggest that openness and growth relations occur through investment, and increasing openness may stimulate foreign direct investment from abroad, while the increased international competition may discourage domestic investment. In this case, the output effect of the two driving forces is ambiguous, depending on the changes in domestic and foreign investment. Grossman and Helpman (1991) further indicate that protection could raise the long-run growth if government intervention in trade encourages domestic investment along the lines of comparative advantage. Alternatively, Batra (1992), Leamer (1995), and Batra and Beladi (1996) also argue that freer trade is the primary source of economic downturns. Trade liberalization and increased openness are believed to reduce tariffs, and thereby the tariff cut reduces the relative price of domestic manufactures. In this case, manufacturing goods domestically becomes less attractive than importing foreign goods, and hence the domestic economy may suffer a loss.[3]

Theoretical disagreement on the role of openness is matched by mixed empirical evidence. Empirical literature has focused on the measurement of a country's openness. Barro (1991) used relative prices of investment goods to international prices as an openness measure. The cross-sectional analysis of 98 countries provided evidence that increasing openness had a positive effect on GDP growth per capita. Edwards (1992) also found a positive and significant effect of openness on GDP growth, using an openness measure that was the difference between actual and predicted trade; the predicted trade volume was obtained from a theoretical model that did not impose tariffs and trade barriers. Levine and Renelt (1992) employed six different measures of trade policies to check on the robustness of the results, but no robust positive relationship was found between increasing openness and long run growth across countries. Harrison (1996) used a panel data for LDCs, but robust positive relations were also difficult to find. Using similar proxies for openness, Edwards (1998) however found that total factor productivity growth was faster in more open economies. Sachs and Warner (1995) then constructed a composite measure of openness in trade, exchange rate, and other policies, and provided strong evidence that increasing openness improved overall growth. Sala-i-Martin (1997) provided further evidence that the measure of openness constructed by Sachs and Warner had robust results on growth, whereas Harrison and Hanson (1999) failed to establish a robust result. Frankel and Romer (1999) further constructed the geographic component of trade, and found a positive effect of trade on real GDP per worker. Finally, the sample period used also matters. For the late 19th century, O' Rourke (2000) provided evidence that increasing tariffs (and thus protection) was positively related to growth. This would imply that increased openness slowed growth during this period.[4]

B. Openness and Inflation

The link between openness and inflation is based on the Barro-Gordon-type model that an unanticipated monetary expansion can cause inflation to rise (Kydland and Prescott, 1977; Barro and Gordon, 1983). Based on this model, Romer (1993) suggests that an inverse relationship between openness and inflation arise through the impact of openness on policy-makers' incentives to pursue expansionary policies. Unanticipated monetary expansion induces real exchange rates to depreciate. The more a country's openness, the greater the harms of real depreciation, and thus less expansion of monetary surprise is expected for more open economies. In this case, inflation falls.

Romer (1993) provided evidence that openness generally exerts a significant negative effect on inflation in a broad cross-section of countries. Lane (1997) also found the inverse relationship between openness and inflation across countries, based on the argument that the inverse relationship was due to imperfect competition and price rigidity in non-traded sectors. Terra (1998) however argued that the inverse relationship was due to indebted countries' need to raise revenue to repay their debts, and significant negative relationships were found only for severely indebted countries.

C. Motivations

This brief review of the literature on openness and growth and openness and inflation relations reveals three important considerations. First, many studies use cross-country data for LDCs. Some studies use cross-industry data within a country. Little has been done for dynamics of the impact of openness at a country level. Accordingly, this study differs importantly from others in the literature by using time-series data for a developing country, Korea, to examine the dynamics of openness-growth and openness-inflation relations simultaneously. The dynamics are examined through computation of impulse response functions and forecast error variance decompositions, which are based on the moving-average representation of the VAR model.

Second, many cross-section studies employ various measures of openness to find their relationships with economic growth and inflation, but it is difficult to obtain long historical data for the openness measures. Perhaps, this has led many studies in this area to the estimation of cross-country averages of LDCs. For time-series analysis, the imports/GDP ratio is generally acknowledged in the literature to be the best measure currently available (e.g. Romer, 1993). Alternative measures of openness in financial markets, as well as in trade, will also be discussed in Section V.

Finally, as noted in Harrison (1996) and Edwards (1998), the issue of causality has not been adequately addressed in this relevant literature. Although the Granger's (1969) definition of causality is not causality as it is usually understood, in practice, however, we would like to know whether a time series *openness* precedes a time series *GDP*, or *GDP* precedes *openness*. This is the purpose of the Granger causality test. Harrison (1996) briefly introduced causal orderings between openness and growth. Yet it is widely known that the causal orderings are sensitive to the number of variables included in the model. This study thus constructs a VAR as a small macro model of the Korean economy and employs IRFs and VDCs techniques to investigate the issues related to causal orderings between openness and growth and openness and inflation.

III. Data Description and Model Specification

As noted earlier, the macroeconomic effects of openness are examined within the context of a seven-variable VAR model. The model is specified and estimated using quarterly data for 1960:1-1997:3. The period 1960:1-1963:1 is used as pre-sample data to generate the lags in the VAR, and the model is estimated over the period 1963:2-1997:3. The beginning of our sample roughly coincides with the period in which the Korean government placed increased reliance on international trade. The end of our sample coincides with breaking out of 1997 financial crisis in Korea.

Quarterly data are used for two reasons. First, the size of our system requires quarterly data in order to have enough degrees of freedom for estimation. The second reason is based on a desire to minimize any problems with temporal aggregation (see Christiano and Eichenbaum, 1987) that might arise with the use of annual data. In addition, the quarterly series is seasonally unadjusted. As pointed out by Sims (1974) and Wallis (1974), seasonally adjusted data may create distortions in the information content of the raw data and render valid inferences somewhat difficult. Several varied procedures to remove seasonal components from the raw data may generate different series, depending on the methodology and time periods used. Therefore, the use of seasonally unadjusted data is warranted to avoid the smoothing problems inherent in the process of seasonal adjustment.

A vector autoregressive process of order p, VAR(p), for a system of k variables can be written as

$$X_t = A + B(L)\, X_t + u_{t,} \qquad (1)$$

where X_t is a k x 1 vector of system variables, A is a k x 1 vector of constants, B(L) is k x k matrix of polynomials in the lag operator L, and u_t is a k x 1 vector of serially uncorrelated white noise residuals. As noted earlier, the standard Sims (1980) VAR is an unrestricted reduced-form approach and uses a common lag length for each variable in each equation. That is, no restrictions are imposed on coefficient matrices to be null, and the same lag length is used for all system variables.

Seven variables are included in the model: real gross domestic product (GDP) in 1990 prices (y), the GDP deflator (P), the narrowly defined money supply (M), real government expenditures (g), the imports/GDP ratio as an openness measure (OPEN), the industrial production index of industrial countries as a foreign output shock measure (YSTAR), and the world commodity price index of all exports as a foreign price shock variable (PSTAR). The data for all variables are obtained from the *international financial statistics*.[5]

Following Romer (1993), the import share in GDP is used as a proxy for openness of an economy. Since even protected economies like Japan have expanded exports to other countries, the import share removes the export share from total trade. Unlike trade share in GDP, the import share reveals import penetration that represents the degree of a country’ s trade openness.

Since macroeconomic policies that are not directly related to trade may even cause a positive correlation between openness and growth (e.g. Levine and Renelt, 1992), domestic monetary and fiscal policy variables are included in the model as control variables and allow to influence aggregate demand. M1 is used as a monetary policy variable. Real government expenditures are measured as the consumption and investment of the consolidated central government in Korea and are deflated by the GDP deflator (1990=100). It is important to include government expenditures in our model since the fiscal policy variable can affect economic activity even if openness has no effect on output. Since monetary and fiscal policy variables can be correlated (e.g. debt monetization), macro effects due to changes in government spending might be incorrectly attributed to money supply if government spending were omitted from the model.

Because the Korean economy heavily depends on international trade, it is also important to include variables like the foreign output and foreign price shocks. The foreign output shock variable, YSTAR, is the industrial production index of industrial countries. The inclusion of YSTAR in our model is similar to Genberg, Salemi, and Swoboda (1987) who used an index of European industrial production to measure a foreign output shock variable in their study of the effects of foreign shocks on the Swiss economy. The foreign price shock variable, PSTAR, is the world commodity price index of all exports. A shock to PSTAR can be transmitted to the domestic economy through two different channels. First, an increase in foreign prices may raise domestic exports but lower import demand. Hence, the net exports may rise domestically. This transmission channel relates to an increase in aggregate demand in which domestic output and prices rise through an increase in net exports. Second, the foreign price shock may reduce aggregate supply because the import prices of intermediate goods to be used in the domestic production process will be increased. Other things being equal, this would tend to reduce domestic output and raise the price level.

Prior to estimation of the VAR, augmented Dickey-Fuller tests were employed to check for first-order unit roots. These tests suggested that the first differences of the logs of YSTAR, PSTAR, M, G, Y and P and the first differences of the level of OPEN should be used in specifying and estimating the model. Based upon the arguments of Engle and Granger (1987), cointegration tests were also performed for the seven variables that required differencing to achieve stationarity. Since no evidence of cointegration was found, the system was estimated with differences of all system variables.

IV. Basic Results

The sources of changes in the growth rates of output and of the price level are examined through the computation of variance decompositions (VDCs) and impulse response functions (IRFs) which, in turn, are based on the moving-average representations of the VAR model and reflect short-run dynamic relationships between variables. The VDCs show the percent of the forecast error variance for each variable that may be attributed to its own innovations and to fluctuations in other variables in the system. The IRFs indicate the direction and size of the effect of a one standard deviation shock to one variable on other system variables over time. Since model variables are converted to first differences prior to estimation of the model, the VDCs and IRFs reported here indicate the effects of a shock to the changes in openness on the growth rates of output and prices.

Since Runkle (1987) has argued that reporting VDCs and IRFs without standard errors is similar to reporting regression coefficients without t-statistics, a Monte Carlo integration procedure is employed to estimate standard errors for the VDCs and IRFs. One thousand draws are employed in the Monte Carlo procedure. For the VDCs, the estimates of the proportion of forecast error variance explained by each variable are judged to be significant if the estimate is at least twice the estimated standard error. For the IRFs, a two standard deviation band is constructed around point estimates. If this band include zero, the effect is considered insignificant.

Since the equations of the VAR contain only lagged values of the system variables, it is assumed that the residuals of the VAR model are purged of the effects of past economic activity. Any contemporaneous relations among the variables are reflected in the correlation of residuals across equations. In this paper, the Choleski decomposition is used to orthogonalize the variance-covariance matrix. In this approach, the variables are ordered in a particular fashion, and, in this way, some structure is imposed in computation of the VDCs and IRFs. When a variable higher in the order changes, variables lower in the order are assumed to change. The extent of the change depends upon the covariance of the variables higher in the order with that lower in the order.[6]

The variables are ordered as: YSTAR, PSTAR, OPEN, M, G, Y, P. Noting the potential sensitivity of the results to variable orderings, theoretical considerations are used (e.g. Bernanke, 1986). The placement of foreign output and price shocks first is based on the assumption that South Korea is characterized as a small open economy so that current-period shocks to foreign output and prices are allowed to influence domestic variables, but the domestic economy cannot contemporaneously affect foreign shock variables. The placement of three domestic policy variables (OPEN, M, G) next is consistent with the familiar textbook treatment of aggregate supply and aggregate demand in which current period shocks to the policy variables can affect Y and P contemporaneously. Assumed in this ordering is that current period shocks to Y have no contemporaneous effect on the three policy variables. This is also consistent with the typical policy reaction functions in which the current values of the policy variables depend only on the lagged values of domestic macro variables. Finally, the placement of Y and P last allows the domestic output and prices to respond directly and indirectly to contemporaneous shocks to domestic policy variables as well as foreign shocks.

The VAR order is set to twelve quarters to reduce serial correlation of the residuals. The marginal significance levels of the Ljung-Box Q statistics range between 0.67 and 0.99. Choice of other lag lengths merely reduces the significance levels of the Q statistics.

Figure 1 shows the point estimates of the IRFs, which are plotted with a dotted line, while the solid lines represent a two standard deviation band around the point estimates. If this band excludes zero, the effect is considered to be significant. For YSTAR and PSTAR innovations, the output effects simply fluctuate around zero over horizons, while the price effects are observed to be positive and significant at short horizons. In the case of OPEN innovation, the effect on output initially rises and the effect quickly becomes *negative.* The negative effect is significant at horizon of four quarters, and a marginal significance is also observed at eight-quarter horizon. In the longer run, however, the effects are not significantly different from zero. The price effects of OPEN are also initially *negative* and significant, and significant negative effects are again observed at horizons of five, nine, eleven, and thirteen quarters, although some positive effects appear significant at short horizons.

The significant, negative output effects of a shock to openness do not appear to support the new growth theories that increasing openness helps the domestic economy to grow. The results also appear to be at odds with the empirical findings of Lee (1995) and Kim (2000) for the Korean economy since the short-run negative effects are in the opposite direction of those predicted by these studies. One explanation for the negative effects found here has been suggested by Aitken and Harrison (1999) based on *a priori* argument of Levine and Renelt (1992). The argument is that trade liberalization of a developing country whose economic fundamentals are not very strong may discourage domestic investment due to increased international competition, and its decrease would be greater than capital inflows from abroad. In this case, net investment falls, as does aggregate demand. Therefore, increasing openness has negative effects on the growth rates of output.

On the other hand, the observed negative price effects of openness are consistent with the findings of Romer (1993), Lane (1997), and Terra (1998). The results appear to be consistent with aggregate demand channel: a fall in net investment due to increased openness reduces aggregate demand and hence the price level falls.

Other domestic policy shocks (M and G) also have non-trivial effects on economic growth and inflation. Therefore, it is of interest to determine the relative importance of changes in openness to other variable shocks. This information can be obtained by computing variance decompositions (VDCs) of Y and P explained by other system variables.

Table 1 reports the VDC results. The estimated standard errors are in parentheses below the point estimates. A * indicates that the point estimate is at least twice the standard error--our rule of thumb for judging significance. VDCs at horizons of 4, 8, 12, 16, 20 quarters are shown in order to convey a sense of the dynamics of the system. Only the effects on Y and P are shown in order to focus upon the variables of central interest to the paper and to conserve space. The forecast error variance of Y explained by OPEN innovation appears to be significant at short horizons, and the effect of openness is greater than the effects of other variable shocks. The price effects of shock to openness are also greater than the effects of other variable shocks, and the effects are significant at all horizons. The results are generally consistent with the IRF results found in Figure 1. Furthermore, the price effects of YSTAR innovations are relatively large and appear to be significant at all horizons. Shocks to M and G also appear to be significant over longer horizons. The shocks emanating from domestic policy variables such as M and G, as well as foreign output shocks, may transmit to the domestic economy through the aggregate demand channel in which output and prices are affected by an increase in aggregate demand. However, the results that price effects are greater and more significant than output effects suggest that aggregate supply is relatively steep in Korea.

V. Alternative Specifications and Sensitivity Results

A. Lag Lengths

It is common practice to choose an *ad hoc* lag length when specifying distributed-lag models. Because economic theory is often not very explicit about the lag lengths in time series relationships, several VAR orders are employed to check on the robustness of the results.

Table 2 shows the results of the VDCs with common lag lengths: 8, 10, 12, 14, and 16 quarters. The 12-quarter lags employed for the basic results in Table 1 are used here as a benchmark lag length.

Although the sample period begins from 1960:1, estimation begins from 1962:2 1962:4, 1963:2, 1963:4, and 1964:2, respectively, due to different lag lengths used. The degrees of freedom reduce by sixteen in each column, and thus the lag length longer than 16 quarters is not used here. The lag length shorter than 8 quarters is not used as well since the serial correlation of residuals appears to be serious with the use of shorter lags. Again, only the effects of OPEN on Y and P are shown to focus upon the variables of central interest to the paper and to conserve space. The forecast error variance of output explained by shocks to openness is small and insignificant for the 8-lag model, while the VDCs with 10-quarter lags are all within one standard deviation of those in the 12-lag model. The results are more convinced when longer lags are used. For 14-quarter and 16-quarter lags, the point estimates are even greater than those in the 12-lag model. A similar pattern is observed for prices. When the lags smaller than 12 quarters are used, the point estimates are relatively small; but the VDCs are large and significant when longer lags are used. Thus, the significant output and price effects of openness are, with only a few exceptions, qualitatively unchanged.

B. Variable Orderings

Another potential problem of this reduced-form VAR approach is that contemporaneous correlation may exist among the residuals of the VAR model. For example, if the current value of the residual in the first equation is correlated with the current value of the residual in the second equation, the variable in the second equation is affected by changes in the variable of the first equation. Thus, a pure innovation in a particular variable lower in order cannot be isolated. For this reason, innovation accounting often uses the Choleski decomposition of the residual variance-covariance matrix to identify orthogonal shocks to each variable. Although the Choleski decomposition orthogonalizes the VAR residuals, it is generally recognized that innovation accounting results of the VAR are potentially sensitive to the ordering of system variables. Specifically, if there is substantial contemporaneous correlation, variable ordering matters. When a variable higher in order changes, the variable lower in order also changes. Consequently, innovation accounting results may be potentially sensitive to the ordering of variables.

The orderings chosen for study are the following: (1) YSTAR, PSTAR, OPEN, M, G, Y, P; (2) YSTAR, PSTAR, M, G, OPEN, Y, P; (3) OPEN, YSTAR, PSTAR, M, G, Y, P; (4) YSTAR, OPEN, PSTAR, M, G, Y, P; and (5) YSTAR, PSTAR, OPEN, M, G, P, Y. As noted earlier, the benchmark ordering (1) is designed to be consistent with a model in which the IS-LM model underlies aggregate demand and where output and the price level respond to current innovations in domestic policy variables as well as foreign shock variables. In ordering (2), OPEN is allowed affected by contemporaneous shocks to M and G. This is the case that monetary and fiscal policy shocks may cause large foreign exchange depreciation; the depreciation would increase exports but decrease imports; and thus the imports/GDP ratio, which is our openness measure, would be affected. Furthermore, this ordering is consistent with the set of structural models in which foreign shocks as well as domestic policy variable shocks have both direct and perhaps indirect contemporaneous effects on OPEN. Ordering (3), however, places OPEN first in the ordering, based on the assumption that any contemporaneous effects flow from the openness variable to all other model variables. Ordering (4) places the openness variable next to YSTAR but prior to PSTAR. Ordering (5) is the same as ordering (1) except that the ordering of Y and P is switched.

The VDCs for all different orderings are reported in Table 3. Although OPEN is ordered in several different places, the results are essentially unchanged. The point estimates in orderings (2) - (5) are all within one standard deviation of those in column (1).[7] The VDCs, thus, indicate that significant effects of openness on the macroeconomy are not materially changed due to variable orderings.

C. Openness Measures

Table 4 further reports the VDC results, employing alternative openness measures. In addition to the imports/GDP ratio, the trade/GDP ratio also reveals the degree of a country's openness to world trade: the more open a domestic economy is, the less is the restriction in world trade, and the higher is the trade share in GDP. This trade share in GDP is most commonly used in the related literature (e.g. Harrison, 1996). The results found in column (2) are similar to our earlier findings in column (1).

While both import shares and trade shares in GDP represent openness to trade, other openness measures used in columns (3) and (4) represent the openness of financial markets. As indicated in Levine and Renelt (1992), openness and growth relations may occur through investment, and hence increasing openness may raise long-run growth only insofar as openness provides greater access to investment goods. When countries begin to liberalize barriers in financial markets, foreign direct investment (FDI) will be stimulated from abroad. Thus, the FDI/GDP ratio is used in column (3) as a proxy for financial market openness. Column (4) further employs interest rate differentials in which a large gap between domestic and foreign interest rates represents a small degree of openness. For these two measures, our sample begins in 1977:1 since this is the earliest date for which we can obtain the FDI and interest rate series. The beginning of our sample roughly coincides with the period in which the Korean government placed increased reliance on FDI and the sale of bonds to foreign investors. Ideally, a debt series that is held by foreigners as a percentage of total debt would also be preferred, but no series of this type is available quarterly. Because sample periods are relatively short in columns (3) and (4), eight rather than 12 lags are used for estimation. It is observed that changes in output and price effects are all within one standard deviation of those in column (1), while the effects in column (4) particularly shrink.

Furthermore, the IRF results are presented in Figure 2. The significant short-run effects of financial market openness are found to be *negative* on the growth rates of output and of the price level. Trade openness measures are also observed to have significant negative effects on Y and P in the short run. One exception is the insignificant response of P to shocks to the imports/GDP ratio.[8] Other than that, the significant short-run effects are all *negative.*

VI. Concluding Remarks

This paper has examined the effects of increasing openness on the growth rates of output and of the price level in Korea. Unlike most studies that concentrate on the estimation of cross-country or cross-industry averages, this study focuses upon the dynamics of openness-growth and openness-inflation relations for a rapidly growing economy, one in which rapid growth has been accompanied by a persistent government intervention in international trade and financial markets. This study also differs from others in the literature by employing VAR techniques that are of a less restrictive empirical framework. The framework of analysis is a seven-variable VAR model that consists of output, the price level, the money supply, real government spending, foreign output and foreign price shocks, and openness measures.

The effects of changes in openness on economic growth and inflation rates are evaluated through the computation of impulse response functions and variance decompositions. The impulse response functions indicate that significant effects of a shock to openness on the growth rates of output and of the price level are *negative.* The variance decompositions also indicate that the effects of openness on these variables are significant and greater than the effects of other variable shocks. The results are, in general, robust across lag lengths, variable orderings, and alternative openness measures. The impulse response functions further indicate that proxies for financial market openness, as well as trade openness, have *negative* impacts on the growth rates of output and of the price level.

In the new growth theories, openness improves productivity and hence economic growth. In the short run, output is found affected negatively by openness measures although there are no longer-run effects. The results do not appear to support the new growth theories, since the short-run negative effects are in the opposite direction of those predicted by the new growth theories. The price effect of openness is also found negative. The significant negative effects of increasing openness on output growth and inflation appear to be consistent with the argument of Aitken and Harrison (1999) and Levine and Renelt (1992) that the increased international competition due to openness may cause domestic investment to decline and its decrease would be greater than an increase in capital inflows from abroad. In this case, net investment falls, so does aggregate demand.

FOOTNOTES

1. Average annual growth rates of real GDP and GDP deflator since 1960 are 8.8% and 13.3%, respectively, in South Korea.
2. The drawback of the VAR, of course, is that it is difficult to distinguish sharply among different structural models, since the VAR technique is a reduced-form approach. Cooley and LeRoy (1985) and Leamer (1985) have pointed out the limitation of the VAR approach.
3. Here, tariffs are assumed to be reduced on final goods, not intermediate inputs. Suppose tariffs are reduced on intermediate inputs, then the tariff cut reduces the import price of inputs, which, in turn, reduces costs of production to boost output. This type of effect would raise aggregate supply.
4. For the late 20th century, however, Edwards (1992, 1993, 1998), Lee (1993, 1995), Sachs and Warner (1995), Sala-i-Martin (1997), and Kim (2000), among others, found that tariff rates had negative effects on the rate of growth.
5. For more details, see the data appendix.
6. Several alternatives to the Choleski decomposition have been suggested. Bernanke (1986) uses the residuals from a structural model as 'fundamental' shocks, and Blanchard and Quah (1989) use long-run constraints that are, in principle, consistent with alternative structural models as fundamental shocks. However, unless the structural models are just identified, in general, there will be correlation across equations in the residuals of the structural model, and the issue of an appropriate ordering arises again.

7. Note that, for ordering (5), the point estimates are identical to those in column (1) since the order of OPEN is unchanged.
8. The results were slightly different from those in Figure 1 because here in Figure 2 eight lags were used rather than twelve to be consistent with others.

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Table 1. Variance Decompositions: Basic results

Vari-able	Horizon (quarter)	YSTAR	PSTAR	OPEN	M1	G	Y	P
		Explained by shocks to						
Y	4	2.8	5.3	9.2*	3.0	2.2	73.7	3.8
		(2.7)	(3.7)	(4.2)	(2.3)	(2.5)	(6.3)	(3.1)
	8	3.2	5.0	11.0*	3.1	3.2	56.6	18.1
		(2.8)	(3.6)	(4.9)	(2.5)	(3.3)	(7.0)	(5.9)
	12	5.1	4.4	9.9*	5.4	5.2	50.7	19.3
		(3.6)	(3.7)	(4.9)	(4.1)	(4.1)	(7.5)	(6.5)
	16	5.9	5.0	8.7	6.1	8.8	45.3	20.1
		(3.8)	(4.0)	(4.9)	(5.0)	(5.2)	(8.1)	(6.7)
	20	5.2	6.6	7.7	8.9	9.9	41.0	20.8
		(3.7)	(4.5)	(4.7)	(6.4)	(5.7)	(8.5)	(6.9)
P	4	8.4*	5.3	11.8*	3.8	5.8	7.2	57.7
		(4.1)	(3.4)	(4.3)	(2.7)	(3.5)	(2.9)	(5.9)
	8	10.0*	5.9	14.5*	9.3*	4.5	8.9	46.9
		(4.6)	(3.0)	(5.0)	(4.6)	(3.0)	(3.3)	(5.7)
	12	15.4*	5.4	18.1*	8.8*	5.7	9.2	37.5
		(5.4)	(3.0)	(5.4)	(3.9)	(3.0)	(3.6)	(5.1)
	16	15.3*	5.0	21.6*	7.9*	6.9*	9.2	34.0
		(5.1)	(3.0)	(5.9)	(3.6)	(3.1)	(3.5)	(4.8)
	20	14.6*	5.3	20.6*	9.3*	7.4*	10.7	32.1
		(4.8)	(3.1)	(5.6)	(4.1)	(3.2)	(3.8)	(4.8)

Note: The numbers in parentheses represent standard errors estimated by using a Monte Carlo integration procedure. The point estimates are significant if the estimate is at least twice the standard error.

Table 2. Variance Decompositions: Alternative lag lengths

Variable	Horizon (quarter)	Explained by shocks to OPEN				
		8 lags	10 lags	12 lags	14 lags	16 lags
Y	4	2.1	5.6	9.2(4.2)	11.9	10.1
	8	1.8	6.6	11.0(4.9)	16.1	23.9
	12	2.2	6.7	9.9(4.9)	15.2	30.6
	16	2.2	6.6	8.7(4.9)	13.3	29.0
	20	2.2	6.3	7.7(4.7)	12.9	28.1
P	4	9.5	10.9	11.8(4.3)	14.0	10.9
	8	11.4	12.4	14.5(5.0)	26.1	23.9
	12	11.2	14.2	18.1(5.4)	31.2	28.6
	16	10.6	15.4	21.6(5.9)	35.8	32.1
	20	10.3	15.9	20.6(5.6)	35.3	34.8

Note: see Table 1.

Table 3. Variance Decompositions: Alternative variable orderings

Variable	Horizon (quarter)	Explained by shocks to OPEN (1)	(2)	(3)	(4)	(5)
Y	4	9.2(4.2)	7.5	9.4	9.7	9.2
	8	11.0(4.9)	8.1	11.2	11.4	11.0
	12	9.9(4.9)	6.8	10.0	10.2	9.9
	16	8.7(4.9)	5.9	8.8	9.0	8.7
	20	7.7(4.7)	5.3	7.7	7.9	7.7
P	4	11.8(4.3)	10.2	12.5	12.3	11.8
	8	14.5(5.0)	12.2	15.2	14.7	14.5
	12	18.1(5.4)	17.7	19.0	18.3	18.1
	16	21.6(5.9)	21.9	22.4	21.8	21.6
	20	20.6(5.6)	20.6	21.4	20.9	20.6

Note: see Table 1. The variable orderings chosen for study are the following: (1) YSTAR, PSTAR, OPEN, M, G, Y, P; (2) YSTAR, PSTAR, M, G, OPEN, Y, P; (3) OPEN, YSTAR, PSTAR, M, G, Y, P; (4) YSTAR, OPEN, PSTAR, M, G, Y, P; and (5) YSTAR, PSTAR, OPEN, M, G, P, Y.

Table 4. Variance Decompositions: Alternative openness measures

Vari-able	Horizon (quarter)	Explained by shocks to			
		Imports/GDP	Trade/GDP	FDI/GDP	r^*/r
Y	4	9.2(4.2)	6.9	1.9	6.0
	8	11.0(4.9)	10.5	11.6	6.9
	12	9.9(4.9)	12.1	11.5	6.8
	16	8.7(4.9)	11.3	10.6	6.7
	20	7.7(4.7)	9.8	9.3	6.6
P	4	11.8(4.3)	15.4	17.7	7.7
	8	14.5(5.0)	19.1	18.7	11.4
	12	18.1(5.4)	26.7	19.1	11.6
	16	21.6(5.9)	33.7	19.4	11.9
	20	20.6(5.6)	33.4	19.7	11.5

Note: see Table 1.

Figure 1. Impulse Responses: Basic results

Note: Point estimates of the IRFs are plotted with a dotted line, while solid lines represent a two standard deviation band around the point estimate.
Figure 1 (continued)

Figure 2. Impulse Responses: Alternative Openness Measures

Note: Point estimates of the IRFs are plotted with a dotted line, while solid lines represent a two standard deviation band around the point estimate.
Figure 2 (continued)

DATA APPENDIX

Quarterly data were obtained from the *International Financial Statistics*. The numbers in brackets are the IFS code for the variables used. The sample period with exception of those discussed below is from 1960:1 to 1997:3.

Y: real gross domestic product (GDP) in 1990 prices [99b.p], billions of Korean won.

P: GDP deflator, 1990=100, generated by the ratios of nominal GDP to real GDP.

M: narrowly defined money supply [34], billions of Korean won.

G: real government expenditures [82], billions of Korean won, deflated by the GDP deflator (1990=100).

YSTAR: industrial production index of industrial countries, 1990=100, obtained from the industrial countries table [11066.I].

PSTAR: world commodity price index of all exports, 1990=100, obtained from the world table [00176AXD].

OPEN: imports/GDP ratio. Since commodity imports in Korea [71.d] were measured in millions of U.S. dollars, nominal exchange rates, period average [rf] were used to convert the imports in U.S. dollars to Korean won. Other openness measures used were as follows. Trade/GDP: total trade converted to Korean won was divided by nominal GDP. FDI/GDP: foreign direct investment in Korea [78bed], millions of U.S. dollars, was again converted to Korean won by using the nominal exchange rates. r*/r: SDR interest rates [99260S] were used as a proxy for foreign interest rates (r*), and the money market rate of interest [60B] in Korea was used for domestic interest rates (r). For the FDI and interest rate series, the sample period begins from 1977:1 to 1997:3 due to data availability of these two series.