RIETI Discussion Paper Series 07-E-022

The Effect of Imports and Exports on Total Factor Productivity in Korea

Sangho KIM
Honam University

Hyunjoon LIM
University of Rochester

Donghyun PARK
Nanyang Technological University

Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

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Sangho KIM*, Hyunjoon LIM+ and Donghyun PARK++

Abstract

We investigate the effect of imports and exports on total factor productivity in Korea during 1980-2003. We find Granger causality from imports to total factor productivity (TFP) growth, but no causality from exports to TFP growth. We then investigate the impact of trade and other variables on TFP growth. According to our results, imports have a significant positive effect on TFP growth but exports do not. In addition, our results indicate that the positive impact of imports arises not only from the competitive pressures associated with the imports of consumer goods but also from technological transfers embodied in imports of capital goods from developed countries.

JEL codes: F10, O40, O33, C22

Keywords: Imports, exports, productivity, economic growth, Korea

* Corresponding Author, College of Business, Honam University, Gwangju 506-714, Korea Email: shkim@honam.ac.kr, Telephone: +82-62-940-5394, Fax: +82-62-940-5116

+ Department of Economics, University of Rochester, Rochester, New York 14627, USA

++ Economics Division, School of Humanities and Social Sciences, Nanyang Technological University, Singapore 639798. Email: adpark@ntu.edu.sg, Telephone: +65-6790-6130, Fax: +65-6792-4217

1 Introduction

Many economists attribute the rapid economic growth of East Asian countries during the second half of the last century to an export-driven growth strategy which initially protected domestic firms from foreign competition. Implementing this strategy, East Asian governments were able to hasten the catch-up process by directing limited resources into a small number of strategically selected industries and absorbing advanced technologies from developed countries. Export expansion contributed to the economic growth not only by facilitating factor mobilization and capital accumulation in a quantitative sense but also by promoting productivity growth through the emulation of advanced foreign technology and through competition in foreign markets. Furthermore, domestic markets were initially protected by trade barriers so that domestic firms would have enough breathing room to grow up from infancy.

Perceptions about East Asian growth later changed, however, as the Japanese economy succumbed to prolonged depression in the early 1990s and regional developing countries suffered from the Asian financial crisis of 1997-1998. This turn of economic events rekindled the earlier debates about East Asian growth which had revolved around the sources of growth and the role of trade. In the context of the productivity debate, accumulationists argued that East Asia's rapid growth was largely driven by input accumulation whereas assimilationists believed the driving force to be a high rate of technical change made possible by the diffusion of technology from developed countries.[1] In the context of the trade and growth debate, economists have focused their attention on the role of trade in East Asian growth. Some support the export-led growth

[1] See, for example, Hwang (1998).

hypothesis, while others advocate the importance of market opening for growth.[2]

In *The East Asian Miracle*, the World Bank (1993) suggested that exports and export-promoting policies had been instrumental in East Asia's adoption of frontier technologies, which enhanced the productivity of exporting firms and economies in general, thus accelerating economic growth. In addition, many studies provided empirical evidence in support of the export-led growth hypothesis by showing that exports had a significant positive effect on productivity and economic growth. In contrast, Lawrence and Weinstein (1999) argued that the World Bank (1993) focused only on the export-growth relationship, and thus ignored the role of imports in promoting productivity. For Japan, Lawrence and Weinstein found that protection was actually harmful to productivity growth, and exports did not enhance productivity whereas imports did. They also find similar evidence for the US and Korea although the evidence is much more preliminary due to the preliminary nature of their empirical analysis for the two countries. Such findings suggest that learning, innovation and competitive pressures resulting from foreign imports are important conduits for growth.

This study investigates the link between trade and productivity growth for Korea, especially the import-productivity nexus. First, we investigate the dynamic interaction between trade variables and productivity growth using a vector error correction model (VECM) which captures both short-run dynamic changes and long-run relationships. Our empirical results suggest that imports cause productivity growth but provide no evidence of any causality from exports to productivity growth. In particular, this direction of causality is apparent in both bivariate models and trivariate models that consist of imports,

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[2] For surveys of the debates on TFP growth and trade in East Asia, see Chen (1997) and Edwards (1993), respectively.

exports, and total factor productivity (TFP). Second, in order to identify the specific reasons for the import-productivity relationship, we estimate a productivity determination equation which includes various trade variables, along with government size and research and development (R&D) investments, as explanatory variables. Our empirical results again indicate that imports, but not exports, are a significant determinant of productivity growth. Furthermore, the beneficial impact of imports stems not only from competitive pressures arising from imports of consumer goods but also from technological transfers embodied in imports of capital goods and imports from developed countries.

Our study is the first to systematically explore the relationship between trade and productivity growth in the Korean economy since we look at the impact of both exports and imports on productivity growth. Previous studies analyzing the relationship between trade and productivity growth in Korea have defined trade as exports. Therefore, they have focused upon the causality between Korean exports and growth, and largely ignored the role of imports in Korean growth. The one paper to examine the impact of imports on Korean productivity, by Lawrence and Weinstein (1999), does so very briefly and only in passing since it is primarily an analysis of Japanese data. The neglect of imports in the analysis of Korean productivity is rather surprising in light of theoretical developments that have established imports as an important channel for technological transfers and economic growth. Such neglect is also unfortunate in light of the fact that Korea's economic success is widely put forth as evidence supportive of the export-led growth hypothesis, which means it would be especially interesting to look at the impact of both exports and imports in Korean growth. In short, our study provides a more balanced and comprehensive analysis of the trade-growth nexus in Korea than the existing studies. At a broader lever, we hope that our study will be a useful contribution to the empirical literature on imports and productivity, which is considerably more limited than the empirical literature on exports and productivity.

2 Literature Review

In this section, we review the existing literature on trade and productivity. In theory, there is a two-way causal relationship between trade and productivity but advocates of export-led growth generally contend that exports enhance productivity growth.[3] These economists argue that firms tend to learn advanced technologies through exports and must adopt them to compete in the foreign marketplace.[4] Firms also learn by doing, and emulate foreign rivals through the trial and error process inherent in the production and sale of export goods.[5] Furthermore, the expansion in production resulting from exports reduces unit production prices and thus increases productivity.[6] In addition to these effects, exports also provide a country with foreign exchange, which is often scarce in the early stages of economic development, enabling a country to import capital and intermediate goods. Thus, for a variety of reasons, exports increase productivity growth.[7] The reverse causation from productivity growth to exports is also intuitively straightforward. Productivity growth improves a country's international competitiveness in price and quality, and thereby boosts its exports.

An extensive empirical literature exists on the relationship between exports and growth, largely because of its bi-directionality. In fact, much of the empirical literature on trade and productivity defines trade as exports rather than imports. Empirical studies have tried

[3] See, for example, Baldwin (2003), Bonelli (1992), Haddad, De Melo and Horton (1996), Weinhold and Rauch (1997), Yean (1997) and Sjoeholm (1999).
[4] Please refer to Balassa (1978), Krueger (1980) and Nishimizu and Robinson (1982).
[5] See Grossman and Helpman (1991).
[6] See Helpman and Krugman (1985).
[7] See McKinnon (1964).

to determine whether exports cause productivity to increase.[8] However, results in this regard seem to depend on both the sample periods and the countries examined. Some studies find unidirectional causality running from exports to productivity while others find reverse causality between the two variables.[9] Clerides, Lach and Tybout (1998) argue that only relatively efficient firms engage in exports, and that exports do not bring down unit production costs. The basic thrust of all these works is a unidirectional causality from productivity growth to exports.[10] In their studies of U.S. firms, Bernard and Jensen (1999a, 1999b) also find that firms with high productivity usually export their products, and exporting firms do not experience productivity and wage increases greater than those of non-exporting firms. On the other hand, a number of studies find either bidirectional causality or absence of causality between exports and productivity.[11] For Korea, some studies support the export-led growth hypothesis whereas other studies either fail to find causality from growth to exports or find bi-directional causality.[12] The evidence on the direction of the causality between exports and growth in Korea is thus ambiguous at best, despite the widespread presumption of the validity of the export-led growth hypothesis.

The theoretical relationship between imports and productivity tends to be more complicated than that between exports and productivity. Increased imports of consumer products encourage domestic import-substituting firms to innovate and restructure

[8] For a literature survey, see Greenaway and Sapsford (1994).

[9] Haddad, De Mel and Horton (1996) is an example of the former while Pavcnik (2000) is an example of the latter.

[10] Shan and Sun (1998), for example, fail to find unidirectional causality from exports to output and thus reject the export-led growth hypothesis for China.

[11] These include Hsiao (1987), Kunst and Marin (1989) and Jin and Yu (1996).

[12] Jung and Marshall (1985), Xu (1996) and Choi (2002) support the export-led growth hypothesis. Darrat (1986), Hsiao (1987), Dodaro (1993) and Dutt and Ghosh (1996) fail to find causality from growth to exports. Finally, Hsiao (1987), Chow (1987), Bahmani-Oskooee and Shabsigh (1991), Bahmani-Oskooe and Alse (1993) and Jin (1995) find bi-directional causality.

themselves in order to compete with foreign rivals; therefore, imports enhance productive efficiency. Under perfect competition in the neoclassical model, an industry reduces factor usage in the short run when trade barriers are removed and the market is opened for imports. In the long run, however, the industry becomes more productive and competitive, and expands its investments in new technology, resulting in a rightward shift of the industry supply curve.[13] In general, the effect on productivity of opening the market depends on both market structure and institutional factors. Under imperfect competition, an import-substituting domestic market shrinks as imports increase, causing investment to fall and thereby productivity to eventually fall.[14] Furthermore, higher future expected profits lead to more active R&D investment and innovation efforts, and such R&D may be greater for exporting firms than for import-substituting firms in light of the large impact of market opening. Imports of capital goods and intermediate goods which cannot be produced domestically enable domestic firms to diversify and specialize, further enhancing their productivity.[15] Finally, there are also theoretical grounds for both positive and negative causality from productivity to imports.[16]

Relative to the empirical literature on exports and productivity, the number of empirical studies on the relationship between imports and productivity is quite limited. In particular, as pointed out earlier, the only study to empirically examine the relationship for Korea – Lawrence and Weinstein (1999) – does so only very briefly and focuses on Japan. Their

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[13] See Haddad, De Melo and Horton (1996) for a more comprehensive discussion. Hicks argued that severe market competition awakens firms from the laziness and comfort of a monopoly market and provides incentives for innovation.

[14] See Tybout (2000) for an extended discussion. Schumpeter, however, suggested that a certain level of monopoly in the market provides firms with excess profits with which to make R&D investments, thus promoting productivity.

[15] See Grossman and Helpman (1991), Sjoeholm (1999) and Tybout (2000).

[16] Productivity growth triggers economic growth and increases income, which, in turn, stimulates imports. On the other hand, increased productivity in an import-substituting industry crowds out imports from the domestic market and thus has a negative impact.

main finding is that imports contributed to TFP growth for a panel data set of Japanese manufacturing industries, mainly through competition effects. A preliminary analysis in the same study fails to yield any systematic evidence that greater levels of protection improved productivity in Korea and the U.S. Lawrence (1999) shows empirically that import competition brought about TFP growth in U.S. industries. Muendler (2004) finds that in the Brazilian manufacturing sector the effects of imports on competition are large even though the effect of intermediate imports on labor productivity is small.[17]

To summarize, the above review of the existing literature reveals two key trends in the on-going debate about the trade-growth relationship. First, empirical tests of the export-led growth hypothesis have produced mixed results. Second, with respect to the role of imports in growth, the empirical literature has lagged behind the theoretical literature. Our study extends previous research on the relationship between trade and productivity in several directions. First, we hope to contribute to the limited empirical literature on the imports-growth nexus by taking an in-depth look at the impact of imports on Korean total factor productivity. It is a particularly interesting to explore the role of imports in Korea since the country's economic success has become a byword for export-led growth. Second, we disaggregate imports into various components in order to more clearly understand the channels through which imports affect productivity in Korea. Third, we eliminate the cyclical effects that co-move with business cycles from the productivity measures in order to control for spurious relation due to cyclical biases. Finally, we update the data set up to 2003 and estimate a TFP equation to investigate the macroeconomic relationship between trade and productivity.

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[17] Additional studies on imports and productivity include Gokcekus (1997), who finds that protectionism reduces technical progress.

3 Empirical Analysis and Results

In this section, we discuss our empirical analysis of the relationship between trade and total factor productivity in Korea. We also report our main empirical results and their implications about the role of trade in Korean productivity growth.

3.1 Variables

Many existing studies on the trade-productivity nexus use labor productivity as the productivity measure, but this partial measure does not allow us to consider the effect of factor substitution between capital and labor. This effect is especially important for the Korean economy, which has continuously experienced capital deepening and adoption of new production technologies. Measures of labor productivity generally include the effects of capital deepening, along with technological progress and structural efficiency changes which determine TFP. It has recently been argued that Korean economic growth was driven mostly by factor accumulation rather than by productivity growth. Therefore, we use TFP, rather than capital deepening or labor productivity growth resulting from trade-induced economies-of-scale, as our measure of productivity in order to measure the effects of trade on structural and technological changes.

We constructed our data on TFP from various sources in the Bank of Korea database and used the data to estimate Solow residuals for the period 1985Q1-2002Q4. The capital stock is taken to be the real amount of tangible fixed assets, adjusted for the capital utilization rate. In addition, we proxy labor inputs by the number of work hours, and use gross domestic product (GDP) as the measure of output.[18] All variables are converted into constant 1995 prices. The measured Solow residual is generally not a good measure of productivity growth in the absence of perfect competition, constant returns to scale,

[18] For capital, we used the perpetual inventory method to expand the capital estimated by Pyo (2003).

and full employment of labor and capital. This implies that the measured Solow residual may be affected by demand-side variables.[19] In the case of Korea, Kim and Lim (2004) find that the Solow residual is not a strictly exogenous variable but instead co-moves with demand shocks.

If measured productivities are indeed influenced by cyclical movements, an empirical correlation between trade and productivity may be spurious in the sense that it is driven by a correlation between trade and business cycles. For this reason, it is desirable to control for cyclical bias in the productivity measure. To address this problem, we follow the method suggested by Basu and Kimball (1997) and Ball and Moffitt (2001). This first step in this method is to regress the log difference of the measured Solow residual on the log difference of the capital utilization rate, which is a proxy for business cycles. The next step is to adjust the average of the regression error term so that it equals the original productivity measure when the productivity measure is adjusted for cyclical factors. Our estimation results indicate that the effect of the business cycle on the measured Solow residual is significant.[20] Our estimation results are shown in (1) below, where CU denotes the capital utilization rate and where t-statistics are inside the parentheses.[21] We find that removing cyclical effects from the measured Solow residual does not affect its overall movement but considerably reduces its variation.[22]

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[19] See Mankiw (1989) and Hall (1989) for more comprehensive discussions.

[20] Labor productivity not being affected by the capital utilization rate is a well-established result in real business cycle theory. Other proxies for business cycles such as military spending, oil shocks and political dummies have been suggested. However, a complete treatment is beyond the scope of our paper.

[21] While the business cycle can affect productivity, productivity can also affect business cycles. To eliminate this endogeneity problem, we only include lagged values of the capital utilization rate as explanatory variables in the regression.

[22] The purpose of adjusting TFP is to eliminate any error that may exist in the Solow residual as a productivity measure – to identify the part of the Solow residual that represents pure productivity. While the cyclical movement of the adjusted TFP is still smaller than the residual, the adjustment is not intended to completely eliminate the correlation between TFP and business cycles. The causality from TFP to business cycles is well-established in real business cycle theory, while the reverse effect from business

$$\Delta \log(TFP)_t = 0.02 + 0.26 \Delta \log(CU)_{t-1}, \qquad (1)$$
$$(8.11) \quad (3.89) \qquad \overline{R}^2 = 0.16, \; D.W. = 2.20$$

Figure 1 below shows the growth rates of the measured Solow residual in Korea, and the TFP estimates we obtained after eliminating the cyclical effects from the residual. TFP increased steeply after the mid 1980s but slowed somewhat in the 1990s, and fell sharply during the financial crisis of 1997-1998. TFP recovered shortly after the crisis but then fell again after 2000.

[Insert Figure 1 here]

Figure 2 illustrates recent trends in Korea's imports and exports. International trade accounts for a substantial share of the Korean economy. The ratio of exports (EXP) to GDP fell below 30% during the late 1980s and mid-1990s but was about 40% or more during other periods. Imports (IMP) showed a great deal of cyclical fluctuation, but their share in GDP ranged between 30% and 40%. Overall, the share of imports declined in the early 1980s but bounced back since the early 1990s.

[Insert Figure 2 here]

Before performing our empirical analysis, we carried out augmented Dickey-Fuller (ADF), Phillips-Peron (PP), and Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992) unit root tests to examine whether the time-series of the variables follow stochastic trends. Table 1 below reports the test results for both levels and first differences. The tests unambiguously suggest the existence of one unit root for every variable, indicating that the time-series are integrated of order 1, I(1).

[Insert Table 1 here]

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cycles to productivity should be eliminated to prevent a spurious relationship. Therefore, it is quite natural that we have a high correlation after adjustment.

To address this problem, we check for the existence of long-run relationships among the variables. It is possible to derive a long-run equilibrium that does not suffer from spurious regression. Table 2 below presents the maximum-likelihood ratio statistics, which indicate the number of long-run relationships and thus the number of cointegration vectors in the parameter matrix. We perform Johansen's cointegration test on the log values of three sets of variables, namely (1) exports (LEXP) and TFP (LTFP), (2) imports (LIMP) and TFP (LTFP), and (3) exports, imports, and TFP. The test results indicate that a restricted constant, which allows a non-zero drift in the unit root process, is included in the multivariate system of equations. The lag values of the VECMs are set equal to two. The null hypothesis of r=0 is rejected at the one-percent level but the null hypothesis of r≤1 cannot be rejected.[23] Consequently, the estimated likelihood ratio tests indicate the presence of a cointegration vector and a long-run relationship in the underlying data-generating process of the time-series variables.

[Insert Table 2 here]

3.2 Causality between Trade and Productivity

Based on the test results of the previous section, we estimate a vector error correction model (VECM) and test for Granger causality on the basis of the coefficient estimates of the model. A VECM model consisting of the variables of IMP, EXP, and TFP may be written as follows:

$$y_t = \sum_{t=1}^{p} \Phi_i y_{t-1} + \varepsilon_t,\ \ \Delta y_t = \alpha\beta' y_{t-1} + \sum_{j=1}^{p-1} \Phi_i^* \Delta y_{t-1} + Z_t + w_t\ ,$$

$$\text{where } \Phi_i^* = -\sum_{j=i+1}^{p} \Phi_j\ ,\ \alpha\beta' = -\Phi(1) = -I_k + \Phi_1 + \Phi_2 + \cdots\cdots + \Phi_p\ , \qquad (2)$$

[23] See Osterwald-Lenum (1992) for critical values.

$w_t \sim N(0,\Sigma)$, and Σ is a non-diagonal symmetric matrix.

In a VECM, all variables included in y_t must satisfy I(1), and residuals from a long-run cointegrating relationship are used as lagged error correction terms in a VAR. If $\beta' y_t = c$ represents a long-run cointegrating relationship and there is a deviation from long-run equilibrium, the error $\beta' y_t - c$ is removed to restore equilibrium at adjustment speed α.

We look at VECM models consisting of two variables – IMP and TFP or EXP and TFP – and three variables – IMP, EXP, and TFP. The chosen ordering of variables is EXP, TFP and IMP, TFP for the bivariate models, and EXP, IMP, and TFP for the trivariate model; this ordering reflects the degree of exogeneity of the variables. However, changes in the order of these variables do not significantly affect our estimation results. Thus, y_t' = [LEXP (LIMP), LTFP] or y_t' = [LEXP, LIMP, LTFP], depending on the number of variables considered. To consider the effects of the Asian crisis and to eliminate any spurious correlation between trade and productivity growth, we include a dummy for the period 1998Q1-1998Q3 as the exogenous variable (Z_t) in (2) above. VECM systems with a lag length of two are estimated, and these lags are chosen to minimize the Akaike Information Criteria (AIC); however, changes in the lag length do not affect our results.

Table 3 below reports the VECM parameter estimates of the three variables, along with VAR model estimates. Although an autoregressive unit root characterizes every variable in the system, we also estimate VAR model to avoid any possible loss of valuable information owing to differencing.[24] In particular, we can expect VAR to elucidate the long-run relationship among the variables. Qualitatively, there are few differences

[24] See Sims (1980) for a fuller discussion.

between the VECM and VAR coefficient estimates. The most salient result of both models is that imports have a significant positive impact on TFP but exports do not.

[Insert Table 3 here]

Figure 3 below reports the impulse response functions in the VAR model, which are the simulated responses of TFP to the trade variables. They allow us to investigate the long-run relationships between TFP and the trade variables. The impulse response function extends over ten quarters and is measured in terms of standard deviations. The effect of a one-standard-deviation shock to imports on TFP is initially positive and significant, and subsequently diminishes to zero. The effect of a shock to exports on TFP is positive but insignificant over the whole period. The responses of TFP to import and export shocks imply that TFP is correlated with imports but not with exports.

[Insert Figure 3 here]

Table 4 below reports Granger-causality tests based on the coefficient estimates of three different models. The estimated models consist of two-variable VECMs, a three-variable VECM and a three-variable VAR model. All the results indicate that there is no causality between exports and TFP growth. On the other hand, all the results indicate that imports Granger-cause TFP growth. In addition, the VAR model also indicates reverse causation from TFP growth to imports. Our finding of no correlation between exports and productivity growth in Korea is consistent with the earlier findings of Darrat (1986), Hsiao (1987), Dodaro (1993) and Dutt and Ghosh (1996). The most striking feature of our results is the correlation between imports and productivity. We can investigate the specific mechanism underlying the import-productivity nexus by decomposing imports into their various components, such as consumer goods versus capital goods, an issue we address in the next section.

[Insert Table 4 here]

Finally, productivity growth has opposing effects on imports and these may cancel each other out. Productivity growth raises imports by raising income but also reduces imports by increasing domestically produced import substitutes. Our finding that Granger causality from productivity to imports is significant only in the VAR model may reflects this ambiguity.

To check for the sensitivity of the results to the specification of economic growth, we substitute TFP growth with GDP growth in our VECM and VAR models, and perform the same tests. Table A1 in the Appendix reports the Granger-causality tests based on the coefficient estimates of these models.[25] The test results for GDP are qualitatively identical to the results for TFP. That is, no causality exists between exports and GDP and imports Granger-cause GDP growth in every model. Similarly, we also find reverse causation from GDP growth to imports in the VAR model. Our empirical results are thus robust in the sense that they are not sensitive to the specification of economic growth. Our evidence again fails to lend support to the export-led growth hypothesis for Korea during 1980-2003.

3.3 The Effects of Different Import Components on Productivity

The empirical results of the previous section suggest that causality runs from imports to productivity growth. Based on these results, we disaggregate imports into various components and included them in a productivity determination equation for the purpose of investigating the import-TFP relationship in more detail. To determine the short-run dynamics of productivity determination, we regress TFP growth on import components,

[25] The coefficient estimates are not reported here but available from the authors upon request.

exports and other variables such as government size and R&D investments. Our TFP equation may be written as:

$$\Delta LTFP_t = \beta_0 + \sum_{i=0}^{l} \beta_{1i} \Delta LIMP_{t-i} + \sum_{i=0}^{m} \beta_{2i} \Delta LEXP_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta LGOV_{t-i} + \sum_{i=0}^{p} \beta_{4i} \Delta LRD_{t-i} + \varepsilon_t \qquad (3)$$

As additional explanatory variables, we use government size (GOV) and R&D investments (R&D), which have been widely considered in the productivity literature, to represent institutional and technological factors, respectively. We use government consumption expenditure as a proxy for GOV to capture the inefficiencies arising from government failure. We use the number of patents registered in the U.S. as our measure of R&D. We include GOV and R&D in addition to the trade variables when we estimate the dynamic impact of trade variables on productivity. We disaggregate imports according to country-of-origin into imports from developed G7 countries (DIMP) and imports from other countries (OIMP). Developed countries in general and the G7 countries in particular are the global technological leaders. As such, imports from the G7 countries are more likely to embody advanced technology than imports from elsewhere. We also disaggregate imports according to processing stages into imports of raw materials (RIMP), capital goods (KIMP) and consumer products (CIMP). In particular, the critical distinction is that between imported consumer goods and imported capital goods. In contrast to consumer goods, capital goods such as machines are used to produce other goods. Therefore, while the main effect of consumer good imports is to intensify competition in the market for consumer goods, the main effect of capital good imports is to import the technology embodied in the good and thus bring about a more efficient production of other goods. The data on the five import components we just defined are available from KOTIS only after 1988Q1.

We eliminate seasonality from the variables by means of an X12-ARIMA, and we perform unit root tests on the variables. Since every variable is integrated of order 1, I(1), we use first differences in the actual estimation. We choose the lags of the explanatory variables by means of the "general-to-specific" method, in which the most insignificant lagged variable is eliminated iteratively from a set of lagged variables. In addition, we also applied the AIC criteria in selecting the appropriate number of lags. To incorporate the effects of the Asian crisis, we represent the period 1998Q1-Q3 with a dummy and include it in the estimation.

Table 5 below presents the coefficient estimates for equation (3), for each of the models. Prior to estimation, we examine correlation among the import variables. We find that the different import components are strongly correlated with each other. The correlation between (RIMP, KIMP), (RIMP, CIMP), (KIMP, CIMP) and (DIMP, OIMP) is 0.965, 0.888, 0.916 and 0.966. The high correlation between the import components causes multicollinearity, and the significance of all import variables thus disappears when they are regressed together. Therefore, we do not simultaneously include the different import variables in our estimation.

[Insert Table 5 here]

Our empirical results indicate that exports do not have a significant effect on TFP growth. Furthermore, their coefficients are all negative except for Model 2. These results fail to support the export-led growth hypothesis with respect to TFP growth in Korea. However, these results do not imply that exports are not beneficial for developing economies since exports may improve economic performance through channels other than TFP growth. For example, exports allow for the realization of economies of scale and provide foreign exchange, thereby speeding up economic growth through capital deepening. We discuss this issue in more detail later.

The coefficients on government size (GOV) are all negative but insignificant, except in the case of Model 1, implying that increases in government spending may slow down TFP growth. TFP is a measure that captures productivity, which is based partly on institutional factors. Increased government spending may create inefficiency in the form of new regulations and bureaucracies. However, in light of GOV's overall insignificance, we should be careful about drawing such conclusions. All of the coefficient estimates on R&D are positive and significant. Those findings suggest that R&D promotes innovation and technical progress, and thus promotes TFP growth.

All import component coefficients are positive, but their significance depends on both product type and country of origin. Imports of capital goods (KIMP) and consumer goods (CIMP) have positive and significant effects on TFP, but raw material imports (RIMP) do not have any insignificant effect. In addition, the coefficient estimates on imports from developed G7 countries (DIMP) are positive and significant, but those from other countries (OIMP) are insignificant. Among the various import components, consumer imports (CIMP) are the most significant and imports from developed countries have the largest coefficients. The significant coefficients of import components range from 0.042 to 0.058, suggesting that imports have a strong impact on TFP growth.

Our empirical findings suggest that increased imports of consumer goods intensify market competition in Korea. Greater competition from imports forces import-substituting Korean firms to become more competitive by improving quality, cutting costs or both. Examples of specific competitiveness-enhancing activities include adopting more efficient production techniques, engaging in innovation, and pursuing cost-cutting restructuring. Our findings also suggest that imports of capital goods help Korean firms to improve their productivity. If certain capital goods are domestically unavailable, their availability through imports may enable a firm to use them to improve the quality or reduce the costs of their products. Those imports can also enable a firm to produce a wider range of products. Capital goods often embody advanced technology and thus serve as powerful mechanisms for transferring technology to the importing firm. Our results also imply that technology transfer from developed countries has a significant positive effect on the efficiency of Korean firms. An important channel for importing superior technology is by importing goods which embody superior technology. Developed countries in general and the large G7 economies in particular are the global technological leaders. Therefore, imports from those countries are much more likely to embody advanced technology, in particular technology unavailable to Korean firms, than imports from other countries. In short, imports of consumer goods, capital goods and goods from developed countries have all contributed to Korean productivity growth. The contribution of consumer goods is largely through competitive effects while the contribution of capital goods and imports from developed countries is largely through technology transfer effects.

The intuition behind why competition should improve firms' productivity is straightforward and plausible. Competition pushes down prices and hence costs, reduces slack and misallocation of resources, provides incentives for organizing production more efficiently, and may even potentially promote innovation. There are also more formal theoretical explanations for a positive relationship between competition and productivity.[26] For example, an increase in the number of firms will lead to sharper managerial incentives and thus improve managerial effort.[27] This is due to greater opportunities for comparing managerial performance. Alternatively, greater competition may make profits more sensitive to managerial effort.[28] A number of empirical studies provide support for the notion that competition promotes productivity.[29] Therefore, there are solid theoretical and empirical foundations for why we observe a significant positive impact of consumer good imports on Korean productivity.

Let us now look at the theoretical basis for our finding of significant positive TFP effects of imports of capital goods and imports from developed countries in Korea. Griliches (1992) introduces the distinction between embodied and disembodied technological spillovers. Embodied technological spillovers refer to knowledge and technology flows that arise directly from flows of goods and services between firms. Griliches argues that such spillovers can arise from either some kind of learning – pure spillovers – or the ability to reap the rents derived by the technological activities of other firms – rent spillovers. More specifically, rent spillovers are positive externalities which arise when the value of inputs exceeds the cost of inputs. The buying firm thus captures some of the rent associated with the technology of the imported good. Pure spillovers are positive externalities which arise from the dissemination of various competencies as well as knowledge in general. Technological spillovers are by no means limited to a specific country and can spread across borders. Indeed a number of empirical studies confirm the

[26] See Okada (2005) for an overview of the theoretical literature.
[27] See, for example, Nalebuff and Stiglitz (1983).
[28] See, for example, Willig (1987).
[29] See Okada (2005) and Nickel (1996, 1997), among others.

importance of international technological spillovers as a source of TFP growth.[30] Our findings for Korea lend further support to such evidence.

With regard to the trade-growth nexus, the broad thrust of our results from the TFP growth equations is that exports do not cause growth but imports have a significant positive impact on growth. To check for the sensitivity of our empirical results to the specification of economic growth, we replace TFP growth with GDP growth. Although our results for the TFP growth regression indicate that exports do not contribute significantly to TFP growth, this does not necessarily mean that exports are not beneficial for a developing country, as we pointed out earlier. In particular, exports allow an economy to realize economies of scale and provide it with foreign exchange, both of which act as catalysts for capital accumulation and thus more rapid economic growth. That is, exports may contribute to growth through capital deepening in East Asia. This is in fact the viewpoint of the accumulationists, who assert that East Asian growth was mostly input-driven rather than productivity-driven. In short, exports may not cause TFP growth but nonetheless bring about economic growth through capital deepening. Therefore, it is worthwhile to run GDP growth regressions to examine the role of exports in the Korean economy.

Table 6 below reports the coefficient estimates for the GDP growth regressions. The results of the GDP and TFP growth regressions are broadly similar. In particular, they both indicate that imports in general and consumer imports in particular benefit growth. Imports as a whole (IMP) and consumer-goods imports (CIMP) have a significant positive impact on GDP growth. In addition, all import components have positive effects

[30] Such studies include Coe and Helpman (1995), Keller (2000), Grunfeld (2002), and Chuang and Hsu (2004).

on GDP growth, but their significances falls in two cases. Specifically, imports from developed countries (DIMP) and capital-goods imports (KIMP) become insignificant. Thus, the technological transfer effects of imports are not as strong for GDP growth as they are for TFP growth. The overall impact of exports seems to be greater for GDP growth than for TFP growth since all export coefficient signs become positive except in Model 10. However, the export coefficients are still all insignificant except in Model 8. Our results thus still fail to support the export-led growth hypothesis. All the R&D coefficients are insignificant for GDP growth, although they were significant for TFP growth. Finally, all the government spending coefficients are insignificant and negative except in Model 9.

[Insert Table 6 here]

4 Concluding Remarks

The existing empirical literature on the relationship between trade and productivity focuses largely on the relationship between exports and productivity. Our study will contribute to the substantially more limited literature on the relationship between imports and productivity. More specifically, our study is the first to systematically explore the relationship between trade and productivity growth in the Korean economy. In particular, our study differs from previous studies on the relationship between trade and productivity in Korea in that we examine the impact of both imports and exports on TFP. To do so, we use quarterly data from 1980Q1-2003Q3. In order to more clearly understand how imports influence TFP, we disaggregate imports into various components and look at the effect of those components on TFP. In addition, we remove cyclical effects from the productivity measures in order to control for spurious relation due the correlation between trade and business cycle. At a broader level, since Korea's economic success is widely presumed to be supportive evidence for the export-led growth hypothesis, our empirical study will help us to more accurately and dispassionately assess the role of trade in the remarkable growth of Korean and other East Asian economies.

Causality tests indicate a unidirectional causality from imports to TFP growth and no correlation between exports and TFP growth. In light of the causality test results, our study estimates productivity equations to investigate the macroeconomic relationship between various components of imports and productivity. Our empirical results suggest that the imports of consumer goods and capital goods have a significant positive impact on TFP whereas raw material imports do not have a significant impact. The results also indicate that imports from G7 countries have a significant positive effect on TFP but imports from other countries do not. These findings imply that the beneficial impact of imports stems not only from competitive pressures arising from the imports of consumer goods but also from technological transfers embodied in the imports of capital goods and imports from developed countries. However, our GDP growth regression results suggest that the beneficial effect of imports on productivity arises primarily from the competitive effects of imported consumer goods.

Many earlier studies on the trade-growth nexus imply that exports enhance productivity growth because firms exposed to international competition tend to absorb best-practice technology. This argument served as a major rationale for why developing countries such as Korea erected trade barriers to protect their infant industries until they become internationally competitive. However, our empirical results suggest that lower trade barriers and higher imports would have been beneficial for Korea's productivity growth during 1980-2003. Many recent studies have argued that Korean economic growth has relied to a large extent on factor input accumulation. Exports facilitate the mobilization of inputs by allowing for economies of scale and providing much-needed foreign exchange. Therefore, exports may contribute to economic growth through factor mobilization rather than productivity growth. To investigate this possibility, we replace TFP growth with GDP growth to test the sensitivity of our empirical results to the specification of growth. Our results remain the same – imports have a positive effect on GDP growth but exports do not. Our findings are thus robust with respect to the specification of growth and again fail to support the export-led growth hypothesis.

Our empirical findings have important implications for Korean policymakers. There is still a widespread philosophical tendency in Korea to view exports as beneficial and imports as harmful. This is perfectly understandable in light of the central role of export-oriented industrialization in the transformation of Korea from a typical poor developing country into one of the most dynamic economies in the world. The Asian crisis of 1997-1998 has further reinforced mercantilist tendencies by pointing to the potential benefits of running trade surpluses and thereby accumulating large international reserves. However, our findings clearly show that the notion of desirable exports and undesirable imports may be misguided and counterproductive. In the case of Korea, we find quite robust evidence in favor of the import-growth nexus, which is supported by the results of our causality tests, productivity determination regressions, and alternative specifications of growth. More specifically, we find that imports, but not exports, have a significant positive impact on TFP growth. It is worth remembering that Korea has already achieved a high per capita income level so that productivity growth will become more important relative to factor accumulation as a source of economic growth. The unmistakable implication for Korean policymakers is the need to open up more to foreign imports, which will help to bring about institutional and technological progress conducive to TFP growth. In light of our findings, policymakers in other East Asian economies, which share Korea's experience of successful export-oriented industrialization, would also do well to consider the potential benefits of both imports and exports in formulating their trade and other policies.

Finally, we discuss the limitations of our study, which are primarily associated with data limitations. In particular, due to unavailability of the relevant data prior to 1980, our empirical analysis is limited to the post-1980 period. Korea's rapid economic growth and industrialization began well before 1980 so that our empirical analysis does not cover the earlier stages of the Korean miracle. To the extent that there have been significant structural changes n the Korean economy since 1980, we have to qualify the validity of our empirical results to the post-1980 period. Nevertheless, the post-1980 period is very much an integral part of Korea's remarkable economic success, so that investigating the role of imports in growth during this period will help us to gain a more comprehensive and well-balanced understanding of the relationship between trade and growth in Korea. Another potential limitation of our empirical analysis is that we are unable to examine the industry-specific effects of trade on productivity due to the poor quality of Korean industry data. In fact, it was such data limitations that prevented Lawrence and Weinstein (1999) from performing a more detailed empirical analysis of the imports-productivity nexus in Korean industries. This is unfortunate since it will be interesting to see how imports influence productivity in different Korean industries. An exciting area of future research is to empirically investigate the impact of imports on productivity in other countries. In this connection, it will be especially interesting to examine other East Asian countries, which share Korea's experience of export-oriented industrialization.[31] This line of research will also help to clarify the role of trade in the East Asian Miracle.

[31] In a recent contribution to this journal, Thangavelu and Rajaguru (2004) find that imports have a significant positive effect on labor productivity in a number of Asian economies.

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Figure 1
Growth of the Solow Residual and TFP with Cyclical Adjustment for the Korean Economy during 1980-2003

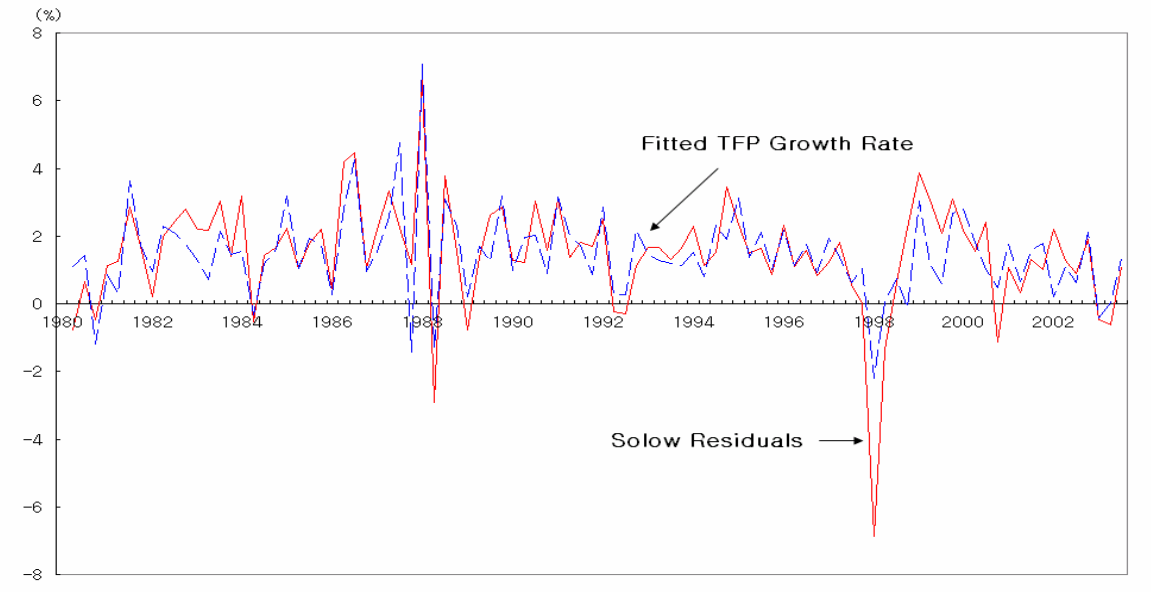
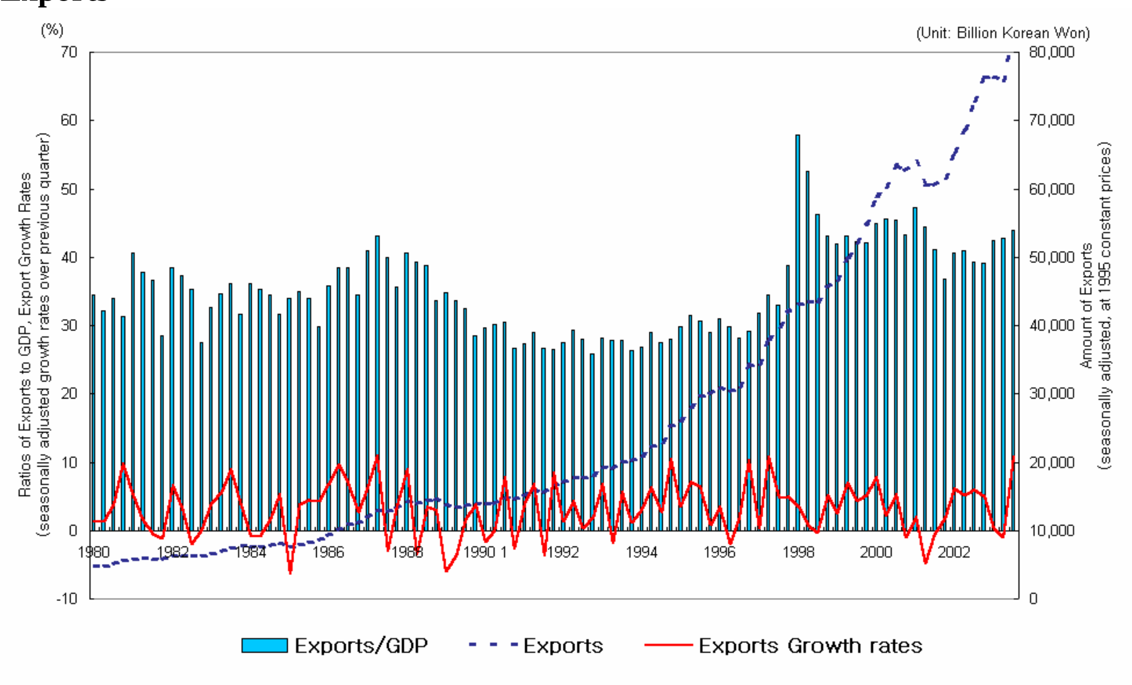


Figure 2
Trends in Korea's Exports and Imports, 1980~2003

Exports



Imports

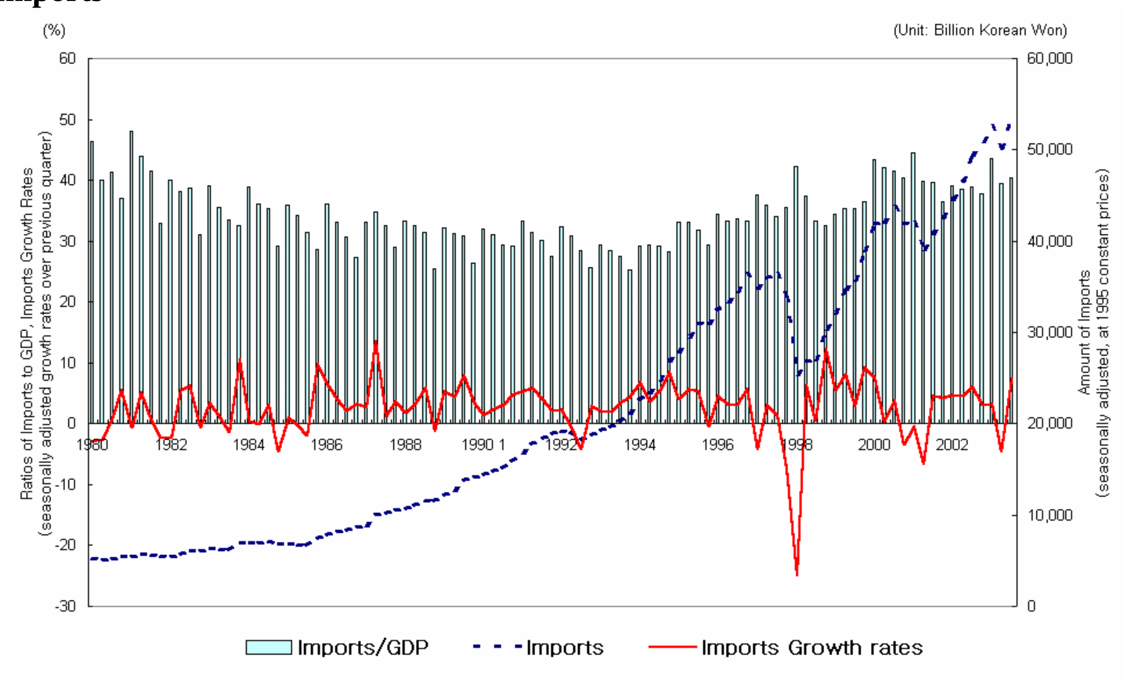


Table 1
Unit Root Tests of the Variables for the Relationship between Trade and Productivity Growth for Korea during 1980Q1-2003Q3

	ADF		PP		KPSS	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
LIMP	-2.18	-5.59*	-2.52	-8.36*	0.16**	0.06
LEXP	-1.96	-4.53*	-2.15	-9.58*	0.18**	0.04
LTFP	0.15	-4.53*	-0.32	-12.19*	0.28*	0.13***

Notes: Test regressions contain a constant and a linear time trend, and lags of the dependent variable are chosen by AIC. *, ** and *** denote rejection of the null hypothesis at the 1, 5, and 10% significance level, respectively. The null hypothesis is the existence of unit root for ADF and PP tests, and the non-existence of unit root for KPSS test.

Table 2
Johansen's Log Likelihood Test for Cointegration of the Variables for the Relationship Between Trade and Productivity Growth for Korea, 1980Q1-2003Q3

H_0 : rank=r	Eigenvalue	Max-Eigen stat	5 % Critical	Trace stat.	5 % Critical
LTFP, LEXP					
None	0.134	13.31	14.26	17.19**	15.49
R≤1	0.041	3.877**	3.841	3.877**	3.841
LTFP, LEXP					
None	0.298	32.63**	15.89	34.85**	20.26
R≤1	0.023	2.223	9.164	2.223	9.164
LTFP, LIMP, LEXP					
None	0.354	40.30**	22.29	56.35**	35.19
R≤1	0.139	13.86	15.89	16.04	20.26

Notes: Test regression includes a constant and a linear deterministic trend in the data. **, and *** denote rejection of the hypothesis at the 5 and 10% significance level, respectively. The test indicates 1 cointegrating equation at the 5% significance level for every set of the variables.

Table 3
Coefficient Estimates of the VECM for the Relationship
Between Trade and Productivity Growth for Korea, 1980Q1-2003Q3

Independent variables	VECM			VAR		
	LTFP	*LIMP*	*LEXP*	*LTFP*	*LIMP*	*LEXP*
EC(-1)	-0.001	0.493	0.028			
	(0.038)	(3.985)	(0.254)			
LTFP(-1)	-0.330	-0.627	-0.664	0.602	0.090	-0.389
	(2.987)	(1.500)	(1.737)	(6.139)	(0.237)	(1.119)
LTFP(-2)	0.113	-0.482	-0.354	0.413	0.360	0.393
	(1.085)	(1.215)	(0.976)	(4.201)	(0.941)	(1.127)
LIMP(-1)	0.064	0.068	0.102	0.066	0.825	0.073
	(2.253)	(0.635)	(1.044)	(2.338)	(7.426)	(0.730)
LIMP(-2)	-0.016	0.005	0.209	-0.074	-0.052	-0.046
	(0.526)	(0.044)	(1.933)	(2.696)	(0.491)	(0.483)
LEXP(-1)	0.047	0.120	-0.063	0.043	0.086	0.955
	(1.400)	(0.940)	(0.542)	(1.322)	(0.679)	(8.225)
LEXP(-2)	-0.022	0.205	0.014	-0.047	-0.111	0.018
	(0.663)	(1.606)	(0.121)	(1.451)	(0.868)	(0.161)
C	0.016	0.036	0.038	0.060	0.524	0.004
	(5.701)	(3.299)	(3.815)	(1.523)	(3.400)	(0.030)
Dummy	-0.015	-0.114	0.013	-0.013	-0.103	-0.004
	(2.223)	(4.433)	(0.564)	(2.326)	(4.491)	(0.210)
R^2	0.276	0.313	0.066	0.999	0.996	0.997

Note: For VECM, all variables are first differenced for estimation. T-statistics are inside parentheses.

Figure 3
Impulse Response Functions in a VAR Model of Imports, Exports and TFP for Korea, 1980-2003

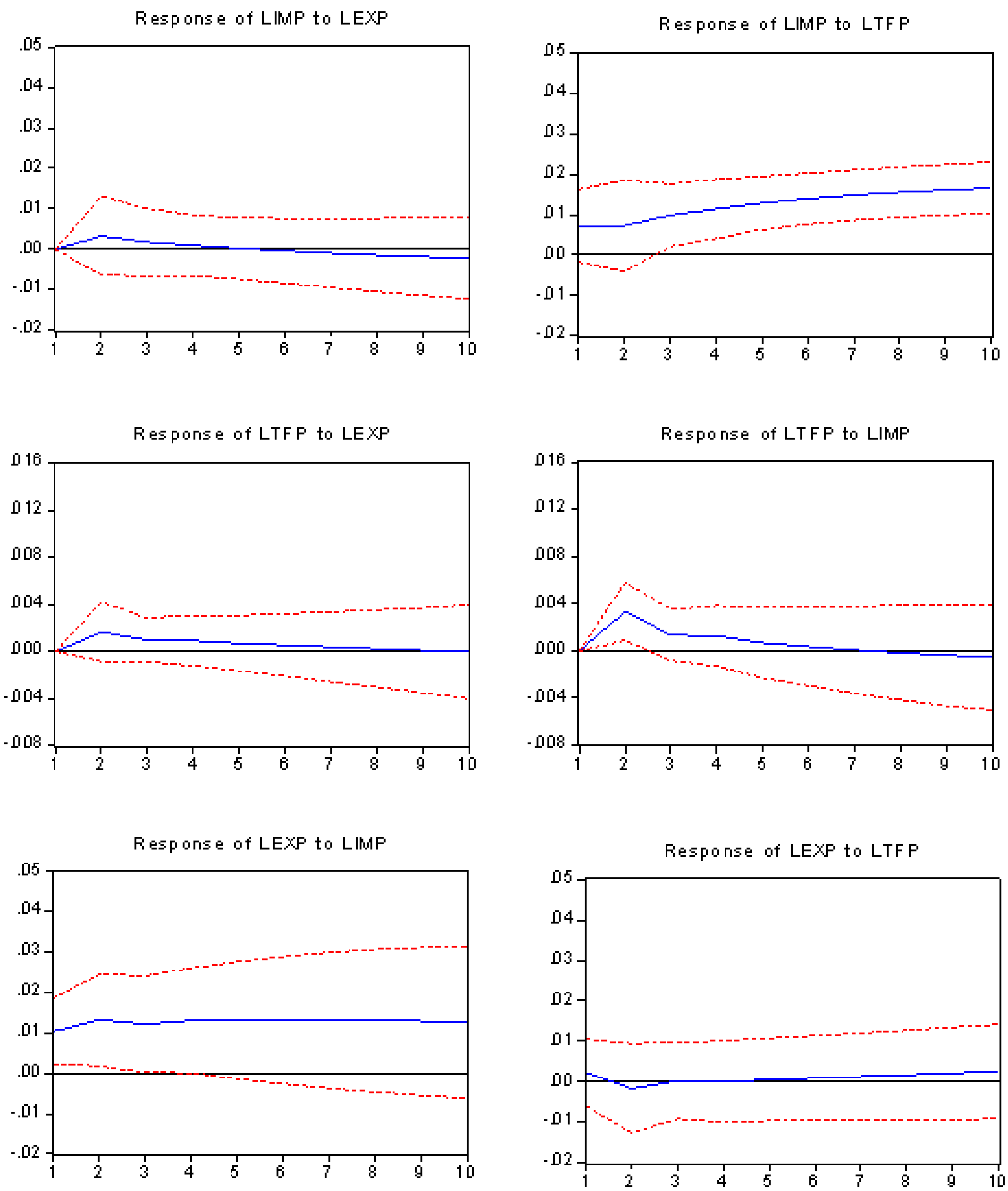


Table 4
Granger Causality Tests for the Relationship
Between Trade and TFP Growth for Korea, 1980Q1-2003Q3

Null Hypothesis (H_0)	Test statistics (χ^2)	Probability	Results
Bi-variate (VECM)			
$\Delta LIMP \not\rhd \Delta LTFP$	18.04*	0.0001	Reject
$\Delta LTFP \not\rhd \Delta LIMP$	1.176	0.555	Do not reject
$\Delta LEXP \not\rhd \Delta LTFP$	4.088	0.129	Do not reject
$\Delta LTFP \not\rhd \Delta LEXP$	1.366	0.505	Do not reject
Tri-variate (VECM)			
$\Delta LIMP \not\rhd \Delta LTFP$	5.987*	0.050	Reject
$\Delta LEXP \not\rhd \Delta LTFP$	2.595	0.273	Do not reject
$\Delta LTFP \not\rhd \Delta LIMP$	2.765	0.250	Do not reject
$\Delta LEXP \not\rhd \Delta LIMP$	3.213	0.200	Do not reject
$\Delta LTFP \not\rhd \Delta LEXP$	3.154	0.206	Do not reject
$\Delta LIMP \not\rhd \Delta LEXP$	4.235	0.120	Do not reject
Tri-variate (VAR)			
$LIMP \not\rhd LTFP$	7.282*	0.026	Reject
$LEXP \not\rhd LTFP$	2.228	0.328	Do not reject
$LTFP \not\rhd LIMP$	12.84*	0.001	Reject
$LEXP \not\rhd LIMP$	1.199	0.548	Do not reject
$LTFP \not\rhd LEXP$	1.299	0.522	Do not reject
$LIMP \not\rhd LEXP$	0.595	0.742	Do not reject

Note: Test statistics are Wald statistics, and test results refer to the rejection of the null hypothesis at the 1% significance level.

Table 5
Coefficient Estimates of TFP Growth Equation for Korea, 1988Q1-2003Q3

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.013 (6.603)*	0.013 (6.113)*	0.013 (6.161)*	0.013 (6.092)*	0.013 (6.645)*	0.013 (6.337)*
$\Delta LIMP$	0.079 (3.420)*					
$\Delta LRIMP$		0.012 (0.562)				
$\Delta LKIMP$			0.042 (1.855)***			
$\Delta LCIMP$				0.042 (2.045)**		
$\Delta LDIMP$					0.058 (1.983)***	
$\Delta LOIMP$						0.045 (1.644)
$\Delta LEXP$	-0.012 (0.398)	0.020 (0.617)	-0.002 (0.954)	0.004 (0.136)	-0.012 (0.352)	-0.006 (0.184)
$\Delta LGOV$	-0.130 (2.509)**	-0.085 (1.502)	-0.074 (1.352)	-0.079 (1.505)	-0.075 (1.395)	-0.085 (1.617)
$\Delta LR\&D$	0.036 (1.956)***	0.039 (1.870)***	0.040 (1.993)***	0.036 (1.787)***	0.037 (1.858)***	0.041 (2.033)**
Dummy	-0.009 (2.216)*	-0.015 (3.564)*	-0.013 (3.098)*	-0.013 (3.051)*	-0.013 (2.891)*	-0.014 (3.059)*
$\overline{R}^2$	0.381	0.254	0.283	0.287	0.286	0.275
D.W.	2.467	2.456	2.506	2.403	2.489	2.487

Note: Absolute values of t-statistics are in parentheses. *, ** and *** are statistically significant at the 1, 5 and 10% significance level, respectively.

Table 6
Coefficient Estimates of GDP Growth Equation for Korea, 1988Q1~2003Q3

Independent Variables	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Intercept	0.010 (4.304)*	0.012 (2.657)*	0.012 (3.705)*	0.014 (3.096)*	0.013 (2.914)*	0.013 (2.911)*
$\Delta LIMP$	0.202 (7.216)*					
$\Delta LRIMP$		0.021 (0.884)				
$\Delta LKIMP$			0.041 (1.723)			
$\Delta LCIMP$				0.129 (3.212)*		
$\Delta LDIMP$					0.043 (1.342)	
$\Delta LOIMP$						0.041 (1.378)
$\Delta LEXP$	0.026 (0.684)	0.109 (2.044)**	0.077 (1.445)	-0.038 (0.695)	0.085 (1.533)	0.087 (1.586)
$\Delta LGOV$	-0.098 (1.559)	-0.013 (0.100)	0.039 (0.467)	-0.030 (0.228)	-0.012 (0.095)	-0.037 (0.279)
$\Delta LR\&D$	0.021 (0.955)	0.030 (0.917)	0.024 (0.789)	0.021 (0.670)	0.022 (0.550)	0.024 (0.597)
Dummy	-0.015 (3.041)*	-0.032 (4.677)*	-0.029 (4.367)*	-0.024 (3.351)*	-0.030 (4.209)*	-0.030 (4.416)*
$\overline{R}^2$	0.674	0.376	0.399	0.413	0.384	0.385
D.W.	2.089	1.839	1.971	1.987	1.923	1.878

Notes: Absolute values of t-statistics are in parentheses. *, ** and *** are statistically significant at the 1, 5 and 10% significance level, respectively.

Table A1
Granger Causality Tests for the Relationship between Trade and GDP Growth for Korea, 1980Q1-2003Q3

Null Hypothesis (H_0)	Test statistics (χ^2)	Probability	Results
Bi-variate (VECM)			
$\Delta LIMP \not\rhd \Delta LGDP$	13.36*	0.001	Reject
$\Delta LGDP \not\rhd \Delta LIMP$	0.204	0.902	Do not reject
$\Delta LEXP \not\rhd \Delta LGDP$	0.224	0.893	Do not reject
$\Delta LGDP \not\rhd \Delta LEXP$	0.016	0.992	Do not reject
Tri-variate (VECM)			
$\Delta LIMP \not\rhd \Delta LGDP$	11.68*	0.002	Reject
$\Delta LEXP \not\rhd \Delta LGDP$	0.397	0.819	Do not reject
$\Delta LGDP \not\rhd \Delta LIMP$	1.179	0.554	Do not reject
$\Delta LEXP \not\rhd \Delta LIMP$	1.626	0.443	Do not reject
$\Delta LGDP \not\rhd \Delta LEXP$	0.866	0.648	Do not reject
$\Delta LIMP \not\rhd \Delta LEXP$	3.330	0.189	Do not reject
Tri-variate (VAR)			
$LIMP \not\rhd LGDP$	16.98*	0.000	Reject
$LEXP \not\rhd LGDP$	0.056	0.972	Do not reject
$LGDP \not\rhd LIMP$	7.611*	0.022	Reject
$LEXP \not\rhd LIMP$	0.787	0.674	Do not reject
$LGDP \not\rhd LEXP$	0.123	0.940	Do not reject
$LIMP \not\rhd LEXP$	0.865	0.648	Do not reject

Note: Test statistics are Wald statistics, and test results denote if the test rejects the null at the 5% significance level.