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Trade and Growth Nexus in South Korea: Analysis Using Vector Error Correction Model and Granger Causality Test

Denu Lemma Tsegaye*

Abstract

This study examines the connection between trade and economic growth in South Korea, where trade has been an important sector of the country's economy. We reviewed the causal relationships between trade and economic growth by employing the Cobb-Douglas production function under the Vector Error Correction (VEC) model and Granger causality test, using time series data between 1960 and 2010. Accordingly, this study indicates that unidirectional long-run causality exists between exports and economic growth in South Korea, while it is bi-directional for imports. Moreover, this study has found unidirectional short-run causality running from exports and imports to economic growth; validating both Export-Led Growth (ELG) and Import-Led Growth (ILG) hypotheses in South Korea. Overall, the implications from this study are that both exports and imports could play an important role in stimulating economic growth; and that a singular trade policy that accentuates export promotion might have difficulty in sustaining economic growth.

***Key word*:** Trade and economic growth, Export-led growth, Import-led growth, Vector Error Correction model.
***JEL Classification*:** F14, F43

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I. INTRODUCTION

Most economists agree that greater openness to international trade has been the basis for sustained and rapid economic growth. This common perspective is in line with assumptions that enhanced trade raises output, creates employment, produces technological innovations, increases economies of scale, and extends markets from autarky (Anderson and Babulla 2008; Dollar and Kraay 2003; Bhagwati and Srinivasan 2002). If trade plays a vital role in economic growth, two mechanisms of trade openness contribute to growth, especially in developing countries. First is through the static gains from trade that result when a country's economy integrates with the world economy and adopts trade policies that follow market principles. Second, and equally important, are dynamic gains from international trade, where increased growth ultimately leads to poverty reduction (Bhagwati and Srinivasan 2002).

The role of international trade in sustaining a country's economic growth is under heated debate currently (see Rodríguez 2007; Wacziarg and Welch 2003; Warner 2003; Dollar and Kraay 2002; and Frankel and Romer 1999), and the role of trade has been a persistent source of controversy among scholars. Greenwald and Stiglitz (2000) examined the impacts of freer trade in increasing economic growth, and showed that restrictive trade regimes "enhance rather than impair" economic growth. Similarly, Yanikkaya (2003) argued that countries that impose barriers on trade could grow faster than countries that allow freer trade. However, these points of view are in complete opposition to that of Bhagwati and Srinivasan (2002), who argue that trade openness enhances economic growth and plays a significant role in poverty reduction.

Furthermore, the rapid economic growth recorded in East-Asian countries compared to the gradual growth in Latin American and Sub-Saharan African (SSA) countries have inspired economists to examine the role that international trade plays in promoting economic growth. Accordingly, cross-country assessment on the role of trade in explaining economic growth has revealed divergent results, which complicates the nexus of trade and growth (Yanikkaya 2003; Rodriguez and Rodrik 2001). The larger strand of literature covered the causal relationship and correlation between different measures of trade openness (sum-of-exports-and-imports ratio to GDP, average tariff rate, and geographic location) and economic growth. For example, Dollar and Kraay (2003) indicated that increased trade openness ratio is directly concomitant to greater economic growth, suggesting countries that are open to international trade—what they refer to as "globalizers"—grow faster than closed economies. In addition, Dollar and Kraay (2003) conclude that a long-run relationship exists between rapid economic growth following improvement in institutional quality. Similar evidence also shows that economies can expand after a country increases its openness to international trade (Bruckner and Lederman 2012; Berg and Krueger 2003; Warner 2003; Frankel and Romer 1999).

The aim of this paper is to examine the relationship between exports, imports, and economic growth in South Korea (hereafter referred as Korea), a country that recorded a "miracle economy" according to World Bank (1993), to find whether trade played a role in the rapid economic growth achieved. We use time serious data from 1960 to 2010. We found that unidirectional long-run causal relationship, as shown by significance of the Error Correction (EC) term, exists between exports and economic growth, while we discovered bi-directional causality for imports in Korea. In addition, Granger causality test based on VEC model indicates evidence in support of unidirectional short-term causality running from exports and imports towards economic growth, which reveals ELG and ILG hypothesis in Korea. In other words, we found that both exports and imports have had a positive impact in igniting economic growth in Korea. Notably, the absence of long-run causality running from enhanced economic growth to increased exports in Korea might be attributable to the fact that increased outputs were absorbed domestically and diverted away from exports.

International trade theories advocate that trade plays an important role as an "engine" of growth and welfare gains. To this end, trade can have a significant and positive role in boosting a country's economy, and the choice is not between an open economy and autarky. Nevertheless, disagreement appears from existing trade regimes in countries with varying degrees of trade liberalization (Stiglitz and Andrew 2005). Studies have found no simple and straightforward relationship between trade openness and economic growth. Remarkably, cross-country studies on the nexus of trade and economic growth indicate divergent results, highlighting the complexity of the trade relationship (Yanikkaya 2003). This complexity related to the nexus of trade and growth implies that countries must be careful in designing optimum specific policies that assure positive and significant gains from international trade.

There are two main hypotheses regarding the relationship between trade and economic growth: the Export Led Growth (ELG) hypothesis and Import Led Growth (ILG) hypothesis. The ELG hypothesis postulates that countries can attain rapid economic growth through adoption of outward-oriented trade policies. The ELG hypothesis states that exports work to lubricate the gears of the "engine of growth". According to Ricardian trade theory, export promotion strategies align countries to make goods they can produce competitively, and trade for goods that other countries produce at relatively lower cost (Golub and Chang 2000). Consequently, consumers will get products at a competitive price, benefitting from an extended domestic market from autarky. However, adoption of export-oriented economic development is a means for achieving sustained and rapid economic growth, not an end *per se* in and of itself.

The ILG hypothesis, on the other hand, accentuates the role that imports play in increasing economic growth; particularly, in channelling technology and innovations, supplying capital and intermediate goods, and improving competition to enhance efficient resource allocation. Proponents of free-trade policy have argued that protection of imports to enhance domestic production results in distortion of resource allocation and production inefficiency. For instance, one view poses that imports of intermediate and capital goods, technological innovations, and productivity raising inputs play a significant role in boosting a domestic economy (Thangavelu and Rajaguru 2004).

Greenwald and Stiglitz (2000) stated that banning imports, or adopting protective policies with high tariffs, primarily result in allocation inefficiency and welfare loss. According to these authors, however, the distortions are only short-term; in the long term, the country attains allocation efficiency and welfare gains.

As these studies show, the evidence regarding whether imports enhance or impair domestic economies is not clear. Consequently, it is misleading to conclude trade policy implications that will work under all circumstances for all countries. To this end, it is necessary to consider all the costs and benefits associated with imports, and countries should allow technology-embodied imports to increase the benefits from trade.

Static and Dynamic Gains from Trade

We classify the gains from countries' participation in international trade into two major categories: "static" gains and "dynamic" gains. The static gains from international trade relate to the benefits that a country receives immediately after opening its market to international trade. Static gains from international trade are consistent with comparative advantage and the Heckscher-Ohlin theorem (Anderson and Babula 2008; Cruz 2008): when a country liberalizes its trade regime, productivity and consumption increase compared to autarky. According to the theory, trade liberalization will subsequently lead countries to use resources they have in abundance according to their comparative advantage (Bhagwati and Srinivasan 2002). However, static gain is a one-time attainment that countries enjoy immediately after trade liberalization, with no guarantee that these gains will continue during post-trade liberalization (Lawrence and Weinstein 1999). The static gains from opening a domestic market to international trade may emanate from improvements in competition and profitability of domestic firms (Lawrence and Weinstein 1999). Thus, there are also possibilities for a country to benefit from international trade after liberalization due to the stiff competition that domestic firms might face from foreign firms.

On the other hand, the dynamic gains from international trade are long run. The benefits could be either positive and/or negative, and there is an ambiguous distinction between the two in trade theory (Lawrence and Weinstein 1999). Bhagwati and Srinivasan (2002) have also stated that enhanced economic growth from trade can also lead to poverty reduction, confirming the "Bhagwati hypothesis" of the early 1960s pointing to economic growth as a principal driver of poverty reduction. The "Bhagwati hypothesis" states in relation to dynamic gains that not only does enhanced trade lead to increased income, but also towards equitable distribution of the economic gains—the ultimate goal of economic growth. In addition, Anderson and Babula (2008) indicated that while there is little doubt that trade increases national income, this might not necessarily correlate with rapid economic growth; there might be negative growth, albeit with increase in aggregate income. Countries' involvement in international trade has both good and bad effects. Thus, countries need policy interventions that balance gains and losses to achieve rapid, sustainable economic growth.

Export Promotion and Import Substitution Trade Policies

Views regarding the distinctions between export-promotion and import-substitution trade policies differ. Bhagwati (1988) has defined export-promotion trade policy based on effective exchange rate regimes that countries adopt. According to Bhagwati (1988), export promotion is, "when the home market sales will give a producer as much as exporting will: the incentive structure then implies effective exchange rate of exports and imports are equalized." Here, no incentives favour either exports or imports—it is bias-free, in other words—as compared to an import-substitution regime with incentives to substitute for imports. Moreover, there might also be circumstances under which the effective exchange rate for exports is greater than that of imports, sometimes called "ultra-export promotion" trade policy (Bhagwati 1988).

Bhagwati (1988) also discussed this concept of basing a country's prevailing effective exchange rate to discourage both exports and imports of goods and services. The effective exchange rate adopted in this case takes into account all incentives: subsidies, preferential loan, tax exemptions, discounted credit, and any form of support provided to exporting and importing firms. Accordingly, Bhagwati defined an import-substitution trade policy as, "the adoption of an effective exchange rate for the country's exports which is less than that for imports." Hence, the exchange rate policy discourages exports and imports, and encourages domestic consumption of domestically produced goods because they are less expensive compared to imports. Stiglitz and Andrew (2005), on the other hand, have defined import-substitution trade policy based on barriers (tariffs and quantitative restrictions) erected against imports of goods and services.

Countries have used both export-promotion and import-substitution trade policies over time. For instance, the adoption of import-substitution trade policy for "infant industry protection" received wide support in the early 1950s, while emphasis shifted to export promotion more recently (Rodriguez 2006). While contentious, Stiglitz and Andrew (2005) revealed that East Asian success has emphasized export-promotion. By the same token, scholars pointed to import-substitution trade policy as one of the root causes for economic failures of Latin American countries (Rodriguez 2006; Stiglitz and Andrew 2005). However, it is important to note that trade liberalization adopted in East Asian countries is highly complex and coupled with government intervention. As a result, the success of East Asian economies might not represent sufficient evidence to conclude that export-promotion trade policy alone leads to rapid economic development.

The source of growth in East Asian economies has been one of the most contested issues among scholars. Early on, scholars pointed to governments' commitments to adopt outer-oriented policies and neutral incentives as major contributors to the rapid growth in East Asia (Lawrence and Weinstein 2001; Krueger 1997). A study by the World Bank (1993) concluded that outward-oriented trade policy was the major contributor to the economic growth achieved in East Asian countries. While the World Bank study found that incentives favouring exports were the major contributors, the Bank overlooked the important role that imports played in the success of East Asian economies (Lawrence and Weinstein 2001). Moreover, Amsden (1992) and Wade (1990) argue that in addition to the important role that trade interventions played, these countries changed the comparative advantage by "getting price wrong"[1]. Rodrik (1995) indicated that the miraculous economic growth achieved in East Asian countries is attributable to industrial policies.

Korean trade policy passed through different stages, from inward looking to outward looking. Harvie and Lee (2003) argued that the trade policy Korea adopted in the 1970s was import substitution, and that Korea supported exports from light industries under the shade of the infant industries of the HCI plan.

Kim (1994) categorizes the evolution of trade and industrialization in Korea into four major phases:

1) the first "import-substitution phase" during the post-war reconstruction period from 1953 to 1960;

2) the second "outward-oriented trade" phase, from 1961 to 1965, also accompanied by various policy reforms;

3) a third phase, from 1966 to 1979, where Korea adopted outward-looking trade policy and implemented its Heavy and Chemical Industrialization (HCI) Plan, and;

4) the forth post-1980s phase depicting an outward-oriented trade policy in line with free market principles.

Notably, the distinct feature of the trade and industrial policy of the third period is that Korea paid little attention to market principles and price stabilization.

Empirical Studies

Previous empirical studies on the nexus of trade and economic growth showed mixed results. Some showed that trade causes economic growth, others concluded that there was no causal relationship between trade and growth, and still others implied that trade could even hurt an economy. These variations arose mainly because of differing analysis methods, the types of indicator variables used, and from the differing regions analysed. To illustrate, in analysing the relationship between exports, imports, and economic growth in Japan and South Korea, Zang and Baimbridge (2012) confirmed the ELG hypothesis for Japan while finding that economic growth surpressed exports in Korea. Similar studies in Central and Eastern Europe and Asia confirmed the ELG hypothesis (Awokuse 2007; Mamun and Nath 2005; Shirazi and Manap 2004; Jin 2002; Zestos and Tao 2002). However, scholars are not in complete agreement. For example, a

[1] "Getting price wrong" is a situation where price/markets fail to signal sensible decision making in an economy.

study in three South American countries (Argentina, Peru and Columbia) did not support the ELG hypothesis (Awokuse 2008). Still other studies failed to identify a causal relationship between exports and economic growth (Gómez, Álvarez-Ude, and Gálvez 2011; Sharma and Panagiotidis 2005; and Tang 2006).

Studies of the relationship between imports and economic growth, on the other hand, have largely confirmed the ILG hypothesis (Gómez, Álvarez-Ude, and Gálvez 2011; Kim, Lim, and Park 2009; Awokuse 2008; Sharma and Panagiotidis 2005; Thangavelu and Rajaguru 2004; and Jin 2002). Importantly, in contrast to the connection between ELG and growth, results confirming the ILG hypothesis have been very consistent. This broad consensus reveals the essential role that imports play in rapid economic growth.

Studies on the nexus of trade and economic growth looking at Korea specifically or as part of cross-country analysis revealed mixed and contradictory results. Zang and Baimbridge (2012) found a negative effect of economic growth on exports. Awokuse (2005) concludes a bi-directional causality between these variables. Konya (2006), meanwhile, reports no causality between exports and economic growth in Korea. Thangavelu and Rajaguru (2004) used VAR and VEC models to conclude that in an open economy imports play a more significant role than exports, especially in East Asian countries (albeit Korea was not part of the analysis). Jin's (2002) research applying the VAR model in Korea on provincial data points to the validity of export-led growth in four selected provinces (Seoul, Kyunggee, Kyungnam, and Pusan).

Kim, Lim, and Park (2009) analysed relationships between exports, imports, factor productivity, and economic growth in Korea, arguing that import Granger cause total factor productivity, while exports failed to evidence causality between the two variables. They concluded that while import growth has a significant and positive effect on economic expansion, the opposite holds true for exports. While such variations might arise from the differing analytical methods employed, and the differing time spans considered in these studies, we can see that scholars have not found a consistent relationship between trade and economic growth.

Data

The data set for this study includes real GDP (RGDP), labor force (Labor), real gross capital formation (RGCF), real exports (REXP), and real imports (RIMP). We collected annual data from the International Monetary Fund (IMF) and the World Bank from 1960 to 2010.

Methodology

We built the econometric model for analysing aggregate growth based on the Cobb-Douglas production function. This growth model includes the key determinant variables of economic growth, as described below:

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta} \quad (1)$$

where, Y_{it} is the aggregate output of country *i* at time *t*, *A* represents total factor productivity (technology), *L* is human capital (labor), *K* is the physical capital stock, and and stand for output elasticity's of labor and capital, respectively.

For computational simplicity of the relationship between the variables, we transformed the standard Cobb-Douglas production function into natural logarithm terms. Hence, we adopted econometric models analogous to the equation (1) above to analyse the nexus of trade and economic growth. Accordingly, we developed a country specific model to account for differences in economic, social, and political characteristics among countries. However, before building models that capture the relationship between the variables, there should be plausible economic theory in support of the relationship among the model's variables (Lutkepohl and Kratzig 2005). Accordingly, for this study we used the augmented Cobb-Douglas production function shown below to capture determinants of aggregate output used in most of the previous studies (see Awokuse 2008, 2007; Yanikkaya 2003; Onafora and Owoye 1998).

$$RGDP = f[(LAB, GCF); REXP, RIMP] \quad (2)$$

where, RGDP represent real GDP as a proxy for economic growth, and LAB, GCF, REXP, and RIMP represent population between age 15 to 64 as a proxy for labor, gross capital formation as a proxy for capital, real exports and real imports as a proxy for technological innovation, respectively in the augmented Cobb-Douglas production function.

Unit Root Test

The primary precaution before embarking on any econometric analysis utilizing time series data is to check for data "stationarity". Time series data is "stationary" if the distribution of stationary process remains unchanged in different samples of same data with respect to time (Maddala and Kim 1998). The reason for this precaution is to avoid spurious regression results common in analysis of time series data. Spurious or non-sense regression results occur when one finds apparently significant results from unrelated data sets. Thus, we applied the Augmented Dickey-Fuller (ADF) test to check for non-stationarity of the time series data used in this study. Subsequent to the ADF test, we employ either differencing or logarithmic transformation to ensure stationarity of the time series data (Hill, Griffiths, and Lim 2012; Maddala and Kim 1998). Stationarity testing of time series data usually preludes co-integration testing (Lutkepohl and Kratzig 2005).

Johansen Co-integration Test

Co-integration testing determines the validity of long-run relationships between variables, given that all variables are non-stationary at level. If there is co-integration, it means that even if the variables are non-stationary[2] at level, there is a long-run relationship between them (Johansen 1988). Moreover, for determining the number of co-integrated vectors Johansen (1988) suggests two tests: Trace test and Maximum Eigen Value test. The trace test examines the hypothesis that at most there are *r* co-integrating vectors, while the Maximum Eigen Value tests the hypothesis that there are r+1 co-integrating vectors (Maddala and Kim 1998). In choosing the test that predicts the number of co-integrating vectors, Johansen and Juselius (1990) suggest that the Maximum Eigen value test is efficient.

The purpose of identifying the co-integrating vectors is to reveal the existence of long-run relationship among the models' variables. In addition, the existence of co-integrated relationship between the variables guides the selection of either the Vector Autoregressive (VAR) or the Vector Error Correction (VEC) models for efficient estimation and forecasting (Hill, Griffiths, and Lim 2012; Maddala and Kim 1998; Johansen and Juselius 1990). In this study, we employ the Johansen co-integration test to examine whether the variables are co-integrated, hence identify the rank of the co-integrating vector.

Vector Autoregressive (VAR) Model

The VAR model has been one of the widely utilized analytical tools in econometrics since used first by Sims in 1980. To estimate the VAR model, it is necessary to conduct regression comparison of the dependent variables with their own lagged values and the lagged values of other independent variables included in the economic model. Consequently, detection of co-

[2]According to Engle and Granger (1987) the components of the vector X_t are said to be co-integrated of order d, b, denoted X_t - CI(d, b) if: (i) all components of X_t are I(d), and (ii) there exists a vector α (≠0) so that $Z_t= \alpha' X_t$-I(d -b), b>0. The vector α is called the co-integrating vector.

integrating vector(s) guide the type of VAR model employed, unrestricted VAR or restricted VAR (VEC model). For instance, if endogenous variables are integrated of order one or *I(1)* and not co-integrated, the unrestricted VAR model will be suitable to adopt using first-order difference of the variables as shown in equation 3 below (Hill, Griffiths, and Lim 2012). As a result, the conventional asymptotic theory is valid for hypothesis testing of the VAR model (Toda and Yamamoto 1995). Nevertheless, there are limitations on the validity of VAR estimates because the explanatory variables included in the model suffer from the multicollinearity problem. Thus, an alternative restricted version of the VAR model, the Vector Error Correction (VEC) model, may be better for optimal estimation and forecasting (Maddala and Kim 1998).

$$Y_t = \alpha_i + \sum_{i=1}^{p} \beta_i Y_{t-i} + \varepsilon_i \qquad (3)$$

where $Y_t = (GDP, LAB, GCF, \ REXP, RIMP)$, which is a 5×1 vector non-stationary variable, α_i is 5×1 vector of constants, p is the number of lags, β_i is a 5×5 matrix of parameters to be estimated, ε_i is a 5×1 vector of error terms, and i is the number of co-integrated equations included in the VEC model.

Similarly, if the endogenous variables in equation (3) are co-integrated—for instance *CI(1,1)*, i.e. co-integrated of order one-one—the VEC model will be an efficient estimation technique (Toda and Yamamoto 1995; Maddala and Kim 1998; Lutkepohl and Kratzig 2005). The VEC model is a modified VAR model that restricts the long run behaviour of endogenous variables to converge to their co-integrating relationship while adjusting for short-run dynamics. Hence, if $\mathrm{Y_t}$ is co-integrated, we can generate equation (3) using a VEC model that considers variables in the regression as potentially endogenous variables, and relates each variable to its own and other variables' lagged value. The VEC model with co-integrating rank (r)—employed by Zang and Baimbridge (2012), Kogna (2006), Awokuse (2008, 2007), Thangavelu and Rajaguru (2004); Onafowora and Owoye (1998)—is shown as follows:

$$\Delta Y_t = \alpha_i + \mu\beta Y_{t-1} + \sum_{i=1}^{p-1} \prod_i \Delta Y_{t-i} + \varepsilon_t \qquad (4)$$

where the error correction coefficient μ and the co-integrating vector $\boldsymbol{\beta}$ are ($p \times r$) matrices, and α_i is a vector of constants.

The coefficients of variables in equation (4) represent a VEC model estimated in this study, and constitute two main noteworthy parts. The first part ($\mu\beta Y_{t-1}$) is the Error Correction term (EC_{t-1}), which represents the long-run causal relationship between co-integrated variables of the estimated model (Lutkepohl and Kratzig 2005, Maddala and Kim 1998). Hence, the error correction term determines long-run causality. If the coefficient (EC_{t-1}) is significant, then it means that there is a long run causal relationship between the estimated variables. According to Johansen and Jesulius (1990), we can interpret the error correction term as the speed of adjustment of the deviation of the dependent variables from their long-run values. However, in multivariate causality testing it is difficult to interpret the error correction because there are more than two variables to which we can attribute causality.

The second part of equation 4 constitutes the coefficients of the lagged explanatory variables ($\sum_{i=1}^{p-1} \prod_i \Delta Y_{t-i}$), representing the short-run causal relationship among endogenous variables included in the model. One can also determine short-run causality by joint significance of the coefficients of the lagged explanatory variables. To determine the short-run causal relationship among endogenous variables it is necessary to estimate Granger causality or conduct block exogeneity Wald test based on the estimated VEC model (Toda and Yamamoto 1995). In a multivariate model, the Granger causality test determines the short-run causality between variables. For instance, if X_t and Y_t are two time series variables, if the past and present values X_t can help to predict the future values of Y_t, say Y_{t+1}, then we can say X_t Granger cause Y_t ($X_t \overset{Gr}{\rightarrow} Y_t$), and vice versa (Maddala and Kim 1998).

Moreover, the Generalized Impulse Response (GIR) function could also help to capture the dynamic effect of a one-time shock to one of the innovations transmitted to the endogenous variables estimated in VEC model. GIR function analysis is a conceptual experiment in which we can interpret current and future responses of the variables as responses to impulses hitting a system (Luktepohl and Kratzig 2005). We can forecast the long-run dynamic relationship, or correlation, among the endogenous variables (response) based on conceptually built positive macroeconomic shock (impulse) on the dependent variables, based on VEC model under the setting of GIR functions (Awokuse 2008; Sharma and Panagiotidis 2005).

Thus, by adopting previously estimated Vector Error Correction model we could generate the GIRF. Through GIRF, a shock to the i^{th} variable not only directly affects the i^{th} variable, but it is also transmitted to all the other endogenous variables ($\sum_{i=1}^{p-1} \prod_i \Delta Y_{t-i}$) through the dynamic (lag) structure of the VAR model (Awokuse 2008; Sharma and Panagiotidis 2005). Moreover, a GIRF traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables based on experimentally generated macroeconomic shocks. Accordingly, if the innovations ε_t are contemporaneously uncorrelated, the interpretation of the impulse response is straightforward: currently generated macroeconomic shocks, impulse of one Standard Deviation (SD), will generate the forecast current and future values of the endogenous variables response (Luktepohl and Kratzig 2005; Sharma and Panagiotidis 2005).

The other important consideration in estimating the VEC model is the selection of the optimum lag length. To determine the lag order of the VEC model, we can adopt sequential testing that starts with the highest lag length and selecting the optimal based on certain criteria (Lutkepohl and Kratzig 2005). Accordingly, we adopted optimal lag order that minimizes Akaike Information Criterion (AIC) and Schwarz Bayesian Criteria (SBC) in this study to avoid the possibility of autocorrelation problem in the model estimated. Toda and Yamamoto (1995) have suggested that estimation of VAR model at levels, even if the variables are non-stationary, will be valid to suggest the optimum lag length. Thus, for this study we estimated the VAR model at levels to determine the optimum lag length to use in the Johansen co-integration test and the estimated VEC model. However, note that the number of observations is relatively small, and comes from annual data, to fix the maximum lag-length freely. As a result, for this study we chose optimum lag lengths that range from two to six based on AIC and SBC estimated from VAR at levels; unless and otherwise the number of coefficients to be estimated becomes greater than the number of observations.

Unit Root Test

We checked data stationarity before embarking on further analysis of the time series data to circumvent spurious regression results. Accordingly, we conducted ADF unit root test for each variable for which we obtained time series data. As can be seen from Table 1 below, we found all variables to be non-stationary at levels. Subsequently, testing for unit root on differenced data, we find that all the variables are stationary at first difference at conventional level of significance. Moreover, the stationarity of time series data at first difference indicates that the data exhibits *I(1)*, integrated of order one. Thus, we can use all data on macroeconomic variables included in the Cobb-Douglas production function because it is stationary at first difference at conventional level of significance[3].

[Table 1: Augmented Dickey Fuller Test for Unit Root]

Johansen Co-integration Test

We use Johansen co-integration test based on Trace and Maximum Eigen statistic to infer whether there exists long-run relationship among the endogenous variables. The existence of co-integrated vectors also helps to determine the type of VAR model to use, either restricted or unrestricted VAR (i.e. VEC model). Co-integration tests usually come prior to estimation of VAR model. Table 2 shows Johansen co-integration test for the output growth model based on data from Korea. Accordingly, both the Trace and Maximum-Eigen value test confirms the rejection of the null hypothesis of "no co-integrated vectors" at 5% level of significance; thus confirming existence of long run relationship among the variables. Furthermore, both Trace and Maximum-Eigen value testing shows the existence of one co-integrating equation, which we include in VEC model estimation.

[Table 2: Johansen Co-integration Test]

Vector Error Correction (VEC) Model Estimates

We estimated a VEC model for co-integrated variables based on annual data from 1960 to 2010 to examine short-run and long-run causal relationship between co-integrating variables. The significance of the Error Correction (EC) term determines the long-run relationship, and summing of lagged coefficients of the independent variables demonstrates the short-run causal relationship at conventional level of significance.

[3] Conventional level of statistical significance denotes a cut-off point of accepting 1%, 5%, and 10% error in hypothesis testing.

As can be seen from table 3 below, the long-run relationship, as verified by the significance of the EC term, implies existence of unidirectional causality between exports and economic growth, running from exports to economic growth. The relationship between economic growth and imports is bi-directional.

[Table 3: Estimates of Vector Error Correction Model, Korea]

In addition, exports, imports, and economic growth in Korea display unidirectional short-run causal relationships. The direction of causality runs from exports and imports to economic growth both in the long and in the short run, which signals the validity of both ELG and ILG hypothesis in Korea. Remarkably, the absence of long-run causality from GDP to exports has an important implication: enhanced export growth in Korea did not track increased economic growth.

Granger Causality Test Based on VEC Model

The Granger causality test elucidates whether there is a short-run causal relationship between exports and imports and economic growth. Table 4 below reports the results of Granger causality test between the endogenous variables included in the estimated VEC model. Both the exports and imports show causal relationships between economic growth uni-directionally in the short run according to the Granger causality test, based on the VEC model in Korea. The uni-directional causality that runs from exports to GDP—thus absence of reverse causality—might be attributable to the fact that Korea diverted exportable items towards its domestic market and away from export markets. Moreover, the results imply that singular trade policy that only focuses on exports might not be effective to enhance economic growth.

[Table 4: Granger Causality Test Based on VEC Model]

Interestingly, the absence of causality that runs from economic growth to exports in Korea could be attributable to the fact that the country diverted some tradeable goods towards its domestic market and away from exports. Perhaps, it also signals the importance of production for domestic consumption and partial absorption of exportable baskets towards the domestic market. This assertion is plausible because we might expect that the industrial expansion that can follow economic growth could improve export performance. However, this study does not show this causality from economic growth to exports, thus conforming "vent-for-surplus" theory[4]. This implies an important policy implication: as an economy booms, domestic markets play a vital role in sustaining growth.

[4] As a consequence of the ensuing increase in aggregate demand, growth may create a situation whereby more of the nation's output is absorbed domestically leaving relatively less for exports (Dolado 1993).

In addition, we ran the Generalized Impulse Response (GIR) function to examine the response of GDP to a shock of generalized one Standard Deviation (S.D.) innovations. Figure 1 below shows the response of GDP to a generalized one S.D. innovation introduced through the GIR function for ten years. Consequently, the results imply that GDP growth responds positively and modestly to generalized one S.D. innovations from exports and imports, a finding that reinforces the existence of the ELG and ILG hypothesis in Korea.

[Figure 1: Generalized Impulse Responses of GDP to One S.D. Shock, Korea]

This study employed the Cobb-Douglas production function under the setting of the Vector Autoregressive (VAR) model. We estimated a VAR model that expresses each variable as a linear function of its own past values, the past values of all other variables considered, and a serially uncorrelated error term, using time series data from 1960 to 2010. Based on significance and appropriate sign of the EC term, we found unidirectional causality running from exports to economic growth in Korea, while we found the causality for imports in Korea to be bi-directional with economic growth. Our Granger causality test also displayed evidence for short-run unidirectional causality between exports, imports and economic growth in Korea. Thus, our findings support both the ELG and ILG hypothesis in relation to Korea. This study displays robust evidence that not only exports, but also imports, appear to have played a significant role in promoting economic growth in Korea. This result could be attributable to the fact that Korea is resource scarce, and thus must import raw materials.

Moreover, the results imply that a singular trade policy that focuses only on exports might not be effective to enhance economic growth. The absence of causality between economic growth and exports in Korea might be one of the central findings of this study. This absence of causality could be attributable to the fact that Korea diverted some tradeable goods towards its domestic market and away from export markets. Perhaps, a major policy lesson stemming from Korea's trade and growth experience is the importance of production for domestic consumption and partial absorption of exports in the domestic market. This assertion is plausible because we might expect that the industrial expansion that can follow economic growth would improve export performance. However, this study does not show this causality from economic growth to exports, thus conforming to "vent-for-surplus" theory. As a consequence of the ensuing increase in aggregate demand, growth may create a situation whereby more national output is absorbed domestically leaving relatively less for exports (Dolado 1993). This signifies an important policy implication: as an economy booms, domestic markets play a vital role in sustaining growth.

The consistency of results supporting the ILG hypothesis from our literature review is particularly important. Imports tend to correlate more with growth compared to exports, based on previous studies (see Gómez, Álvarez-Ude, and Gálvez 2011;Kim, Lim, and Park 2009; Awokuse 2008; Sharma and Panagiotidis 2005; Thangavelu and Rajaguru 2004; and Jin 2002). Similarly, our study also revealed that imports played an important role in sustaining economic growth in Korea. The case for the significance of imports in stimulating economic growth assumes that imports provide capital and intermediate goods used as inputs to industrial production for the domestic market. A recent study by Shin and Lee (2013) revealed that during the early stages of economic development, Korea favoured capital goods imports compared to consumption goods, with the Korean Government levying a higher tariff on imports of consumption goods. This favouring of capital goods imports seems to have changed, as Korea's economy opened to increased international competition.

Table 1: Augmented Dickey Fuller Test for Unit Root

Variables	*Levels*			*First difference*	
	Test statistic	ρ-value		Test statistic	ρ-value
$LnGDP$	-2.883	0.177		-6.177	0.000
$LnLAB$	-2.357	0.397		-4.083	0.012
$LnGCF$	-3.209	0.100		-6.134	0.000
$LnEXP$	-2.401	0.602		-5.377	0.000
$LnIMP$	-3.054	0.129		-6.431	0.000

Note: critical values are -3.96(1%), 3.41 (5%), and -3.13 (10%) with constant and trend, R. Davidson and J. G. MacKinnon (1993) as cited in Hill, Griffiths, and Lim (2012).

Source: Author's computation, based on data collected from WB (2012), IMF (2009, 2012).

Table 2: Johansen Co-integration Test

Co-integrating rank (r)	*Trace test*			
	Eigen value	Trace Statistic	Critical Value**	Prob.
$r = 0^{*}$	0.539	72.557	69.819	0.030
$r \leq 1$	0.288	35.351	47.856	0.430
$r \leq 2$	0.234	19.043	29.797	0.490
$r \leq 3$	0.115	6.217	15.495	0.670
$r \leq 4$	0.007	0.343	3.841	0.558
Co-integrating rank (r)	*Maximum Eigen (λ-max) Value test*			
	Eigen value	*λ-max* Statistic	Critical Value**	Prob.
$r = 0^{*}$	0.539	37.206	33.877	0.019
$r \leq 1$	0.288	16.307	27.584	0.640
$r \leq 2$	0.234	12.827	21.132	0.468
$r \leq 3$	0.115	5.874	14.265	0.630
$r \leq 4$	0.007	0.343	3.841	0.558

Note: Trace and Maximum Eigen test indicates one co-integrating equation.*, ** denotes rejection of the null-hypothesis and critical values at 5% level of significance, respectively.

Source: Author's computation, based on data collected from WB (2012), IMF (2009, 2012).

Table 3: Estimates of Vector Error Correction Model, Korea

Explanatory Variables	Dependent variables				
	$\Delta LnGDP$	$\Delta LnLAB$	$\Delta LnGCF$	$\Delta LnEXP$	$\Delta LnIMP$
EC_{t-1}	-0.427*** (24.339)	-0.152 (0.814)	-0.376*** (9.273)	-0.134 (1.935)	-0.439*** (14.756)
$\sum \Delta LnGDP$	-0.339 (0.628)	-0.684 (1.571)	-0.367 (0.299)	-0.326 (0.349)	-0.556 (0.758)
$\sum \Delta LnLAB$	0.316* (2.780)	0.204 (0.845)	0.353 (1.622)	0.332** (3.633)	0.480** (4.486)
$\sum \Delta LnGCF$	0.692** (3.423)	0.673 (0.878)	1.043** (4.864)	0.374 (1.228)	0.892** (4.319)
$\sum \Delta LnEXP$	0.999*** (7.203)	1.231 (2.930)*	1.586*** (8.686)	0.628** (4.358)	1.326*** (7.556)
$\sum \Delta LnIMP$	-1.164*** (8.942)	-1.052 (2.277)	-1.967*** (10.460)	-0.760*** (5.611)	-1.478*** (7.806)
Statistics:					
R^2	0.568	0.222	0.561	0.446	0.576
S.D.	0.139	0.201	0.196	0.136	0.185
σ	0.105	0.204	0.149	0.116	0.138
D.W.	1.991	1.961	1.790	1.766	1.821

Note: values in the table are summed regression coefficients and F-statistic in parenthesis. R^2 is the coefficient of determination, S.D. is the stand. error of the dependent variable, is stand. error of regression, D.W. is the Durbin Watson statistic. *, **, *** shows significance at 10%, 5%, and 1% level.

Source: Author's computation, based on data collected from WB (2012), IMF (2009, 2012).

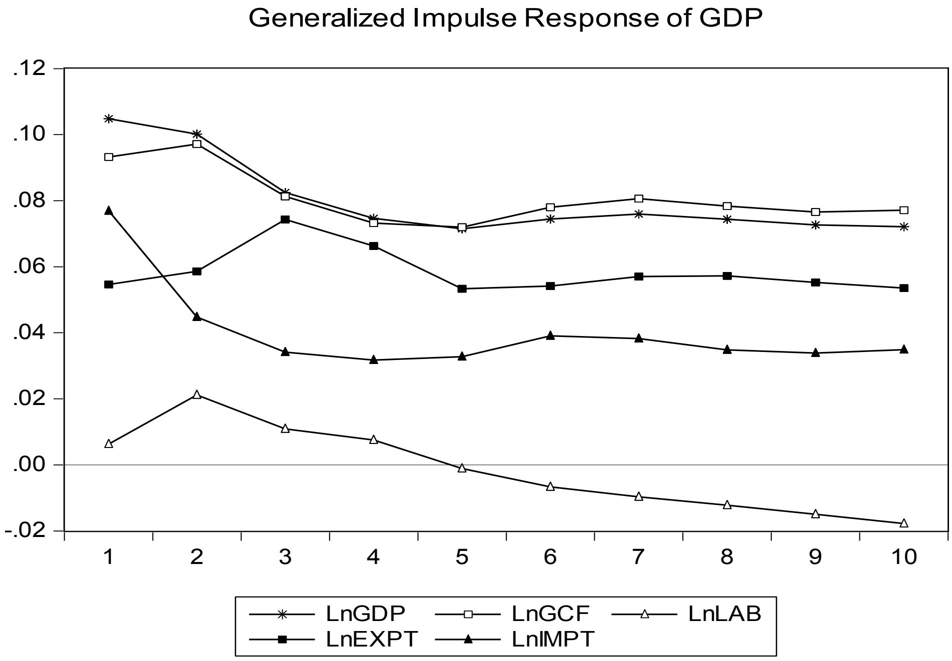
Table 4: Granger Causality Test Based on VEC Model

	Dependent Variable				
	$\Delta LnGDP$	$\Delta LnLAB$	$\Delta LnGCF$	$\Delta LnEXP$	$\Delta LnIMP$
$\Delta LnGDP$	—	3.144 (0.208)	0.598 (0.741)	0.699 (0.705)	1.516 (0.468)
$\Delta LnLAB$	5.560* (0.062)	—	3.244 (0.197)	7.265** (0.026)	8.972** (0.011)***
$\Delta LnGCF$	6.847** (0.033)	1.757 (0.415)	—	2.456 (0.295)	8.637** (0.011)
$\Delta LnEXP$	7.714*** (0.000)	5.859 (0.053)	17.372*** (0.000)	—	15.112 (0.000)
$\Delta LnIMP$	17.884*** (0.000)	4.555 (0.103)	20.919*** (0.000)	11.222*** (0.004)	—

Note: values in parenthesis are estimated P-values, all other values are asymptotic Granger causality values. *, **, *** shows significance at 10%, 5%, and 1* level, respectively.

Source: Author's computation, based on data collected from WB (2012), IMF (2009, 2012).

Figure 1: Generalized Impulse Responses of GDP to One S.D. Shock, Korea



Source: Author's based on data collected from WB (2012), IMF (2009, 2012).

Awokuse, Titus O. 2005. "Exports, Economic Growth and Causality in Korea." *Applied Economics Letters,* 12 (11): 693–696.

Awokuse, Titus O. 2007. "Causality between Exports, Imports, and Economic Growth: Evidence from Transition Economies." *Economics Letters,* 94 (11): 389–395.

Awokuse, Titus O. 2008. "Trade Openness and Economic Growth: Is Growth Export-led or Import-led?" *Applied Economics,* 40 (2): 161–173.

Berg, Andrew, and Anne Krueger. 2003. "Trade, Growth, and Poverty: A Selective Survey." International Monetary Fund (IMF) Working Paper No. 03/30.

Bhagwati, Jagdish. 1988. "Export Promoting Trade Strategies: Issues and Evidence." *The World Bank Research Observer*, 3 (1): 27-57.

Bhagwati, Jagdish, and Thirukodikaval Nilakanta Srinivasan. 2002. "Trade and Poverty in the Poor Countries." *The American Economic Review,* 92 (2): 180-183.

Brückner, Markus, and Daniel Lederman. 2012. "Trade Causes Growth in Sub-Saharan Africa." World Bank (WB) Policy Research Working Paper No. 6007.

Cruz, Mortiz. 2008. "Can Free Trade Guarantee the Gains from Trade?" World Institute for Development Economic Research, United Nations University Working Paper No. 97/2008.

Dollar, David, and Aart Kraay. 2002. "Trade, Growth, and Poverty." *The Economic Journal,* 114 (2): F29 – F49.

Dollar, David, and Aart Kraay. 2003. "Institutions, Trade, and Growth." *Journal of Monetary Economics,* 50 (7): 133–162.

Frankel, Jeffrey A. and David Romer. 1999. "Does Trade Cause Growth?" *The American Economic Review* 89 (3): 379-399.

Golub, Stephen S., and Chang-Tai Hsieh. 2000. "Classical Ricardian Theory of Comparative Advantage." *Review of International Economics,* 8 (2): 221-234.

Gómez, David Matesanz, Guadalupe FugarolasÁlvarez-Ude, and Isis MañalichGálvez. 2011. "Trade-led Growth Hypothesis in Cuban Commercial Regimes since 1960." *Economics of Transition,* 19 (2): 287–304.

Greenwald, Bruce, and Joseph E. Stiglitz.2000. "Helping Infant Economies Grow: Foundations of Trade Policies for Developing Countries." *The American Economic Review,* 96 (2): 141-146.

Hill, R. Carter, William E. Griffiths, and Guay C. Lim. 2012. *Principles of Econometrics.* 4th Ed. (International Student Version). New Jersey: John Wiley & Sons.

International Monetary Fund (IMF). 2009. "International Financial Statistics." CD-ROM, IMF: Washington, DC.

International Monetary Fund (IMF). 2012. *International Financial Statistics.* IMF: Washington, DC.

Jin, Jang C. 2002. "Exports and Growth: Is the Export-led Growth Hypothesis Valid for Provincial Economies?" *Applied Economics,* 34 (1): 63-76.

Johansen, Søren, and Katarina Jusileus. 1990. "Maximum Likelihood Estimation and Inference with Co-integration: with the Applications to the Demand for Money." *Oxford Bulletin of Economics and Statistics,* 52(2): 169-210.

Johansen, Søren. 1988. "Statistical Analysis of Co-integration Vectors." *Journal of Economic Dynamics and Control,* 12 (2-3): 231-254.

Kim, Sangho, Hyunjoon Lim, and Donghyun Park. 2009. "Imports, Exports and Total Factor Productivity in Korea." *Applied Economics,* 41 (14): 1819–1834.

Kónya, László. 2006. "Exports and Growth: Granger Causality Analysis on OECD Countries with a Panel Data Approach." *Economic Modelling,* 23 (6) 978–992.

Lawrence, Robert Z., and David E. Weinstein. 2002. "Trade and Growth: Import-led Or Export led? Evidence from Japan and Korea." National Bureau of Economic Research (NBER) Working Paper No. 7264.

Lütkepohl, Helmut. 2005. *New Introduction to Multiple Time Series Analysis.* Berlin: Springer Verlag.

Maddala, G.S., and In-Moon Kim. 1998. *Unit Roots, Co-integration, and Structural Change*. New York: Cambridge University Press.

Mamun, K. A. Al, and H. K. Nath. 2005. "Export-led Growth in Bangladesh: A Time Series Analysis." *Applied Economics Letters,* 12(6): 361-364.

Onafowora, Olugbenga A., and OluwoleOwoye. 1998. "Can Trade Liberalization Stimulate Economic Growth in Africa?" *World Development,* 26 (3): 497 – 506.

Rodríguez, Francisco, and Dani Rodrik. 2001. "Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence." In *NBER Macroeconomics Annual 2000,* eds. Ben S. Bernanke and Kenneth Rogoff, 261 – 338. Cambridge, MA.

Rodríguez, Francisco. 2006. "Openness and Growth: What Have We Learned?" Department of Economic and Social Affairs (DESA), United Nations University Working Paper No. 51.

Sharma, Abhijit, and Theodore Panagiotidis. 2005. "An Analysis of Exports and Growth in India: Co-integration and Causality Evidence (1971–2001)." *Review of Development Economics,* 9(2): 232–248.

Shin, Hochul, and Keun Lee. 2013. "Asymmetric Trade Protection Leading not to Productivity but to Export Share Change: the Korean Case from 1967 to 1993." *Economics of Transition, 20(4): 745-785.*

Shirazi, Nasim Shah, and Turkhan Ali Abdul Manap. 2005. "Export-led Growth Hypothesis: Further Econometric Evidence from South Asia." *The Developing Economies,* 43 (4): 472–488.

Stiglitz, Joseph E., and Charlton, Andrew. 2005. *Fair Trade For All: How Trade Can Promote Development*. Oxford: Oxford University Press.

Tang, Tuck Cheong. 2006. "New Evidence on Export Expansion, Economic Growth and Causality in China." *Applied Economics Letters,* 13 (12): 801–803.

Thangavelu, Shandre Mugan, and Gulasekaran Rajaguru. 2004. "Is there an Export or Import led Productivity Growth in Rapidly Developing Asian Countries? A multivariate VAR Analysis" *Applied Economics,* 36 (10):1083–1093.

Toda, Hiro Y., and Taku Yamamoto. 1995. "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes." *Journal of Econometrics*, 66 (1-2) 225-250.

Wacziarg, Romain and Karen Horn Welch. 2003. "Trade Liberalization and Growth: New Evidence." *The World Bank Economic Review,* 22 (2): 187–231.

Warner, Andrew. 2003. "Once More into the Breach: Economic Growth and Integration" Center for Global Development Working Paper No. 34.

World Bank (WB). 2012. "World Development Indicators Database." Washington, DC: WB.

Yanikkaya, Halit. 2003. "Trade Openness and Economic Growth: A Cross-Country Empirical Investigation." *Journal of Development Economics,* 72 (1): 57– 89.

Zang, Wenyu and Mark Baimbridge. 2012. "Exports, Imports and Economic Growth in South Korea and Japan: A Tale of Two Economies." *Applied Economics,* 44 (3): 361–372.

Zestos, George K. and Xiangnan Tao. 2002. "Trade and GDP Growth: Causal Relations in the United States and Canada." *Southern Economic Journal,* 68 (4): 859-874.

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