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Empirical Evidence on Korea's Import Demand Behavior Revisited

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Abstract

This paper attempts to re-examine Korea's import demand behavior with an enhanced econometric technique and an up-to-date dataset. To achieve the goal, an autogressive distributed lag (ARDL) approach is adopted. Our results show the existence of the long-run relationship between Korea's imports and its major determinants such as income and price. It is also found that income plays an important role in influencing Korea's imports in both the short- and long-run. On the other hand, price is found to have a significant impact on Korea's imports only in the short-run.

Keywords: ARDL, Cointegration, Imports, Korea

1. Introduction

Numerous studies have investigated Korea's import demand behavior. This list includes Mah (1993 and 2000), Bahmani-Oskooee and Rhee (1997), Santos-Paulino (2002), Tang (2005), Baek (2012), Bahmani-Oskooee et al. (2012) and Baek (2013). Mah (1993), for example, applies OLS to quarterly data for the period 1971-1988 in estimating the determinants of import demand equation for Korea; he finds that Korean imports are more sensitive to price changes over the sample period. Using the same data set, Bahmani-Oskooee and Rhee (1997) conduct Johansen (1990) cointegration analysis; they conclude that income plays more important role in determining Korea's imports. Mah (2000) employs the bounds testing method to examine Korea's import demand for information technology products over the period 1980-1997; he reports that both income and price changes have significant impacts on the imports of those products. More recently, Baek (2012) analyzes macroeconomic factors affecting exports and imports in Korea; he finds that Korean imports are more sensitive to changes in domestic income than other factors (i.e., exchange rate).

This paper attempts to contribute to the existing literature by reexamining Korea's import demand equation with an enhanced time series econometrics and an up-to-date dataset. More specifically, as Bahmani-Oskooee and Rhee (1997) did, we use a cointegration approach in tackling the issue. Unlike them, however, we employ an autoregressive distributed lag (ARDL) bounds testing approach to cointegration (hereafter ARDL cointegration method) to quarterly data for the 1989-2014 period. The ARDL cointegration approach is known to be more efficient and is well suited for small sample size than conventional cointegration analysis (i.e., Johansen cointegration). In addition, we explicitly incorporate structural breaks into our ARDL modeling. Structural breaks in time series are likely to affect estimated results but have been mostly neglected by previous studies.(Note 1) It is expected that these efforts would lend confidence in the robustness and reliability of our empirical findings.

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2. The Empirical Model

In examining import demand functions, it is a common practice to relate the volume of imports demanded to a measure of domestic income (i.e., GDP) and domestic prices relative to the price of import substitutes (e.g., Santos-Paulino, 2002; Tang, 2005). If the price and income elasticities of demand are assumed to be constant, the import demand equation is defined as:

$$m = (\frac{p^*}{p} e)^{\varphi} y^{\tau} \tag{1}$$

where m is the import volume; p^* is the foreign prices; p is the domestic prices; e is the nominal exchange rate; φ is the price elasticity of import demand; y is the domestic income; and τ is the income elasticity of import demand. After taking logs, Equation 1 can be expressed as follows:

$$\ln m_t = \alpha_0 + \alpha_1 \ln rp_t + \alpha_2 \ln y_t + \varepsilon_t \tag{2}$$

where $\alpha_1 = \varphi$ and $\alpha_2 = \tau$; rp_t is the relative prices. (Note 2) In the empirical model adopted in this paper we modify Equation 2 to capture a possible structural break that may result in changes in Korea's import demand. Hence, the following specification is used for the empirical analysis:

$$\ln m_t = \alpha_0 + \alpha_1 \ln rp_t + \alpha_2 \ln y_t + \alpha_3 dum_t + \varepsilon_t \tag{3}$$

where m_t is the import volume in Korea; y_t is the real income of Korea; rp_t is the relative price of Korean imports, which is defined as $rp_t = ip_t / cp_t$, where ip_t is the import price index for Korea and cp_t is the consumer price index for Korea as a proxy for domestic price;(Note 3) dum_t is the dummy variable capturing a possible structural break – in this paper, taking one for 2008:4 and zero for otherwise; (Note 4) and ε_t is the error term including all other factors affecting the import demand. If a rise in Korea's real income results in an increase in demand for imported products, α_1 is expected to be positive. If import price increases at a faster than domestic price and has a negative effect on import demand, α_2 is expected to be negative.

In order to carry out the ARDL cointegration procedure, following Pesaran et al. (2001), Equation 3 is reformulated as a conditional error correction model (ECM) as follows:

$$\begin{aligned}\Delta \ln m_t = {} & \alpha_0 + \alpha_1 dum_t + \sum_{i=1}^{p} \delta_i \Delta \ln m_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta \ln y_{t-i} + \sum_{i=0}^{p} \vartheta_i \Delta \ln rp_{t-i} \\ & + \theta_1 \ln m_{t-1} + \theta_2 \ln y_{t-1} + \theta_3 \ln rp_{t-1} + \mu_t \end{aligned} \tag{4}$$

Without lagged level variables – that is, m_{t-1}, y_{t-1} and rp_{t-1}, Equation 4 would be the same a standard VAR model. The linear combination of lagged level variables is replaced the lagged error-term from Equation 3, which results in an error-correction specification expressed in Equation 4. The ARDL cointegration procedure consists of the following two steps. The first step of the modeling is to identify the presence of the long-run (cointegration) relationship among the three variables by conducting the joint significance test of m_{t-1}, y_{t-1} and rp_{t-1} in Equation 4. For this purpose, the standard *F*-test can be used to test the null hypothesis of none-existence of the long-run relationship (no cointegration) - that is, $H_0 : \theta_1 = \theta_2 = \theta_3 = 0$

against $H_0: \theta_1 \neq 0, \theta_2 \neq 0, \theta_3 \neq 0$. Under the null hypothesis, however, the (asymptotic) distribution of this *F*-statistic is non-standard, irrespective of whether the variables are integrated of order zero ($I(0)$) or integrated of order one ($I(1)$) processes. Pesaran et al. (2001) thus tabulate two new sets of critical values that account for integrating properties of all variables. If the calculated F-statistic lies above the critical value of band, a conclusive decision can be reached without carrying out unit roots tests on the variables; for example, if the calculated *F*-statistic is higher (lower) than the upper (lower) critical value, then the null hypothesis can (cannot) be rejected. Unlike conventional cointegration methods that require classifying the variables into $I(0)$ and $I(1)$, therefore, this procedure does not require pre unit root testing. At the second step the long-run effects and the associated short-run effects are simultaneously estimated in the selected ARDL framework. The long-run estimates of the selected variables are derived from estimates of θ_2 and θ_3 normalized on θ_1. The short-run effects come from the estimates of coefficients related to first-differenced variables.

3. Empirical Results

Because the ARDL cointegration approach assumes the variables must be $I(0)$ or $I(1)$, the computed *F*-statistic is not valid with $I(2)$ variables. The test to make sure that no variable in Equation 4 is $I(2)$ series is conducted using the Dickey Fuller generalized least squares (DF-GLS) test (Elliot et al., 1996). The results indicate that the null hypothesis of a unit root cannot (can) be rejected for any of the levels (first differences) of the variables at the 10% level (Table 1), suggesting that all the series are $I(1)$ processes. Because of inability of the DF-GLS to capture the possibility of a structural change, however, the power of the DF-GLS test is likely to decrease with an undetected structural break in the series, thereby providing misleading results. For completeness, therefore, we investigate unit roots in the existence of a structural break using the Zivot and Andrews (ZA) test. The results shows that the null hypothesis cannot (can) be rejected for the levels (first differences) of im_t and y_t but can be rejected for the level of rp_t (Table 1), indicating that im_t and y_t are $I(1)$ processes and rp_t is $I(0)$ process, respectively. Unlike conventional cointegration methods, therefore, the *F*-test is still applicable after taking into account a structural break in the series, proving that the use of the ARDL model is indeed desirable to deal with the current issue.

Table 1. Results of DF-GLS and Zivot-Andrew unit root tests

Variable	DF-GLS test			
	Level		First difference	
$\ln im_t$	-2.23 (1)		-4.83** (7)	
$\ln y_t$	-0.95 (1)		-5.68** (2)	
$\ln rp_t$	-1.42 (4)		-5.30** (3)	
Variable	Zivot-Andrew Test			
	Level	Time break	First difference	Time break
$\ln im_t$	-3.99 (3)	2008:4	-5.33** (3)	1998:4
$\ln y_t$	-2.82 (3)	2008:4	-5.65** (3)	1991:1
$\ln rp_t$	-5.02** (3)	2007:4		

Notes: ** and * denote rejection of the null hypothesis at the 5% and 10% levels, respectively. The 5% and 10% critical values for the DF-GLS (Zivot-Andrew), including a constant and trend, are -3.03 (-4.80) and -2.74 (-4.58), respectively. Parentheses are lag lengths.

As discussed above, the first step of the ARDL approach requires the application of the *F*-test in order to identify whether the long-run (cointegration) relationship among the three variables (m_t, y_t and rp_t) exists or not. The results show that the calculated *F*-statistic (4.39) is above the upper critical value (4.19) at the 10% level, (Note 5) thereby rejecting the null hypothesis of no cointegration, suggesting there exists the long-run equilibrium relationship between Korea's import demand and its major determinants over the period 1989-2014.

Table 2. Results of estimated long-run coefficients

Variable	Coefficient	*t*-ratio
$\ln y_t$	1.88	21.07**
$\ln rp_t$	-0.01	-0.03
dum_t	-0.53	-1.83*
constant	-4.18	-9.89**

Notes: ** and * represent statistical significance at the 5% and 10% levels, respectively.

With the identified long-run relationship among the three variables, the long-run coefficients and the associated short-run coefficients are then estimated based on the selected ARDL model defined by Equation 4. To that end, the maximum lag of six is chosen based on the Akaike Information Criterion (AIC). The estimates of the long-run coefficients are shown in Table 2. The estimated coefficient on the real GDP carries a positive sign and is statistically significant at the 5% level, indicating that economic growth in Korea tends to increase imported products for Korea in the long-run; for example, a 1% increase in economic growth pushes the Korean imports to increase by 1.88%. This empirical evidence substantiates the findings of Mah (1993), Bahmani-Oskooee and Rhee (1997), Tang (2005), Baek (2012 and 2013). On the other hand, the estimated coefficient on the relative price carries a negative sign as expected but is found to be statistically insignificant even at the 10% level, suggesting that changes in relative price do not seem to have a significant effect on Korean imports in the long-run. This finding is at odds with other studies (e.g., Mah, 1993 and 2000), which argue for a strong, negative effect of the relative price on Korean imports. Finally, the estimated coefficient on the dummy variable is significantly negative at the 10% level, implying that the recent financial crisis indeed reduces Korean imports.

The estimates of the short-run (including an error-correction term) are summarized in Table 3. The results show that, as seen in the long-run findings, the real income of Korea has a significant effect on Korean imports in the short-run. Similarly, the recent financial crisis is also found to have a significant short-run effect on Korean imports. Unlike the long-run results, however, the relative price is found to be statistically significant at least at the 10% level, indicating that the relative price is an important determinant of Korea's imports in the short-run. It is important to note that the error-correction term (ec_{t-1}) is negative and statistically significant at the 5% level, which is another sign of cointegration (Kremers et al., 1992; Banerjee et al., 1998). In addition, the estimated coefficient of ec_{t-1} reflects the adjustment speed toward the long-run equilibrium. The coefficient of -0.15 in the model, for example, means that approximately 15% of the adjustment takes place within one quarter; in other words, it takes more than 6 quarters (e.g., 1/0.15 =6.67 quarters) in order to achieve the long-run equilibrium.

Finally, the estimated ARDL model passes all the diagnostic tests (Table 3). For example, the Lagrange Multiplier (LM) and Ramsey's RESET statistics are used to test for serial correlation and for model specification, respectively. Both statistics are distributed as χ^2 with different degrees of freedom. The calculated LM statistic using four degrees of freedom is found to statistically insignificant at the 10% level, supporting serial correlation free residuals. The calculated RESET statistic with on degree of freedom is also found to be statistically insignificant, suggesting that our ARDL model is correctly specified.

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Table 3. Results of error-correction equation of Korea's imports

Variable	Coefficient	t-ratio
$\Delta \ln y_t$	2.85	9.88**
$\Delta \ln y_{t-1}$	0.63	2.19**
$\Delta \ln y_{t-2}$	-0.22	-0.86
$\Delta \ln y_{t-3}$	-0.36	-1.51
$\Delta \ln y_{t-4}$	0.61	2.69**
$\Delta \ln rp_t$	-0.14	-1.89*
$\Delta \ln rp_{t-1}$	0.22	2.92**
dum_t	-0.08	-2.49**
ec_{t-1}	-0.15	-2.89**
$\chi^2_{SC}(4)$=**2.14 [0.71]**, $\chi^2_{FF}(1)$=**1.50 [0.22]**, $\chi^2_N(2)$=**1.17 [0.56]**, $\chi^2_H(1)$=**0.06 [0.80]**		

Notes: ** and * denote statistical significance at the 5% and 10% levels, respectively. ec_{t-1} indicates an error-correction term. $\chi^2_{SC}(4)$, $\chi^2_{FF}(1)$, $\chi^2_N(2)$, and $\chi^2_H(1)$ denote chi-square statistics to test for no serial correlation, no functional form misspecification, normality and homoskedasticity, respectively. Brackets are *p*-values.

4. Conclusions and Policy Implications

In this short paper, we empirically reexamine Korea's import demand equation. To address this issue adequately, we adopt an enhanced time series econometrics - an autogressive distributed lag (ARDL) bounds testing approach to cointegration. Furthermore, we pay close attention to an important time series issue related to how we should incorporate a potential structural break in our modeling. Although the use of the ARDL method does not radically change the findings of previous studies on the issue, it does make a substantive difference to the estimates of some variables, which is the main contribution of this paper.

The results show that there exists the long-run relationship between Korea's import demand and its major determinants such as domestic income and price. We also find that economic growth plays a pivotal role in influencing Korea's imports in both the short- and long-run. On the other hand, price is found to be an important determinant in Korea's imports in the short-run, but not in the long-run. Finally, the market shock such as the recent financial crisis is found to significantly reduce Korea's imports in the short- and long-run.

An important implication of our findings is that, given the significant income impact on Korea's imports, Korea's recovery from the recent slow growth – an average GDP growth rate of 0.6% over the past three years - is likely to increase Korea's demand for imports, thereby causing the trade surplus to deteriorate. Another important implication is that, since Korea's imports seem to significantly respond to changes in relative prices in the short-run, a depreciation of the Korean won may lead to an increase in inflation as Korean prices of imported products tend to increase. This thus explains why simultaneous analysis of the short- and long-run is crucial in modeling the determinants of Korea's import demand.

It should be pointed out that, since our analysis is conducted using aggregate import data between Korea and the rest of the world, the findings may suffer from the so-called aggregation bias problem (Baek, 2011; Baek, 2014); that is, within aggregate imports some of significant factor impacts (e.g., income and relative prices) are likely to be offset by other insignificant effects, thereby resulting in insignificant impacts. Future research should address this issue by employing disaggregate trade data in a modeling.

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Notes

Note 1. It should be pointed out that several studies – for example, Tang (2005), Bahmani-Oskooee et al. (2012) and Baek (2012 and 2013) - use the ARDL cointegration approach in examining Korea's import demand function. However, they do not incorporate structural breaks in their modelling. Furthermore, some studies tackle the issue with a relatively small size (i.e., Tang, 2005; Bahmani-Oskooee et al., 2012). Since a small sample size tends to increase sampling variances through a decrease in the sample variation in each of explanatory variables, this problem may cause the estimated coefficients in a model to be very sensitive to its specifications and even inefficient, thereby undermining the credibility of their findings (Wooldridge, 2013).

Note 2. It is worth mentioning that in this analytical framework, other factors such as exchange rate, market structure and trade barriers are assumed to affect import demand through changes in relative prices (Tang, 2005).

Note 3. Quarterly data for the period 1989:1-2014:2 are obtained from the Organization for Economic and Cooperation Development (OECD) statistical database.

Note 4. This break is identified based on the ZA test (see the empirical results section) and involves the recent financial crisis that peaked in 2008.

Note 5. The critical value bounds are generated for the sample size (n=102) and 20,000 replications using the statistical software known as Microfit 5.