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Analyzing a Long-Run Relationship between Exports and Imports Revisited: Evidence from G-7 Countries

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Abstract

The main objective of this study is to provide an up-to-date and robust assessment of the long-run relationship between exports and imports in the G-7 countries. Using an expanded sample size and an enhanced econometric technique - autogressive distributed lag (ARDL) bounds testing approach to cointegration, our results show that exports and imports are cointegrated for five out of the seven countries and the estimated long-run coefficients are less than one.

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1. Introduction

Many studies have sought to identify the existence of a long-run (cointegration) relationship between exports and imports in developing and developed countries (Table 1). Examples include Bahmani-Oskooee and Rhee (1997), Apergis et al. (2000), Arize (2002), Dulger and Ozdemir (2005), Narayan and Narayan (2005), Holmes (2006), Kalyoncu (2006), Herzer and Nowak-Lehmann (2006), Lau et al. (2006), Kim et al. (2009), and Chen (2011). If the nation's exports and imports are cointegrated, for example, it suggests that its trade deficit is a short-run phenomenon during which its exports and imports drift apart and thereby the long-run equilibrium relationship would be obtained given shifts in macroeconomic policies. If exports and imports are not cointegrated, on the other hand, the country's trade deficit is not sustainable. This, in turn, implies that a huge trade deficit for the country may lead to a balance-of-payment crisis and its default on external debts in the near future.

The existing research has typically used either country-specific time series data or panel data of a group of countries to tackle the issue. However, the empirical studies that have adopted country-specific time series data (mainly in the unit root and cointegration framework) have mostly been conducted with a relatively small sample size (usually less than 40 annual observations). It is known that, when dealing with small numbers of observations, the standard tests for unit roots and cointegration may suffer from their probable poor size and power properties (Harris and Sollis, 2003) – for example, the tendency to over-reject (under-reject) the null when it is true (false), thereby raising questions about the validity of the results. By assuming that a single country's experience (i.e., economic development trajectory and trade patterns) would mirror the pattern revealed by a group of countries, on the other hand, the results of the panel studies are likely to suffer from what is known as aggregate bias problem. Due to these shortcomings, therefore, there remains a strong need for improved and up-to-date analysis of this issue.

The primary contribution of this paper is to re-examine the existence of a long-run relationship between exports and imports for the G-7 countries, using recent advances in time series econometrics and an expanded sample size. The G-7 countries, officially known as the group of seven industrialized countries, are made up of the seven wealthiest developed countries such as Canada, Japan, France, Germany, Italy, the United Kingdom (UK) and the United States (US). To achieve the main objective, we first apply an autogressive distributed lag (ARDL) bounds testing approach to cointegration developed by Pesaran et al. (2001) to quarterly data for 1989:Q1-2013:Q4 (100 observations). The bounds test for cointegration is proven to be more robust and perform better for finite sample size than conventional cointegration analysis (Pesaran et al., 1999). In addition, the bounds test is relieved of the burden of establishing the same order of integration (i.e., integrated of order one, or $I(1)$) among variables and of pretesting for unit roots; hence, it is a convenient tool to examine the cointegrating relationship when variables used in the model are not known with certainty whether the series are $I(1)$ or $I(0)$. Further, unlike the standard cointegration methods (i.e., Johansen test), the bounds test allows the use of different optimal number of lags to different variables in a model. Hence, it enables us to conduct appropriately constructed and comprehensive analyses for identifying the cointegrating relationship between exports and imports. We then apply three different methods - fully modified least squares (FMOLS), dynamic least squares (DOLS) and canonical cointegration regression

(CCR) – to the same dataset so as to establish robustness of our empirical findings. Considering the pivotal role that the current account sustainability plays in affecting a country's economic growth and development, using complementary approaches is indeed desirable to draw more balanced and robust conclusions. We hope that our effort contributes to better knowledge of the complementary features of different modeling strategies and of the different policy implications of current account imbalances on an individual country. The remaining sections present theoretical framework, empirical methodology, estimations results, and conclusions.

2. A Theoretical Framework

In examining the long-run relationship between exports and imports, economists generally rely on a theoretical framework developed by Husted (1992). In this model the current period budget constraint of the individual economy is stated as follows:

$$C_0 = Y_0 + B_0 - I_0 - (1+r_0)B_{-1} \tag{1}$$

where C_0 is the current consumption; Y_0 is the output; B_0 is the international borrowing and could be positive or negative; I_0 is the investment; r_0 is the one period world interest rate; and $(1+r_0)B_{-1}$ is the initial size of external debt. Because Eq. (1) must hold for every period, a budget constraint in every period can be combined to derive the economy's *intertemporal budget constraint*, stating that the amount a country borrows (lends) in international markets equals the present value of the future trade surpluses (deficits).

For the purpose of deriving an empirically testable model from Eq. (1), Husted (1992) makes several assumptions – for example, the world interest rate is stationary with mean r, and exports and imports are nonstationary – and modifies Eq. (1) with exports (X_t) and imports (M_t) of good and services as follows:

$$X_t = \psi_0 + \psi_1 M_t + e_t \tag{2}$$

Eq. (2) can be used to test the *weak* and *strong* conditions for the intertemporal budget constraint. The weak condition (necessary condition) for the intertemporal budget constraint holds when e_t is found to be a stationary process. The strong condition (necessary and sufficient condition), on the other hand, holds when $\psi_1 = 1$ and e_t is found to be a stationary process. In time series modeling, for example, if X_t and M_t are both nonstationary processes, then under the weak (strong) condition, they are cointegrated (with the cointegrating vector (1, -1)).

3. The ARDL Bounds Testing Approach to Cointegration

The ARDL bounds testing approach to cointegration is used to examine the existence of the long-run relationship between exports and imports in the G-7 countries. To explain the bound testing procedure, we start with a vector of two variables z_t , where $z_t = (y_t, x_t')'$, y_t is the dependent variable and x_t is a vector of regressor. Following Pesaran et al. (2001), we then formulate the conditional error correction model (ECM) of interest as follows: [1]

$$\Delta y_t = \alpha_0 + \pi_{yy} y_{t-1} + \pi_{yx.x} x_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta x_{t-j} + \theta w_t + u_t \quad (3)$$

where α_0 is the constant; π_{yy} and π_{yx} are the long-run parameters; δ_i and γ_i are the short-run parameters; w_t is a vector of exogenous variables (i.e., dummy variables). The bounds test procedure for identifying for the existence of a long-run relationship between y_t and x_t is through the testing of the joint significance of the lagged levels of variables (y_{t-1} and x_{t-1}) in Eq. (3). This is equivalent to testing the null hypothesis of $H_0 : \pi_{yy} = 0, \pi_{yx.x} = 0'$ (no cointegration) against the alternative hypothesis of $H_1 : \pi_{yy} \neq 0, \pi_{yx.x} \neq 0'$, using the standard *F*-test.[2] Pesaran et al. (2001) provide two sets of critical values covering all possible classification of the variables into $I(0)$ or $I(1)$ processes; for example, the upper bound values assume that all the variables are $I(1)$, and the lower bound values assume that they are $I(0)$. If the computed F -statistic falls outside the critical value bounds, a conclusive decision can be made; for example, if the computed *F*-statistic is higher (lower) than the upper (lower) bound of critical values, then the null of no cointegration can (cannot) be rejected. If the *F*-statistic falls inside these bounds, inference is inconclusive.

4. Empirical Results

4.1. Data

The data set for the G-7 countries contains 100 quarterly observations for the period 1989:Q1 to 2013:Q4 and is collected from the Organization for Economic and Cooperation Development (OECD) statistical database. All variables are in natural logarithms.

4.2. Unit root test: identifying $I(2)$ variables

Unlike conventional application of cointegration analysis, the bounds test for cointegration can be applicable even when it is not known with certainty whether the underlying regressors are $I(1)$ or $I(0)$; hence, this method does not require a unit root test to determine the

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[1] Key assumptions in the ARDL bounds testing are: (1) variables (y_t and x_t) in Eq. (3) are purely *I*(1), purely *I*(0) or cointegrated; (2) the errors u_t are serially uncorrelated; (3) the errors u_t are uncorrelated with Δx_t – that is, exogeneity of Δx_t; and (4) the cointegration rank is at most one, which is equivalent to single equation analysis.

[2] After the appropriateness of the four assumptions are investigated – for example, assumption (1) in Table 2 and assumptions 2-4 in Table 3, the joint hypothesis $\pi_{yy} = 0$ and $\pi_{yx.x} = 0'$ in Eq. (3) is tested to determine if exports and imports are cointegrated. Once cointegration is established, the error-correction components of Eq. (3) is set equal to zero and the long-run effects are derived by normalizing $\pi_{yx.x}$ on π_{yy}.

order of integration each variable exhibits.[3] Ouattara (2004), however, proves that the bounds test cannot be applicable to $I(2)$ processes. Before implementing the bounds test, therefore, it is necessary to conduct a unit root test and to ensure that all the variables are *not* $I(2)$ variables.

Whether we have $I(2)$ variables in the model is determined using the Dickey Fuller generalized least squares (DF-GLS) test (Elliot et al., 1996). Table 2 presents the results of the DF-GLS tests for a unit root in 14 variables. The results show that the null hypothesis of a unit root cannot be rejected for 11 out of the 14 level series at the 5% level, but can be rejected after first-differencing, indicating that they must be $I(1)$ variables. For the remaining three variables, on the other hand, the null hypothesis of a unit root can be rejected at least at the 5% level, suggesting that they are stationary $I(0)$ processes. From these findings, therefore, we conclude that all the variables must be either $I(0)$ or $I(1)$ processes and the bounds test can be pursued on them safely.

4.3. The bounds test for cointegration: are exports and imports cointegrated?

In the bounds test framework, the *F*-test is used to determine the existence of the long-run relationship between the variables. Since there is a possibility of bidirectional causality between exports and imports, each variable in the model - X_t and M_t - is taken as the dependent variable in calculating the *F*-statistics. Table 3 summarizes the results of the bounds test for cointegration. The results show that, when X_t (M_t) is the dependent variable - $F(X_t|M_t)$ ($F(M_t|X_t)$), the calculated *F*-statistics are higher than the upper critical value (5.73) at the 5% level for Canada, France, Japan and UK (Germany), thereby rejecting the null hypothesis of no cointegration. This indicates that exports and imports in those countries have a tendency to converge to a long-run equilibrium and their trade imbalances are indeed sustainable in the long-run. This further suggests that for Canada, France, Japan and UK (Germany), there exists a long-run relationship between variables only when X_t (M_t) is used as the dependent variable, and the variable M_t (X_t) can be treated as the "long-run forcing" variable in explaining X_t (M_t) in our model. For Italy and US, on the other hand, the calculated *F*-statistics are far below than the lower critical value (4.94) at the 5% level in both cases, thereby supporting lack of cointegration. This suggests that the intertemporal budget constraint does not hold for these two countries; in other words, since the discrepancy between exports and imports (as a share of total output) tends to grow without bounds, the growth in international indebtedness may be unsustainable over time. Note that, since the specification in Eq. (3) is based on the assumption that the error terms u_t are serially uncorrelated, Lagrange multiplier (LM) test is used to test the null hypothesis of no serial correlation against order 1 ($\chi^2(1)$). The results show that the null hypothesis cannot be rejected

[3] Unit root tests are prerequisite to conduct conventional cointegration approaches (i.e., Johansen test). Because of inability of the standard unit root tests (e.g., ADF-type tests) to capture the possibility of a structural break, however, the size and power of those tests are likely to deteriorate with an undetected structural break in the series, thereby providing misleading results associated with unit roots and cointegration tests. Under the ARDL approach, on the other hand, variables could be a combination of $I(0)$ and $I(1)$; hence, the ARDL overcomes the potential shortcoming of unit roots. Further, the ARDL is able to capture a structural break simply by incorporating dummy independent variables in the equation.

at the 5% level for all cases, indicating that our models do not suffer from serial correlation (Table 3).

Since exports and imports are cointegrated for Canada, France, Germany, Japan and UK, we use the selected ARDL model outlined by Eq. (3) to estimate the long-run coefficients. For this purpose, based on the Akaike Information Criterion (AIC), the maximum number of lag length is set to eight. Table 4 reports the estimated long-run coefficients. The results show that all coefficients are positive and statistically significant at the 5% level, indicating that higher imports (exports) lead to higher exports (imports) for Canada, France, Japan and UK (Germany). However, the estimated coefficients of those countries are less than one, ranging from a low of 0.60 (Japan) to a high of 0.91 (Canada), suggesting that the necessary and sufficient condition for the intertemporal budged constraint does not hold for these countries. It is important to emphasize that, since a highly significant error-correction term is further evidence of the existence of a stable long-run relationship between the selected variables, the associated error correction terms are also estimated within the ARDL framework (Table 4). The results show that the coefficients of the error-correction terms are negative and statistically significant at the 5% level for all five countries. Finally, the Cumulative Sum (CUSUM) and CUSUM of squares tests show that the parameters are generally stable over time (Table 4); hence, our selected ARDL models seem to be well-specified.

Finally, for the purpose of the robustness check, we also estimate Eq. (3) by employing three different alternative methods such as fully modified least squares (FMOLS), dynamic least squares (DOLS) and canonical cointegration regression (CCR) (Table 5).[4] The results show that, as found in the ARDL analysis, a rise in imports (exports) increases exports (imports) for Japan and UK (Germany), and the estimated coefficients are less than unity. It is thus concluded that the estimation results generated by the three alternative methods are remarkably consistent with our findings obtained from the ARDL approach, which we believe can shed new light on the long-run behavior of the current account balance.[5]

5. Concluding Remarks

The main objective of this paper is to provide an up-to-date and robust assessment of the long-run relationship between exports and imports. To that end, an autogressive distributed lag (ARDL) bounds testing approach to cointegration is applied to the G-7 countries for the period 1989:Q1-2013:Q4. The results show that exports and imports are cointegrated for five out of the seven countries - Canada, France, Germany, Japan and UK, and the estimated long-run coefficients are less than one, indicating that only the necessary condition for intertemporal budget constraint holds for those countries. For Italy and the US, on the other hand, exports and imports are not found to be cointegrated, suggesting that trade imbalances in the two countries are not sustainable in the long-run.

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[4] Note that unlike the ARDL, the first requirement of the use of these methods is that the variables must be $I(1)$. The results of the unit root tests (Table 1), however, show that import variables for Canada and France are $I(0)$. Hence, these two countries are excluded for the robustness check. Once again, since under the ARDL variables could be a combination of $I(0)$ and $I(1)$, it is proven to be a more desirable approach for studying the long-run relationship between exports and imports.

[5] The author thanks a referee for raising the issue discussed here.

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TABLE 1: Summary of the Selected Studies on a Long-Run Relationship between Exports and Imports

Studies	Countries	Data	Methods	Results
Bahmani-Oskooee and Rhee (1997)	Korea	1963-1991 (quarterly)	Johansen cointegration test	Cointegrated
Apergis et al. (2000)	Greece	1969-1994 (annual)	Gregory-Hansen cointegration test	Cointegrated
Arize (2002)	50 countries	1973-1998 (quarterly)	Johansen cointegration test	Cointegrated for 31 countries
Dulger and Ozdemir (2005)	G-7 countries	1974-2001 (quarterly)	Fractional unit root test	Cointegrated only for France, Italy and Canada
Narayan and Narayan (2005)	22 least developed countries	1960-2000 (annual)	ARDL, DOLS, Philip-Hansen, Engle-Granger	Cointegrated for 6 countries
Herzer and Nowak-Lehman (2006)	Chile	1975-2004 (annual)	Gregory-Hansen cointegration test	Cointegrated
Holmes (2006)	11 OECD countries	1980-2002 (quarterly)	Panel cointegration	Cointegrated for 6 countries
Kalyoncu (2006)	22 OECD countries	1960-2004 (annual)	Panel unit root tests	Cointegrated
Lau et al. (2006)	Indonesia, Korea, Malaysia, Philippines and Thailand	1976-2001 (quarterly)	Panel unit root tests	Cointegrated
Kim et al. (2009)	Indonesia, Korea, Malaysia, Philippines and Thailand	1981-2003 (quarterly)	Nonlinear unit root test	Cointegrated for 5 countries
Chen (2011)	8 OECD countries	1970-2009 (quarterly)	Nonlinear unit root test	Cointegrated only for Belgium

TABLE 2: Results of Dickey-Fuller Generalized Least Squares (DF-GLS) Test

Variable	Canada	France	Germany	Italy	Japan	UK	US
$\ln X_t$	-2.79 (2)	-2.98 (1)	-2.30 (2)	-2.89 (1)	-3.08* (2)	-2.07 (7)	-2.20 (3)
$\Delta \ln X_t$	-3.71** (4)	-5.76* (1)	-5.13** (2)	-5.91** (1)		-3.28** (7)	-4.17** (3)
Decision	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)
$\ln M_t$	-3.85** (1)	-3.30* (1)	-2.83 (2)	-2.37 (2)	-2.73 (2)	-2.19 (7)	-2.71 (2)
$\Delta \ln M_t$			-4.71** (2)	-5.18** (2)	-5.01** (2)	-3.50* (7)	-5.77** (2)
Decision	I(0)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)

Note: ** and * indicate rejection of the null hypothesis at the 1% and 5% levels, respectively. The 1% and 5% critical values for the DF-GLS, including a constant and trend, are -3.58 and -3.03, respectively. Parentheses are lag lengths chosen by a modified AIC (MAIC).

TABLE 3: Results of ARDL Bounds Testing Approach to Cointegration

Country	$F(X_t \mid M_t)$		$F(M_t \mid X_t)$	
	F-statistic	$\chi^2(1)$	F-statistic	$\chi^2(1)$
Canada	6.18	0.07 [0.79]	1.43	1.33 [0.25]
France	6.34	0.13 [0.72]	4.35	0.90 [0.34]
Germany	1.91	1.10 [0.29]	7.25	0.71 [0.40]
Italy	1.90	0.33 [0.57]	1.99	0.08 [0.78]
Japan	9.17	0.57 [0.45]	4.44	0.25 [0.62]
UK	8.20	0.70 [0.40]	2.84	0.01 [0.96]
US	0.96	0.09 [0.76]	1.34	0.05 [0.82]

Note: The upper (lower) bound critical value for F-statistic with unrestricted intercept and no trend at the 5% significance level is 5.73 (4.94). Parentheses are p-values. $\chi^2(1)$ is LM statistic for testing no serial correlation against order 1.

TABLE 4: Results of Estimated Long-Run Coefficients

Country	Long-run coefficient	EC_{t-1}	CUSUM	CUSUMSQ
Canada	0.91** (21.50)	-0.14** (-3.08)	Stable	Stable
France	0.76** (13.69)	-0.09** (-2.71)	Stable	Stable
Germany	0.91** (46.04)	-0.23** (-3.80)	Stable	Stable
Japan	0.60** (11.26)	-0.18** (-3.41)	Stable	Unstable
UK	0.79** (28.71)	-0.34** (-4.00)	Stable	Stable

Note: ** and * denote significance at the 1% and 5% levels, respectively. Parentheses are t-statistics. EC_{t-1} is an error-correction term.

TABLE 5: Results of Estimated Long-Run Coefficients using FMOLS, DOLS and CCR

Country	FMOLS	DOLS	CCR
Germany	0.93**	0.93**	0.93**
	(54.87)	(56.79)	(54.96)
Japan	0.71**	0.72**	0.71**
	(27.52)	(27.91)	(27.51)
UK	0.83**	0.83**	0.83**
	(35.09)	(35.92)	(35.16)

Note: ** and * denote significance at the 1% and 5% levels, respectively. Parentheses are t-statistics.