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Empirical analysis of import demand behavior of least developed countries

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Abstract

This paper examines the long-run stability of import demand function in Least Developed Countries (LDC) using recently developed panel cointegration techniques. We test for cointegration using two data sets: a) annual data for 15 countries between 1965 and 2004 and b) annual data for 22 countries between 1984 and 2004. We find that cointegration is present and that, indeed, there is a stable import demand function in these economies. The income elasticity ranges from 1.26 to 1.69 and price elasticity ranges from -0.72 to -0.75.

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1. Introduction

The growth and development of a country's economy promotes and deepens economic transactions with other countries in the process. In particular, the import and export of goods and services is an essential factor in the sustainable expansion of a domestic economy in terms of both demand and supply. In the initial stages of economic development, the level of capital accumulation and quality of labour force are generally low. Hence, domestic output is low, and it is difficult to allocate domestic demand such as consumption and investment. Moreover, exports to other countries are limited to primary goods (mainly natural resources) and tend not to be a very large share of the overall economy.

In less-developed and developing countries, this peculiar macroeconomic structure means that medium- to long-run trends in imports play an important role. These economies are small, which makes them vulnerable to economic fluctuations of their trading partners and the global economy. Import prices, for example, are significantly affected by exchange rate volatility due to fluctuations in international financial markets as well as speculative trade in primary goods on a global scale and the accompanying surges in market conditions. In addition, these regions tend to lack adequately organised and finely tuned macroeconomic policy management, which means short-term domestic economic fluctuations can become serious swings. These conditions are a notable characteristic of countries with small-scale economies.

Further, the behaviour of import demand is very important for applied work. It is central to basic tasks such as gross domestic product (GDP) forecasting and the impact of exchange rate changes on the current account. Such questions arise daily in the work of central banks, investment bank analysis and multilateral organisations such as the International Monetary Fund (IMF). However, until now there have been no reliable estimates for the least developed countries (LDCs), and this paper attempts to fill this gap.

The United Nations Conference on Trade and Development (UNCTAD) defines LDCs as countries where the three-year average gross national income per capita is less than USD 750. As of 2003, 50 countries were grouped into this category (United Nations 2005). In these regions, imports accounted for roughly 45% of GDP (2002 average), nearly double that of G7 nations (approximately 24%). In other words, there is a high risk that the import trends in these regions, which are based on the instability of import prices and domestic income, will exert a destabilising impact on the macroeconomy as a whole. This exposes the vulnerability of an economy highly dependent on imports. Thus, it is significant that we carefully study the issue of long-run stability of the import function in LDCs.

The stability of the import function means that income elasticity and price elasticity—systematic factors of the import function—are fixed (largely unchanged) during the sample period. Examination and verification of this stability includes a number of vigorous empirical analyses from the perspective of functional form specification and structural change. Through Stern *et al*. (1976), Goldstein and Khan (1985), and Sawyer and Sprinkle (1999), it is possible to survey a broad range of leading research conducted to date. Much of the analysis on developing regions is limited to individual countries. A detailed survey is conducted in Sawyer and Sprinkle (1999). On the other hand, examination and verification that separate the unique features of developing regions as a whole are limited. Khan (1974), Hemphill (1974), Faini *et al*. (1992) and Reinhart (1995) represent some of the few examples, but none look at LDCs.

During the compilation of this research, the advances in econometrics since the 1980s, especially the development of non-stationary time series analysis, has reformed traditional methods of analysis, marking a major breakthrough. The method of cointegration tests makes it possible to precisely examine and verify a series with a long-run fixed relationship. This is a suitable method of analysis when examining and verifying the long-run stability among the variables of imports, income and import relative prices.

Hence, the import function of various countries has been vigorously analysed using the method of cointegration tests. These include the analyses of Matsubayashi and Hamori (2003) on the G7 countries; Carone (1996) on the U.S.; Mah (1994), Hamori and Matsubayashi (2001), Urbain (1996), and Masih and Masih (2000) on Japan; Dutta and Ahmed (1999) on Bangladesh; Dutta and Ahmed (2004) on India; and Razafimahefa and Hamori (2005) on Madagascar and Mauritius. Analysis through cointegration tests is attractive, but there are systematic problems, such as low testing power when the sample size is small. To overcome this difficulty, panel time series analysis was vigorously researched in the 1990s.

Harb (2005) conducted a pioneering analysis that applied panel time series analysis to the import demand function. His analysis involved the preparation of a panel series for 19 developed and 21 developing countries based on a time series of approximately 30 years, starting in 1970. First, the stability of the import function for both groups was examined and verified through cointegration tests developed by Pedroni (1999, 2004), with cointegrating vectors estimated simultaneously. Harb (2005) obtained interesting results that indicated an overall cointegrating relationship for both regions, with developed countries demonstrating higher income elasticity and developing countries demonstrating higher price elasticity.

This paper considers the leading research surveyed and conducts an analysis focused on the following three features, which have not been incorporated previously. The first feature is the examination and verification of the stability of the import function in LDCs through panel cointegration tests. As pointed out above, to date, no study has focused on the import function in LDCs, possibly because analysis is difficult with a relatively small sample size. It is likely that such difficulties can be overcome with the application of panel time series analysis. In Harb (2005), only one LDC, Burkina Faso, is included among the developing countries. Our empirical research, however, includes more than 20 LDCs.

The second feature is the rigorous examination of robustness. In Harb (2005), only one sample period is considered. On the other hand, our empirical study covers two sample periods, 1965 to 2004 and 1985 to 2004. Such examinations are suitable to check the problem of robustness due to a small sample size.

The third feature is that when there is a cointegrating relationship, it is possible to find the income elasticity and price elasticity in LDCs by estimating the cointegrating vector. There are already several examples of cointegrating vector estimates in the case of developed countries. A comparison with these results should make it possible to identify the unique import behaviour patterns of LDCs.

This paper is organised as follows: Section 2 presents the estimation equations and introduces and organises the data sets to be utilised. Section 3 discusses the results of a panel time series analysis. Section 4 summarises the knowledge obtained from this paper's analysis and its interpretation.

2. Model and Data

Following the traditional approach (Sawyer and Sprinkle 1999), we express the demand for imports as a function of real income and relative prices as follows:

$$\ln(IM_t) = \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(RP_t) + u_t, \tag{1}$$

where IM_t is real imports at time t, Y_t is the real GDP at time t, RP_t is the relative price at time t, and u_t is the error term with zero mean and finite variance. For example, Bahmanie-Oskooee and Ratha (2008) studied the exchange rate sensitivity of U.S. bilateral trade flows where an analogous import demand function is estimated.

Based on the availability of data, this paper analyses the import demand function using the following two data sets:

Case 1
Sample period: 1965–2004 (annual data)
Countries: Bangladesh, Benin, Burkina Faso, Burundi, Chad, Congo, Haiti, Lesotho, Madagascar, Malawi, Mauritania, Niger, Rwanda, Togo, Zambia (15 countries).

Case 2
Sample period: 1985–2004 (annual data)
Countries: Bangladesh, Benin, Burkina Faso, Burundi, Chad, Comoros, Congo, Ethiopia, Guinea, Haiti, Lesotho, Madagascar, Malawi, Mauritania, Mozambique, Myanmar, Niger, Rwanda, Senegal, Togo, Uganda, Zambia (22 countries).

The first data set uses the data of 15 countries over the period from 1965 to 2004. The second data set uses the data of 22 countries over the period from 1985 to 2004. The data were obtained from the World Development Indicators (World Bank). The real imports (in constant local currency units), real output (in constant local currency units) and real import prices are used for empirical analysis. Real import prices are obtained as the ratio of import prices to the GDP deflator. The data are expressed in logarithms.

Tables 1 and 2 illustrate the results of panel unit root tests on each of the variables for Case 1. Table 1 indicates the results on the level of each variable, while Table 2 presents the results of the first difference of each variable. We employed five types of tests: the Levin, Lin and Chu test; Breitung test; Im, Pesaran and Shin test; PP-Fisher chi-square test; and the PP-Choi test (Levin *et al.* 2002; Breitung 2000; Im *et al.* 2003; Choi 2001; Maddala and Wu 1999). The auxiliary regression for each test includes the individual effect and individual linear trend. As shown in Tables 1 and 2, each variable has one unit root in almost all cases.

Tables 5 and 6 illustrate the results of the panel unit root tests on each of the variables for Case 2. As demonstrated from these two tables, each variable is found to have one unit root in almost all cases.

3. Empirical Techniques

Two types of panel cointegration tests were conducted. The first was the residual-based panel cointegration test developed by Pedroni (1999, 2004). He proposed several tests for cointegration that allow for heterogeneous slope coefficients across cross-sections. This consists of seven component tests: the Panel v-test, Panel rho-test, Panel PP-test, Panel ADF test, Group rho-test, Group PP-test and Group ADF-test. In the null hypothesis, the residuals are nonstationary (i.e. there is no cointegrating relationship). In the alternative hypothesis, the residuals are stationary (i.e. there is a cointegrating relationship among the variables). However, for the first four tests it is assumed that the residuals under the alternative hypothesis have common AR coefficients, but for the remaining three tests, it is assumed that the residuals under the alternative hypothesis have individual AR coefficients. Pedroni (2000) demonstrates that the standardised test statistic is asymptotically normally distributed.

The second test employed was the Johansen-type panel cointegration test developed by Maddala and Wu (1999). They use Fisher's result to propose an alternative approach to test for cointegration in panel data by combining tests from individual cross-sections to obtain a test statistic for the full panel. There are two kinds of Johansen-type tests: one is the Fisher test from the trace test and the other is the Fisher test from the maximum eigenvalue test. In the Johansen-type panel cointegration test, we chose the lag order to be 1. If p_i is the *p*-value from an individual cointegration test for cross-section i, then under the null hypothesis for the panel,

$$-2\sum_{i=1}^{N}\log(p_i) \to \chi^2(2N), \tag{2}$$

where $\chi^2(2N)$ is a chi-square distribution with $2N$ degrees of freedom.

When we estimate the cointegrating vector for panel data, we cannot use the ordinary least squares, because we have a problem of endogeneity for repressors. In order to consider this problem, we use the fully modified ordinary least squares (FMOLS) proposed by Pedroni (2000).

4. Empirical Results

4.1 Case 1 (1965–2004, 15 countries)

First, we analysed the import demand function for Case 1. We conducted panel cointegration tests for the import demand function of the 15 countries over the period 1965 to 2004. Table 3 illustrates the results of panel cointegration tests for Case 1. As evident from Table 3, the null hypothesis (in which there is no cointegrating relationship) is rejected in nine of the eleven cases at the 5% significance level.

As the existence of the cointegrating relationship was supported, we estimated the import demand function using the FMOLS developed by Pedroni (2001). [Remark 5] Table 4 illustrates the estimation results. As is evident from this table, the sign condition of the import demand function holds for LDCs. The output elasticity was significantly estimated at a positive value of 1.26, while the relative price elasticity was significantly estimated at a negative value of −0.75.

It is clear from the above results that a cointegrating relationship is supported when using panel data for the region of LDCs; thus, the existence of the import demand function is statistically supported.

4.2 Case 2 (1985–2004, 22 countries)

Next, we analysed the import demand function for Case 2, which includes 22 countries over the period 1985 to 2004. Table 7 indicates the results of the cointegration tests. As demonstrated in this table, the null hypothesis (in which there is no cointegrating relationship) is rejected in nine of the eleven cases at the 5% significance level. Thus, it is evident that the existence of a cointegrating relationship is supported. Subsequently, we estimated the import demand function using FMOLS. Table 8 presents the estimation results. The sign condition of the import demand function holds for all cases. The output elasticity was significantly estimated at a positive value of 1.69, while the relative price elasticity was significantly estimated at a negative value of −0.72.

As is evident from the above results, a cointegrating relationship and the existence of an import demand function is statistically supported when using panel data for LDCs.

5. Implication of Empirical Results

We found that the import function in LDCs is in a cointegrating relationship and is stable overall. The factors behind this need to be evaluated. One point is that many of these regions have adopted an international monetary union (e.g. Western African Economic and Monetary Union, Central African Economic and Monetary Community) or a fixed exchange rate system, so the relative import price is likely to be stable compared with countries that have adopted flexible exchange rate systems. Therefore, they are likely to have a structure where import volume is not easily affected by unstable movements in import relative prices or exchange rates due to speculative trade or other factors.

A second point is that trade partners are largely unchanged over the long run. The

United Nations (2005) lists the import partners of each LDC and demonstrates that most are former suzerain powers from the colonial period or neighbouring developing countries.

The third point is that the imported items themselves remain largely unchanged in the long run. Generally, developing countries ought to promote industrial policies that advance their domestic supply capability and bring a change in imported items, from final consumer goods to intermediate goods, raw materials and otherwise. However, in the case of LDCs, which have been in a pre-industrialisation stage for a long time, it is difficult to expect a gradual change in the imported items themselves. These factors may, as a result, stabilise the import function.

Next, we take a detailed look at the value of the cointegrating vector. To reiterate the results of our analysis, the income elasticity of LDCs ranges from 1.26 to 1.69 and price elasticity ranges from −0.72 to −0.75. This does not differ substantially from the values for developing countries in Harb (2005): 1.07 for income elasticity; −0.79 to −0.84 for price elasticity.

Here, we describe the developing countries included in Harb (2005). Harb (2005) lists the following 19 countries as developing countries: Burkina Faso, Chile, Colombia, Costa Rica, Cyprus, India, Israel, Jordan, Kenya, Malaysia, Malta, Mauritius, Morocco, Pakistan, Philippines, South Africa, Sri Lanka, Thailand and Venezuela. Among them, only Burkina Faso is defined as a least developing country. The average GDP per capita of the 19 developing countries is approximately USD 4,291 (based on the 2000 standard). In contrast, the average GDP per capita of the LDCs (22 countries) that we have set as Case 2 is at a low level of approximately USD 324, indicating that the GDP per capita was less than 8% of the GDP of the countries listed by Harb (2005).

Thus, the income level in the economies of the LDCs that we analysed is extremely low compared with the other developing countries. This justifies the significance of classifying LDCs into a distinct category for analysis. It is possible to say that our latest verification is interesting for the following reason: it has suggested a new idea that the import behavioural pattern in extremely poor countries is almost identical to that seen for developing countries.

When conducting a comparison with the values for developed countries in Harb (2005) (1.69 for income elasticity; −0.32 to −0.39 for price elasticity), one interesting feature is that income elasticity is relatively low and price elasticity is relatively high for LDCs. In the case of LDCs, because many import items are final consumer goods and manufactured goods, and almost all are allocated to domestic demand (e.g. consumption, capital investment), it is possible that they are not easily impacted by short-term economic trends. However, because the level of import prices is likely to have a direct impact on the same items, it is possible that price elasticity is high. Meanwhile, developed countries arguably have relatively low price elasticity and high income elasticity because raw materials and intermediate goods account for a large share of imports, and these items are affected more by domestic economic trends than by import prices. The results of our current examination and verification are consistent with this reasoning and provide interesting information on the import behaviour patterns of LDCs.

6. Concluding Remarks

The import demand function is one of the most fundamental relationships among macroeconomic variables and its empirical investigation is widely documented in the literature of international economics. Therefore, it is important to know the determinants that yield stationary long-run relationships in an import demand function, that is, to examine the presence of a cointegrating relationship among the variables involved in an import demand model. If the variables included in an import demand function are cointegrated, then we can say that the import demand function is stable, and a cointegrating relationship exists over the period analysed.

In this study, we apply panel cointegration techniques to import demand data for LDCs.

The reason this combination is fruitful is that data are often scarce for these countries, and thus, conventional cointegration tests—which involve only one country—would not be feasible. The results in this paper would be of interest primarily for applied analysis such as forecasting performed by banks or international financial institutions. The estimates of import demand elasticities would be of particular interest for applied work. We used two cases: one consisted of 15 countries over the period 1965 to 2004, and the other 22 countries over the period 1985 to 2004. This study documents that there was a long-run import demand function in LDCs during the period analysed, and that the stimulation of domestic business conditions in LDCs will inevitably be linked to the quantity of imports in both cases. Thus, policy makers in LDCs should pay attention to not only domestic balances but also external balances when implementing related policies.

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Table 1 Panel Unit Root Tests: Level
(Case 1: 1965–2004, 15 countries)

Variable	Method	Test Statistic	*p*-value
$\ln(IM_t)$	Levin, Lin, and Chu test	-1.618	0.053
	Breitung test	-0.581	0.281
	Im, Pesaran, and Shin test	-0.349	0.363
	PP-Fisher chi-square test	29.894	0.471
	PP-Choi test	0.322	0.626
$\ln(Y_t)$	Levin, Lin, and Chu test	0.879	0.810
	Breitung test	3.719	1.000
	Im, Pesaran, and Shin test	1.724	0.958
	PP-Fisher chi-square test	22.261	0.844
	PP-Choi test	1.348	0.911
$\ln(RP_t)$	Levin, Lin, and Chu test	0.594	0.724
	Breitung test	-0.289	0.386
	Im, Pesaran, and Shin test	-1.989	0.023
	PP-Fisher chi-square test	37.410	0.166
	PP-Choi test	-0.819	0.206

Note:
Exogenous variables: Individual effects and individual linear trends.
Automatic selection of lags based on AIC: 0 to 6.
Newey-West bandwidth selection using Bartlett kernel.

Table 2 Panel Unit Root Tests: First Difference
(Case 1: 1965–2004, 15 countries)

Variable	Method	Test Statistic	p-value
$\ln(IM_t)$	Levin, Lin, and Chu test	-19.325	0.000
	Breitung test	-6.847	0.000
	Im, Pesaran, and Shin test	-17.022	0.000
	PP-Fisher chi-square test	564.098	0.000
	PP-Choi test	-19.280	0.000
$\ln(Y_t)$	Levin, Lin, and Chu test	-11.309	0.000
	Breitung test	-5.481	0.000
	Im, Pesaran, and Shin test	-13.946	0.000
	PP-Fisher chi-square test	414.610	0.000
	PP-Choi test	-17.502	0.000
$\ln(RP_t)$	Levin, Lin, and Chu test	-10.493	0.000
	Breitung test	-8.836	0.000
	Im, Pesaran, and Shin test	-14.252	0.000
	PP-Fisher chi-square test	634.006	0.000
	PP-Choi test	-20.410	0.000

Note:
Exogenous variables: Individual effects and individual linear trends.
Automatic selection of lags based on AIC: 0 to 6.
Newey-West bandwidth selection using Bartlett kernel.

Table 3 Panel Cointegration Tests:
(Case 1: 1965–2004, 15 countries)

	Test Statistic	*p*-value
(a) Pedroni Residual Cointegration Tests		
Panel v-stat	0.523	0.348
Panel rho-stat	-2.343	0.026
Panel PP-stat	-4.270	0.000
Panel ADF-stat	-2.363	0.025
Group rho-stat	-1.088	0.221
Group PP-stat	-3.849	0.000
Group ADF-stat	-2.788	0.008
(b) Johansen Fisher Panel Cointegration Tests		
(Lag order in first differences is one)		
Fisher Statistic from trace test	66.380	0.000
Fisher Statistic from maximum-eigenvalue test	59.510	0.001
(Lag order in first differences is two)		
Fisher Statistic from trace test	57.130	0.002
Fisher Statistic from maximum-eigenvalue test	44.460	0.043

Table 4 Panel FMOLS Results
(Case 1: 1965–2004, 15 countries)

Explained Variable	Explanatory Variables			
	$\ln(Y_t)$		$\ln(RP_t)$	
	Estimate	*t*-stat	Estimate	*t*-stat
$\ln(IM_t)$	1.26	(22.33)	-0.75	(-16.62)

Table 5 Panel Unit Root Tests: Level
(Case 2: 1985–2004, 22 countries)

Variable	Method	Test Statistic	*p*-value
$\ln(IM_t)$	Levin, Lin, and Chu test	-1.426	0.077
	Breitung test	2.760	0.997
	Im, Pesaran, and Shin test	-0.542	0.294
	PP-Fisher chi-square test	44.332	0.458
	PP-Choi test	-0.007	0.497
$\ln(Y_t)$	Levin, Lin, and Chu test	-1.671	0.047
	Breitung test	1.330	0.908
	Im, Pesaran, and Shin test	0.363	0.642
	PP-Fisher chi-square test	40.759	0.611
	PP-Choi test	1.303	0.904
$\ln(RP_t)$	Levin, Lin, and Chu test	-2.757	0.003
	Breitung test	-0.178	0.429
	Im, Pesaran, and Shin test	-1.608	0.054
	PP-Fisher chi-square test	55.527	0.114
	PP-Choi test	-1.320	0.094

Note:
Exogenous variables: Individual effects and individual linear trends.
Automatic selection of lags based on AIC: 0 to 6.
Newey-West bandwidth selection using Bartlett kernel.

Table 6 Panel Unit Root Tests: First Difference
(Case 2: 1985–2004, 22 countries)

Variable	Method	Test Statistic	p-value
$\ln(IM_t)$	Levin, Lin, and Chu test	-11.316	0.000
	Breitung test	-6.307	0.000
	Im, Pesaran, and Shin test	-11.789	0.000
	PP-Fisher chi-square test	451.194	0.000
	PP-Choi test	-15.496	0.000
$\ln(Y_t)$	Levin, Lin, and Chu test	-12.190	0.000
	Breitung test	-6.595	0.000
	Im, Pesaran, and Shin test	-11.920	0.000
	PP-Fisher chi-square test	280.554	0.000
	PP-Choi test	-12.203	0.000
$\ln(RP_t)$	Levin, Lin, and Chu test	-12.387	0.000
	Breitung test	-10.225	0.000
	Im, Pesaran, and Shin test	-12.998	0.000
	PP-Fisher chi-square test	342.175	0.000
	PP-Choi test	-14.180	0.000

Note:
Exogenous variables: Individual effects and individual linear trends.
Automatic selection of lags based on AIC: 0 to 6.
Newey-West bandwidth selection using Bartlett kernel.

Table 7 Panel Cointegration Tests:
(Case 2: 1985–2004, 22 countries)

	Test Statistic	*p*-value
(a) Pedroni Residual Cointegration Tests		
Panel v-stat	-0.043	0.399
Panel rho-stat	0.323	0.379
Panel PP-stat	-5.546	0.000
Panel ADF-stat	-6.191	0.000
Group rho-stat	2.252	0.032
Group PP-stat	-5.588	0.000
Group ADF-stat	-6.581	0.000
(b) Johansen Fisher Panel Cointegration Tests		
(Lag order in first differences is one)		
Fisher Statistic from trace test	119.500	0.000
Fisher Statistic from maximum-eigenvalue test	105.000	0.000
(Lag order in first differences is two)		
Fisher Statistic from trace test	173.300	0.000
Fisher Statistic from maximum-eigenvalue test	148.600	0.000

Table 8 Panel FMOLS Results
(Case 2: 1985–2004, 22 countries)

Explained Variable	Explanatory Variables			
	$\ln(Y_t)$		$\ln(RP_t)$	
	Estimate	*t*-stat	Estimate	*t*-stat
$\ln(IM_t)$	1.69	(34.64)	-0.72	(-17.18)