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Determinants of the Dominican Republic's Export Demand Function: Results from the Bounds Test for Co-integration

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ABSTRACT

This study presents an empirical examination of the Dominican Republic's aggregate export demand function under alternative growth and foreign exchange regimes during the periods of 1960-1984 and 1985-2005. Using the 'bounds' testing approach to co-integration and a method is developed to derive long-run price and income demand elasticities for exports, two export demand functions are estimated and both show the existence of a long-run (co-integrated) relationship between exports, relative prices and foreign income. During the era of inward-oriented growth (1960-1984), the estimated price elasticity of exports has the expected sign and is above unity, indicating that relative prices exerted an above-unity effect on exports. Moreover, the income-demand elasticity is above unity and shows that exports were strongly affected by foreign economic activity. During the era of outward-oriented growth (1985-2005), the price elasticity of demand is below unity and denotes that exports became price inelastic, indicating that devaluation could not be used to increase their growth. However, the income-demand elasticity, though slightly smaller than during the previous period, indicates that total exports continued to be income elastic.

Key words: Price/income export demand elasticities, foreign exchange regimes, error correction model, 'bounds' test

INTRODUCTION

In the early 1980's in response to a deceleration of growth and balance of payments difficulties attributed to trade distortions caused by an inward-oriented model the Dominican government began to put into practice an industrialization strategy designed to promote economic growth by expanding exports of light manufactures, non-traditional and agro-industrial products (World Bank, 1985). One important element of this Outward-oriented Industrial (OOI) policy framework was an export promotion program under Law No. 69 of 1979, which aimed to reduce the country's substantial reliance on traditional commodities and encourage exports of light manufactures, agro-industrial and non-traditional goods by granting both foreign exchange and fiscal incentives. The foreign exchange incentive scheme allowed exporters of these products to keep a fixed portion of their foreign exchange earnings by exempting them from the requirement that they surrender all these earnings to the Central Bank. In addition, products with a high content of domestically produced agricultural inputs and that required a greater incentive to promote their production and exportation could be granted a tax credit certificate. Exporters could also benefit from a provisional import arrangement that waived import duties on any foreign-made inputs used to manufacture non-traditional products as long as the merchandise was exported. The other and perhaps most important, component of this strategy originated with signing in 1983 of an International Monetary Fund (IMF) three-year Extended Fund Facility (EFF) agreement which called for the

implementation of various measures including the substitution of the government-set parity exchange rate system by a flexible-exchange rate regime and the devaluation of the Dominican peso in January 1985 by replacing the fixed one-to-one exchange rate between the Dominican peso and the US dollar with a D.R.\$3.10 = U.S.\$1.00 exchange rate. These changes in relative prices were the mechanism through which movements in the exchange rate were expected to generate growth of exports by making them more price competitive.

Using a recent development in econometric analysis of time series, this study estimates two export demand equations and derives long-run relative-price and income demand elasticities estimates for these functions employing a method developed by Bardsen (1989).

This study presents an empirical examination of the Dominican Republic's aggregate export demand function under alternative growth and foreign exchange regimes during the periods of 1960-1984 and 1985-2005. During the first period, this nation pursued an industrialization strategy whose principal objective was geared toward increasing production of previously imported nondurable consumer goods for the domestic market. The key element of this Inward-oriented Industrial (IOI) policy framework was an industrial promotion program that allowed chosen firms to import intermediate and capital goods used in their operations duty free and with foreign exchange from a preferential government-fixed parity system. Meanwhile, exporters were required to surrender their foreign exchange earnings to the monetary authorities at the cheaper government-determined rate system and not at a higher market-determined rate. In addition, the structure of Dominican exports overwhelmingly consisted of such agricultural commodities as sugar, coffee, cocoa and tobacco. Engels law suggests that the income elasticity of demand for these exports is generally lower than that for manufactured goods, meaning that a rise in income in the developed world will not necessarily translate into higher demand for primary products from the less developed countries. Therefore, the specific objectives of this paper are to determine whether: (1) during the 1960-1984 period Dominican exports had income and price elasticities of demand below unity and (2) the outward-oriented strategy executed during the post-1984 period lead to exports with income and price demand elasticities higher than those of the previous growth regime.

MATERIALS AND METHODS

The methodological framework for conducting the empirical analysis uses the recently developed 'bounds' testing approach to the analysis of level relationships of Pesaran *et al.* (2001). These researchers have developed a method for the analysis of time series that takes into consideration whether the variables under consideration are stationary or non-stationary. Failure to take into account the time series properties of the underlying variables can lead to spurious results and invalid inferences. One way to avoid the problems of 'spurious results' is to estimate a dynamic function which includes lagged dependent and independent variables, i.e., an Error Correction Model (ECM). Pesaran *et al.* (2001) have extended and formalized the ECM approach to test for the existence of co-integration between the dependent variable and its determinants. The theoretical logic behind the concept of co-integration is that although the dependent variable and its determinant (s) may be individually non-stationary, over the long-run they will nonetheless tend to move together, so that a linear combination of them will be stationary (Engle and Granger, 1987). Moreover, data generated by such a model are sure to be co-integrated (Granger 2004). This follows directly from Granger's Representation Theorem which states that if the dependent variable and the independent variable(s) are co-integrated, then an ECM representation generates co-integrated series (Engle and Granger, 1987). According to Harris (1995), the practical

implications of Granger's theorem for dynamic modelling are that it provides the ECM with immunity from the spurious regression problem, provided that the terms in levels co-integrate. The ECM-based bounds testing approach has been chosen to estimate the import demand functions for the following reasons. First, it does not require that the order of integration of the underlying regressors be ascertained prior to testing the existence of co-integration between the dependent variable and the independent variables. It thus eliminates the uncertainty associated with pre-testing the order of integration. Second, it can be applied to studies that have a small sample size, as is the case in the present inquiry. Several researchers applied this approach in relatively small sample sizes. Pattichis (1999) estimated a disaggregated import demand function for Cyprus employing annual data for 1975-1994 (twenty observations). Chang *et al.* (2005) calculated an import demand equation for South Korea using yearly data for 1980-2000 (twenty-one observations). Jeon (2009) employed the bounds testing approach to obtain estimates of the long-run income elasticity of demand for imports and exports in China during the period of 1979-2002 (twenty-four observations). Thus, in line with Pesaran *et al.* (2001), an export demand function for the Dominican Republic can be expressed within an Error Correction Model (ECM) as follows:

$$\begin{aligned} \Delta \log X = & \alpha_0 + \alpha_1 \log(RPX)_{t-1} + \alpha_2 \log Z_{t-1} + \alpha_3 \log X_{t-1} \\ & + \sum_{i=0}^{l_3} \alpha_4 \Delta \log(RPX)_{t-i} + \sum_{i=0}^{l_3} \alpha_5 \Delta \log Z_{t-i} + \sum_{i=1}^{l_3} \alpha_6 \Delta \log X_{t-i} + u_t \end{aligned} \quad (1)$$

where, Δ is the first difference operator, where X is exports at constant 1970 Dominican pesos, RPX is the relative price of exports (P_d/eP_f), where P_d is the implicit price deflator of the Dominican gross domestic product, e is the units of D.R. peso per units of U.S. dollar, or the domestic price of foreign currency and P_f is the U.S. consumer price index; Z is a measure of foreign income represented by the U.S. gross domestic product and u is the error term.

In performing the ECM estimation, the maximum number of lags of the terms in levels is set equal to one and on the first-difference variables the process starts off from a maximum of three lags, then the optimum number is chosen based on the Akaike's Information Criterion (AIC), the Ramsey RESET test and the R^2 . Thus, the formulation with the lowest AIC, the Ramsey RESET test results for the best-fit specification and the highest R^2 is selected. In Eq. 1 and following Bardsen, 1989, the long-run elasticity derived for the relative-price variable (Ψ) is $-(\alpha_1/\alpha_3)$ and for the income demand variable (π) is $-(\alpha_2/\alpha_3)$. After estimating Eq. 1 the Wald test is used to assess the significance of the lagged level explanatory variables by imposing the following restrictions on the estimated long-run coefficients of the export demand equation:

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = 0 \text{ (no co-integration exists)}$$

$$H_A: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0 \text{ (co-integration exists)}$$

Pesaran *et al.* (2001) provide two sets of critical value bounds covering the two polar cases of the included lagged level explanatory variables (Table 1). For a given significance level of the lagged level explanatory variables, if the calculated Wald F-statistic lies outside the respective

bounds of the critical values, then conclusive inference can be made about the characteristic of the underlying regressors without having to know their order of integration. If the computed F-statistic falls below the lower bound, for example, then this would lead us to conclude that there is no co-integration relationship between the terms in levels. If, on the other hand, the computed F-statistic exceeds the upper bound of the critical value, then the alternative hypothesis of a co-integrated relationship between the terms in levels will be accepted.

The empirical analysis uses annual statistics. Following Sanz *et al.* (1999) the data used in the econometric analysis were converted into index numbers with 1960 = 100 and 1985 = 100. Data on the Dominican Republic's exports of goods and services were downloaded from the Dominican Central Bank's web site. They are available in current and in constant 1970 pesos for the period 1970 to 2005 and have been used to calculate the export price indexes. Data for the pre-1970 period were obtained from Marti, (1997). Data on the exchange rate between the Dominican peso and the United States dollar are from the International Monetary Fund's International Financial Statistics Year book. Data for the United States gross domestic product were obtained from the Bureau of Economic Analysis. The implicit GDP deflator and the Consumer Price Index (CPI) for the United States were downloaded from Economic History Services (EH.net).

RESULTS AND DISCUSSION

Table 2 contains the estimates of the export function for the 1960-1984 period. The Wald F-statistic is 4.58 and exceeds the upper bounds value [I (1)] of 4.14 at a 10 percent level of significance (Table 1). This result shows that during the era of inward-oriented industrialization there existed a co-integrated relationship between total exports, relative prices and foreign income. The variable for the estimated long-run relative price elasticity of exports (-2.10) has the expected sign and its high value indicates that Dominican exports were price elastic. Moreover, the estimated long-run foreign income demand elasticity of exports shows that Dominican exports were income elastic. Specifically, a one percent rise in United States economic activity produced 1.88% increase on total exports. The estimated equation passes the battery of diagnostic tests up to third order. The Breusch-Godfrey's LM test for serial correlation rejects the presence of serial correlation. The ARCH test rejects the existence of first and second order heteroskedasticity in the disturbance term. The Ramsey RESET specification test shows no general equation specification error. Lastly, the plots of CUSUM and CUSUM of Squares tests (Fig. 1 and 2) reveal that the estimated parameters are stable over the sample period.

Table 3 summarizes the estimates of the export function for total exports for the 1985-2005 period. The Wald F-statistic is 5.42 and exceeds the upper bounds value [I(1)] of 4.14 at 5 and 10% levels of significance (Table 1). This result shows that during the era of outward-oriented industrialization there existed a co-integrated relationship between exports, relative prices and

Table 1: Critical value bounds for the wald F-statistic

Level of significance (%)	Lower bound value I (0)	Upper bound value I(1)
1	5.15	6.36
5	3.79	4.85
10	3.17	4.14

Source: Pesaran *et al.* (2001), Table C1.iii: Case III: Unrestricted intercept and no trend.

Table 2: Estimated ECM for total exports, 1960-1984 dependent variable: Total exports included observations: 21 after adjusting endpoints

Variable	Coefficient	t-Statistic	Probability
Constant	-1.77	-1.20	0.26
LogZ (-1)	0.78	1.82	0.10
LogRPX (-1)	-0.86	-2.39	0.04
LogXT (-1)	-0.41	-2.56	0.03
DlogZ (-2)	-2.15	-1.55	0.15
DlogZ (-3)	-2.05	-1.32	0.21
DlogRPX (-1)	0.47	1.67	0.12
DlogRPX (-2)	0.34	1.33	0.21
DlogRPX (-3)	0.71	3.19	0.01
DlogXT (-2)	0.35	1.68	0.12
Elasticity			
Price (η)	-2.09		
Income (ϵ)	1.88		
Model criteria			
R ²	0.64		
Adjusted R ²	0.34		
DW	1.77		
SER	0.11		
F-statistic	2.13		
Wald F-test	4.58		0.03
Diagnostic tests	[1]	[2]	[3]
Breusch-godfrey LM	0.14 (0.71)	2.38 (0.15)	1.63 (0.26)
ARCH	0.17 (0.68)	0.06 (0.94)	0.09 (0.97)
Ramesy RESET	0.00 (0.95)	0.42 (0.67)	0.65 (0.60)

Table 3: Estimated ECM for total exports, 1985-2005 dependent variable: Total export included observations: 19 after adjusting endpoints

Variable	Coefficient	t-Statistic	Probability
Constant	-4.09	-3.63	0.00
LogZ (-1)	1.34	3.26	0.01
LogRPX (-1)	0.4	3.3	0.01
LogXTL (-1)	-0.89	-3.54	0
DlogZ	3.63	2.76	0.02
DlogRPX	0.07	0.64	0.53
DlogXT (-1)	0.2	-0.98	0.35
Elasticity			
Price (η)	0.45		
Income (ϵ)	1.5		
Model criteria			
R ₂	0.58		
Adjusted R ²	0.38		
DW	1.86		
SER	0.06		
F-statistic	2.8		
Wald F-test	5.38		0.01
Diagnostic tests	[1]	[2]	[3]
Breusch-godfrey LM	0.01 (0.91)	0.35 (0.71)	0.82 (0.51)
ARCH	0.22 (0.65)	2.91 (0.09)	1.49 (0.27)
Ramsey RESET	0.80 (0.42)	0.71 (0.52)	0.50 (0.69)

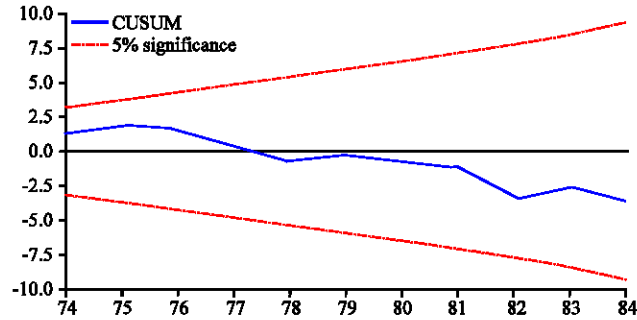


Fig. 1: CUSUM test for ECM for total exports, 1960-1984

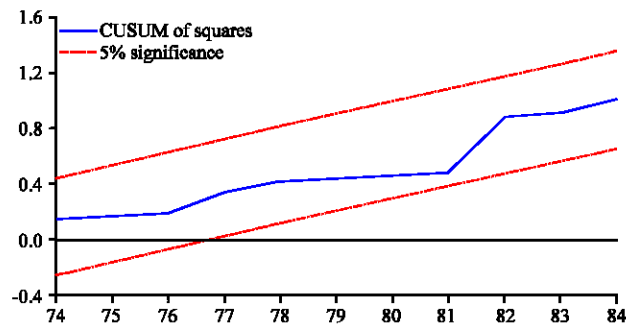


Fig. 2: CUSUM of squares test for ECM for total exports, 1960-1984

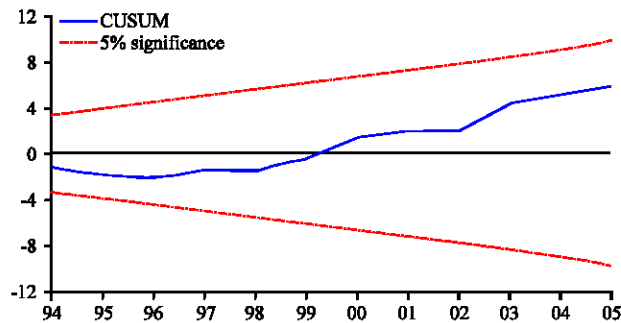


Fig. 3: CUSUM test for ECM for total exports, 1985-2005

foreign income. The variable for estimated long-run relative price elasticity of export demand (+0.45) does not have the expected sign and its low value indicates that exports are price inelastic. The estimated long-run foreign income elasticity of demand indicates that these exports are income elastic. In other words, a one percent rise in United States economic activity produces a 1.50% increase on total exports. The estimated equation passes the battery of diagnostic tests up to third order. The Breusch-Godfrey's LM test for serial correlation rejects the presence of serial correlation. The ARCH test rejects the existence of first and second order heteroskedasticity in the disturbance term. The Ramsey RESET specification test shows no general equation specification error. Lastly, the plots of CUSUM and CUSUM of Squares tests (Fig. 3 and 4) reveal that the estimated parameters are stable over the sample period.

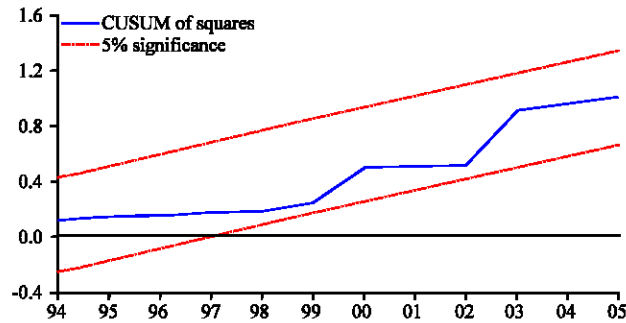


Fig. 4: CUSUM of squares test for ECM for total exports, 1985-2005

CONCLUSION

This study presented an empirical examination of the Dominican Republic's aggregate export demand function under alternative growth and foreign exchange regimes during the periods of 1960-1984 and 1985-2005. Using the 'bounds' testing approach to the analysis of level relationships developed by Pesaran *et al.* (2001), the results for both periods indicate that there existed a long-run equilibrium relationship between total exports, relative prices and foreign income. During the era of inward-oriented industrialization (1960-1984), the estimated price elasticity of exports has the expected sign (-2.10) and indicates that relative prices exerted an above-unity effect on exports. The estimated foreign income demand elasticity (+1.88) shows that exports were strongly responsive to the growth of the United States economy. Turning to the era of outward-oriented industrialization (1985-2005), the estimated price elasticity of export demand is +0.42 and denotes that exports became price inelastic. The estimated foreign income demand elasticity of exports (+1.50) indicates that exports continued to be strongly responsive to U.S. economic activity. However, the value of this metric is lower than that of the previous time period. This result is of noteworthy significance, since the OOI strategy was designed to promote economic growth by switching from exporting traditional products with presumably lower income demand elasticities to exporting non-traditional, agro-industrial and manufactured goods with seemingly higher income demand elasticities.

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