MULTISECTORAL THIRLWALL'S LAW: EVIDENCE FROM ECUADOR (1987-2008)

Diego Linthon Delgado[1]

ABSTRACT

Using a vector error correction model (VECM), we calculated income elasticity of exports and imports of Ecuador for the period (1987-2008). Following the methodology of Sanjaya Lall (2000), the goods are classified according to the degree of technology intensity incorporated in its production. The results of the coefficients, of the generalized impulse-response functions and variance decomposition indicate that goods with higher technological content have higher income elasticity so its impact on the balance of payments is greater. We conclude that Ecuador's economic growth is constrained by its balance of payments, according to Thirlwall's law (1979), because of its primary export character.

Keywords: International economics, economic growth, time-series models.

JEL Classification: F14, F43, C22.

RESUMEN

Mediante un modelo de vector de corrección del error (VEC), calculamos las elasticidades ingreso de las exportaciones e importaciones del Ecuador para el periodo (1987-2008). Siguiendo la metodología de Sanjaya Lall (2000), los bienes son clasificados de acuerdo al grado de intensidad tecnológica incorporado en su producción. Los resultados de los coeficientes, de las funciones generalizadas de impulso-respuesta y la descomposición de la varianza indican que los bienes con mayor contenido tecnológico tienen mayor elasticidad ingreso por lo que su impacto en la balanza de pagos es mayor. Concluimos que el crecimiento económico del Ecuador está restringido por su balanza de pagos, de acuerdo con la ley de Thirlwall (1979), debido a su carácter primario exportador.

Palabras clave: Economía internacional, crecimiento económico, modelos de series de tiempo.

Clasificación JEL: F14, F43, C22.

INTRODUCTION

In order to determine if there is an external con straint to growth for Ecuador, we estimate the income elasticity of exports and imports by technology intensity. We use a vector error correction model (VECM), which allows us to estimate the elasticity and identify short-term relationships between variables, it also provides two analytical tools: the impulse-response functions and variance decomposition. These tools allow us to perform a dynamic analysis of the behavior of the series.

The theoretical basis of this paper is the Thirlwall's balance of payments constraint growth model (BOPC), which in its original version proposed that the growth of a country is closely linked to the performance of its exports and imports. However, for the purposes of this paper we consider the extension of Thirlwall's law given by Araujo and Lima (2007), which they called multi-sectorial Thirlwall's law (MTL); that is, it is considered that the productive sectors have different income elasticity and therefore have a different impact on the external sector. This paper concludes that goods with higher technological content added to their production are those with the greatest impact on the balance of trade. In addition, it is found that there is a balance of payments constraint to growth, due to the primary export character of Ecuador and a lack of diversification; this reduces the chances of maintaining sustained trade surpluses that relax the external constraint. Thus, a change in the production structure would favor the balance of trade and boost economic growth; and also, what increases in domestic income adversely affect the balance of payments by the high income elasticity of imports. Therefore economic policy should be directed towards control of imports, especially of medium and high technology in order to appease its effect on external accounts. The rest of the article is organized as follows: Section I theory and literature used are described. In section II a brief analysis of the structure of the external sector of Ecuador is shown. Section III presents the model, the integration testing, co-integration analysis and the results. Finally conclusions are presented.

I.THEORETICAL FRAMEWORK

This paper was developed under a post-Keynesian perspective which considers that the difference between the growth rates of the economies is explained by differences in their demands, for this particular case we refer to external demand as the determinant of the expansion or contraction of economic growth.

The model of the balance of payments constrained growth (BOPC) developed by Thirlwall (1979) emphasizes external demand as an engine of growth. For this author, given that the real exchange rates are constant (or vary little) and that trade must be balance in the long run, there is a close relationship between gross domestic product (GDP) growth and the growth rate of exports over the income elasticity of demand for imports. This relationship is known as "Thirlwall's law".

Alonso and Garcimartín (1998), Andersen (1993), Perrotini (2002), McCombie (1997), Thirlwall (1979), Moreno-Brid (1998), among others, have found empirical evidence of Thirlwall's law for different countries using different econometric methods. Ochoa, Ordóñez and Loaiza (2011) confirmed this law to the Ecuadorian case.

Although Thirlwall's law focuses on demand also considers aspects of supply because the productive structure affects the income elasticity of exported and imported goods and therefore in the external balance and growth.

Concerning the latter, Pasinetti (1981; 1993) offers a vision of growth through structural change. According to him, the changes in the productive structure lead to change in the levels of production; this because the sectors have different income elasticity and therefore different levels of demand. Authors like Setterfield (1997), Thirlwall (1997), McCombie and Roberts (2002), Palley (2002) have paid attention to the influence of the productive structure over the income elasticity of exports and imports.

A study to highlight is the one made by Araujo and Lima (2007), who estimated the Thirlwall's growth rate under the framework of sector dynamics. The result of this study was what the authors called "Multi-sectorial Thirlwall's law". According to this law, the GDP growth rate is linked to the exports growth rate, which in turn is directly related (inversely) with sectorial income elasticity of demand for exports (imports).

The multi-sectorial version differs from the original because while the second one suggests that the GDP growth rate of a country will rise when the foreign income increases, the first one proposes that a country can grow by changing their structure of exports and imports even if foreign income does not increase.

Prate Romero, Silveira and Jayme Jr. (2011), based on multi-sectorial Thirlwall's law, conclude that a change in the productive structure is crucial for the external stability and economic growth of Brazil. This change should encourage the productio and export of goods with medium and high technological content.

[1] PhD student in economics at UAM. I thank Dr. Carlos Gómez Chiñas for the valuable observations and comments made on this article. [diego_linthon22@hotmail.com]

I.1 THIRLWALL'S LAW

Thirlwall (1979) states that the balance of payments acts as a constraint to growth because in the long run the external sector must be balanced because reserves are finite and because the inability to permanently finance deficits with external debt. Thus, the adjustment will come through a contraction of aggregate demand, which will cause a decrease in investment, productivity and production, leading to a GDP contraction. In contrast, an expansion of aggregate demand, demand for exports specifically for their ability to achieve external balance without deteriorating the balance of payments, will relax the external constraint making it possible to create a virtuous circle of investment, productivity and growth.

Therefore, the external balance is necessary for promoting higher GDP growth rates. Thirlwall's law is based on Harrod's external dynamic multiplier, which explains the long-term economic growth and it is as follows:

$$x = Bq + Ez \quad (1)$$
$$m = aq + ny \quad (2)$$
$$x + q = m \quad (3)$$

Where:

x=growth rate of exports
m=growth rate of imports
q=growth rate of relative prices
y= growth rate of domestic GDP
z=GDP growth rate of the rest of the world

Equation (1) is the export function; the equation (2) is the import function and equation (3) denotes the equilibrium in the balance of trade. It is considered that the growth rate of relative prices is constant and therefore equal to zero (q=0). So, by replacing equation (1) and (2) in (3) and solving for (y), we get the growth rate of GDP consistent with the balance of payments equilibrium (y*).

$$y^* = Ez/n \quad (4); \quad ez = x$$

Equation (4) is the original Thirlwall's law and shows the relationship between the growth rate of exports (x) and the income elasticity of imports (π) and indicates that a higher (lower) growth of exports in relation to the income elasticity of imports means that the rate of growth of domestic GDP, consistent with the balance of payments equilibrium, will be higher (lower).

Therefore, an increase in income of the rest of the world (z) will induce an increase in foreign demand for domestic goods, so that (y*) will be higher (with π constant); it is therefore a model with emphasis in external demand as a driver of economic growth[2]. Also, elasticity plays a key role in determining the ratio (x/π), which in turn differ according to the degree of the technological intensity of domestic production; so a change in the productive structure towards sectors with higher income elasticity of demand (higher technology content) will have a positive effect on the ratio (x/π), and thus the growth rate of GDP, consistent with balance of payments equilibrium, will be higher.

Therefore, quantifying the impact of the different goods on the balance of trade is crucial for the formulation of trade policies which drives to stability and growth of Ecuador.

As stated before, this article starts from the premise of the strong relationship between technological content, the income elasticity and external performance; and the relationship between structural change and economic growth.

I.2 SANJAYA LALL METHODOLOGY FOR THE CLASSIFICATION OF GOODS

In order to synthesize the diversity of products that Ecuador trades with the rest of the world, we use the methodology of Lall (2000) and rank the goods according to the intensity or technological content included in its production. The classification is shown with detail in Table 1.

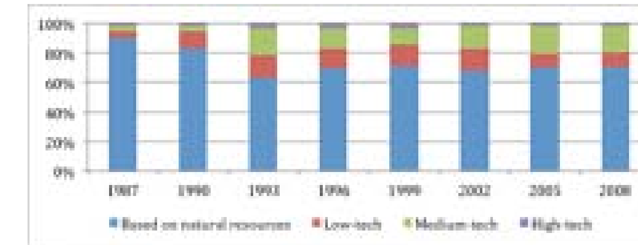
[2] For more detail see McCombie and Thirlwall, 1994.

Table 1. Products by technological intensity as rated by Sanjaya Lall

	Commodities	Manufactures based on natural resources	Products with low technological content	Products with medium technological content	Products with high technological content
Definition	Goods that do not have any industrial processing	Low-tech products that do not require much industrial processing	These are products with a technology level that is highly prevalent in the market, it does not require special knowledge or skill in its manufacture	These goods require highly qualified labor and required extended periods of learning the technique for their manufacture. They are distinguished by a high investment in research and development	They are goods with the highest investment in research and development. They require infrastructure and high level work for their production
Examples	Fruits, rice, crude, wool, among others.	Petroleum, prepared fruits, prepared meat, among others.	Textiles, leather products, footwear, ceramics, furniture, jewelry, paper, among others.	Vehicles, fertilizers, watches, chemicals, motors, medical equipment, among others.	Televisions, turbines, tablets, movie players, medical equipment, microscopes, among others.

Elaborated by author

Figure 1. Exports by technological intensity[3] (In percentages)



Elaborated by author on the basis of official figures from CEPAL.

II. STRUCTURE OF THE EXTERNAL SECTOR IN ECUADOR (1987-2008)

This study suggests that one of the determinants of weakness in the external sector of Ecuador is the structure of its foreign trade; that is, the composition of exports and imports. Our hypothesis is that the export primary structure has favored the superiority of imports over exports because the differences between the income elasticity of the goods; thus reducing the possibility of improving the external relationship and Wcausing imbalances in all the system.

II.1 EXPORTS BY TECHNOLOGICAL INTENSITY

Figure 1 shows that in 1987 exports based on natural resources accounted for 90% of total exports, but then these were decreasing and by 2008 their share was reduced by 20%; this is favorable in our framework because they are products with the lowest income elasticity within the group of exportable goods. About the exports with low technological content, these represented 5% in 1987 but from 1996 to 2008 these increased and reached 10% of the total, a weak improvement but beneficial for external stability.

Medium technology goods also experienced an increase in the share of total exports, because they represent 3% in 1987 and 18% in 2008, this significant increase is important for the objective of external stability, because they are products with higher income elasticity and as mentioned these are products which lead towards external stability. Only high technology goods are those that have not changed much from 1987 to 2008, their share is only around 2%.

The products with low and medium technological content are those who have shown remarkable changes in their share of total industrial exports, and these products could level off the problems of the balance of payments in the medium and long term. However, we have to keep in mind that the share of primary goods is still too high, making of Ecuador a primary export economy. Although industrial exports have experienced a change in composition in the last twenty years, its share in total exports is still very low in relation to the primary exports; therefore, to improve the situation of the balance of trade, a change must take place in both directions: first, a diversification of industrial exports, and second an increase of industrial exports in total exports at the expense of primary exports.

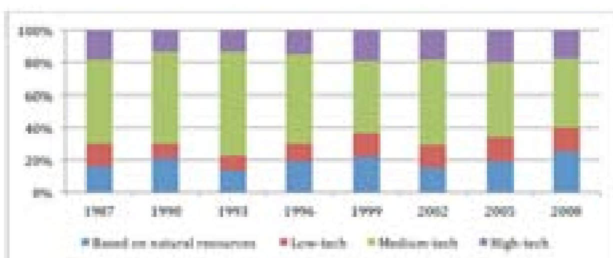
II.2 IMPORTS BY TECHNOLOGY INTENSITY

Figure 2 shows that the imports of medium technological content represent about 50% of the total imports during the studied period, except in 1999

[3] Primary exports are excluded because they represent the 80% of total exports.

when they accounted for 38%; an evolution of the share of natural resources imports is also observed, as they went from 16% in 1987 to 25% in 2008; concerning low technology imports, these have maintained their share of the total at 11%; and high technology imports have reduced their share with 14% in 2008. When comparing the composition of industrial imports from 1987 to 2008, we see that the low, medium and high technology reduced their participation, whereas those based on natural resources grew. This means, that the imports with less impact on trade balance have increased, this is a positive sign to improve the relationship between exports and imports because now the imports with lower income elasticity have greater participation.

Figure 2. Imports by technology intensity (In percentages)



Elaborated by author on the basis of official figures from CEPAL.

Summarizing, the structure of imports by technological intensity has changed in favor of those with lower income elasticity, but medium technology imports still have the largest share of total and therefore the external stability is not guaranteed in the medium and long term. This compromises the balance of balance of payments and economic growth.

III. THE MODEL

Data on exports and imports by technological level come from the database of CEPAL and are expressed in dollars; the GDP of Ecuador and the United States was obtained from the World Bank and are expressed in 2000 dollars and the real exchange rate was obtained from the Central Bank of Ecuador.

In order to test the hypothesis that income elasticity of exports and imports of Ecuador vary by technological intensity, we estimate the following equations:

I) Products of medium and high technology, M3 and X3 for imports and exports respectively.

I) Products of low technology or based on natural resources, M2 for imports and X2 for exports.

III) Primary products M1 and X1. Total imports M0 and total exports X0.

IV) Based on the above, equations to estimate are:

$$\ln X(i) = \beta_0 + \beta_1 \ln R + \beta_2 \ln Z \qquad i \in (0,3)$$
$$\ln M(i) = \beta_0 + \beta_1 \ln R + \beta_2 \ln Y \qquad i \in (0,3)$$

Where iE(0,3) represents the different levels of technological degree, X for exports, M for imports, R for the real exchange rate, Y the national income and Z for foreign income.

Such figures were conducted through a unit root and seasonality tests to identify the order of integration of the variables to avoid making spurious results. For the selection of the specification of equation[4], we used Hamilton's methodology (1994), which allows us to select the test specification more consistent with the time series, both under the null hypothesis of a unit root and seasonality. Next, to verify the existence of long-term relation between sets, the Johansen's method was used (1995); then, tests of autocorrelation, heteroscedasticity and normality the residues of the estimated models were performed.

In order to determine the short-term relation between variables, a vector error correction model (VECM) was developed. In addition, two innovative analysis tools were used: the impulse response functions and variance decomposition. The first shows the dynamic response of exports and imports to innovations in the real exchange rate and income, these innovations should be interpreted as an increase of one standard deviation in the variable in question; in terms of variance decomposition, this is understood as the

[4] Whether to include an intercept or an intercept and deterministic trend

weight for residues on the final prediction error of the estimated models.

III.1. UNIT ROOT AND SEASONALITY TESTS[5]

To strengthen the results of the unit root and seasonality tests, the results of three tests are compared: the tests Dickey-Fuller augmented (ADF, 1979), the Phillips-Perron (PP, 1988) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992). These tests help us to determine if the variables enter in the model in levels, first differences or second differences[6].

While the ADF and PP tests contrast the null hypothesis of a unit root against the alternative of seasonality; in contrast, the KPSS tests the null hypothesis of seasonality with the alternative of non-seasonality. The inclusion of the KPSS test is supported by the fact that often the ADF and PP tests cannot reject the presence of unit roots due to their lack of power (Cuevas, 2010).

The results indicate that total exports (X_0), exports of primary goods (X_1), imports of low technology or based on natural products (M_2), domestic income (Y) and external income (Z) are variables integrated of order 2 (I (2)), while the other variables are presented as integrated of order 1 (I (1)). Although the results from the tests are contradictory, and the order of integration varies between 1% and 5% level; the series X_0, X_1, M_2, and Y are shown as I(2), this is explained by the structural change that suffered these series in the late nineties due to the economic crisis faced by Ecuador and ending in the dollarization of its economy.

Referring to external income (Z), there is doubt about its order of integration, since the ADF test rejects the null hypothesis of unit root at the 5% level; the KPSS test indicates the non-rejection of the null hypothesis of seasonality, for both 5% and 1% of significance; however, the PP test indicates no rejection of the null hypothesis of unit root at all levels of significance.

It should be mentioned that in finite samples, as in the case of this research, the ADF test has a better performance than the PP test (Cuevas, 2011). So, from now on the Z series will be treated as I(1).

However, although we found four variables I(2) and seven I(1), we proceeded to standardize the order of integration of the variables (it means, the variables I(2) shall be treated as I(1)), with the purpose of carrying out tests co-integration using the Johansen procedure (1995)[7].

III.2 CO-INTEGRATION ANALYSIS

Once homogenized the order of integration of the variables included in the model, we proceed to determine whether there is or not a long-term relationship between the integrated variables of order[8] To do this, we chose the Johansen's method (1995), which allows us to determine if the non-seasonality variables are co-integrated. The Johansen's method is attended by the test statistic of the trace to determine long-term relationships between variables. The results for all categories of exports and imports indicate the existence of at least one co-integrating relationship between the series[7].

Therefore, it is concluded that the series I(1) maintain a long term relationship; this prevents that the estimated co-integrating vector is poorly constructed and thus be a spurious regression.

III.3 DIAGNOSTIC TESTS

We made tests of abnormality, autocorrelation and heteroscedasticity on residuals to rule out any of them on the residuals of the estimated regressions.

[5] For reasons of space the complete results of unit root and seasonality tests are not included. The results can be requested to the author.
[6] Most economic variables are I (1); that is, we must differentiate once to make them seasonality. (Gujarati, 2004)

[9] The complete results of the co-integration tests are not included because of space and can be requested to the author.

The tests were performed with the same order of lags (equal to 3) for exports and imports, in order to maintain standardized results.

The LM statistics show the absence of serial autocorrelation up to lag 5. Similarly, the multivariate normality test, through the Jarque-Bera statistic and the probability values indicate, generally, that the residuals are normally distributed. Regarding the multivariate White heteroscedasticity test, this suggests that in all cases both 5% and 10% level, the null hypothesis of homoscedasticity cannot be rejected.

III.4 RESULTS

In this section the results for each technological level of exports and imports, obtained through the construction of the VECM, are discussed. The results of the impulse response functions and the variance decomposition for each feature are also analyzed. Table 2 shows that the income elasticity of total imports is higher than the income elasticity of total exports, implying that Ecuador is unable to finance its imports with the foreign exchange from exports. This would explain the trade deficits, especially in the industrial sector. We also see that with lower (higher) technological content of the goods, lower (higher) is their income elasticity, as stated by the theory.

This means that Ecuador is a primary export country; with increasing external income, the demand for this kind of products is not significantly increased; causing trade deficits and lower economic growth rates.

Concerning the impulse response functions (FIR), we see that X_0 responds negatively to increases in Z; also their variations are mainly explained by their own movements and secondarily by changes in R.

This suggests that to promote the growth of total exports, it should implement policies that alter the behavior of X_0 and R.

Table 2. Income elasticity, impulse response functions and variance decomposition. Ecuador(1987-2008)

Variables	εp	$\varepsilon x, \varepsilon y$	FIR: In itself	FIR: z, y	DV
X_0	-1.56	1.34	(+)	(-)	X_0, R
M_0	0.48	1.83	(+)	(+)	M_0, Y
X_1	- 2.1	1.08	(+)	(+)	X_1, R
M_1	1.74	1.9	(+)	(+)	M_1, Y
X_2	-1.24	2.2	(+)	(-)	X_2, Z
M_2	1.57	1.98	(-)	(+)	M_2, Y
X_3	-1.08	3.49	(-)	(-)	X_3, R
M_3	0.86	1.4	(-)	(-)	R, Y

Elaborated by author

Notes:

εp=price elasticity

εx, εy = income elasticity of exports and income elasticity of imports respectively

FIR = impulse response functions

DV = variance decomposition

The DV column indicates the order of the variables that have more weight on variations in the mentioned series.

Regarding total imports, these show a positive response to increases in both Y and R; suggesting that to a depreciation of the real exchange rate, total imports tend to grow, this may be due to a lack of substitute products in the domestic market and the need of imported inputs for productive activities. The changes in total imports depend mostly on their own variations and on the real exchange rate.

Therefore, we can say that for the goal of external balance, promoting domestic production of products with higher income elasticity is key to reducing total imports and to promote total exports that lead the country to external stability.

III.5. MULTI-SECTORIAL INCOME ELASTICITY AND CONSTRAINED GROWTH

According to the original Thirlwall's Law ($y=Ez/\pi$), the higher (lower) the income elasticity of demand for exports and lower (higher) the income elasticity of imports is, higher (lower) the rate at which the economy grows will be.

Income elasticity of exports and imports of goods for each category were estimated by technological intensity, reaching the following conclusion: the higher the level of technology incorporated in the goods is, the higher the income elasticity will be, although for Ecuador, for the period 1987-2008, we find that this cannot be said for the case

In this context, in order to define whether Ecuador is constrained by the balance of payments, in terms of multi-sectorial Thirlwall law estimated in this study, table 3 is shown; which is constructed with the different trade patterns we assume for Ecuador using the different income estimated elasticity.

Table 3. Growth constrained by Balance of payments. Ecuador(1987-2008)

Table 3. Growth constrained by Balance of payments. Ecuador (1987-2008)

Trade pattern	Exports	x	Imports	π	$Y_b = \frac{x}{\pi}$	Y	$Y - Y_b$
1	X_1	1.08	M_0	1.83	0.59	3.22	-2.63
2	X_2	2.2	M_0	1.83	1.2	3.22	-2.02
3	X_3	3.49	M_1	1.98	1.76	3.22	-1.46

Elaborated by author

Notes:

X_1: Primary goods

X_2: Low-technology or resource-based goods

X_3: Medium and high technology goods

x: Growth rate of exports

M_0: Total imports

M_1: Primary goods

π: Income elasticity of demand for imports

Y_b: GDP growth rate according with balance of payments equilibrium

Y: Effective rate of GDP growth

According to the original Thirlwall's law, for all cases shown in Table 3, Ecuador growth is constrained by its balance of payments.

In the first case, if Ecuador were exporter (net) of primary goods and importer of all kinds of goods, the economy would have to constrain its GDP growth rate in 2.63% in order to have a growth rate consistent with its balance of payments equilibrium; on the other hand, the case 3, if Ecuador were exporter (net) of medium and high-tech products and importer (net) of primary goods, the economy would still have to reduce its GDP in 1.46% to maintain the balance of payments equilibrium.

Indeed, the reality of the Ecuadorian economy is closer to case 1; and therefore the contraction of its GDP growth rate should be much higher than in case 3.

As Ochoa, Loaiza and Ordoñez (2011) pointed out, the estimates of Thirlwall's law for Ecuador are best applied when the debt service on the applied model of Rhodd and Elliot (1999) is incorporated, and although we rely on the original Thirlwall's Law, our estimates and analysis give us an overview of the changes affecting the growth rate of Thirlwall when we incorporate goods with different levels of technology.

On this basis, we uphold for Ecuador the hypothesis that the income elasticity of exports and imports increases as high as the technological content of goods; and hence a change towards the export of goods with medium and high technology content which would give to the country a more robust situation in terms of economic growth and external stability.

CONCLUSIONS

In this article we estimated the income elasticity of exports and imports by technological intensity, with the objective of finding evidence of the multi-sectorial Thirlwall's law for Ecuador. The results of the vector error correction model (VECM) indicate that the higher the technological content of goods is, the higher the income elasticity will be. Hence, because Ecuador is a primary exporter and importer of goods with high technological content, a change in foreign income does not significantly promote the growth of national exports; in contrast, an increase in national income generates a considerable increase in demand for imported goods with high technological content, disfavoring the country's relationship with the rest of the world. In addition, the Thirlwall's law is verified for Ecuador in the period (1987-2008), which would force the country to contract its growth in the medium or long term. This suggests that, in order to avoid such contraction, the country should promote a change in its productive structure in favor of goods with high income elasticity, because these have a major positive impact on the balance of trade and this would help to achieve equilibrium of balance of payments and economic growth. Finally, with the income elasticity quantified by type of goods, we provide a guide for the direction of economic policy in foreign trade, seeking a change of orientation to promote stability and growth of Ecuador.

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