Does Technological Progress Reduces External Constraints to Growth?

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ABSTRACT

Differences in income-elasticities of imports and exports among countries bring about different degrees of external constraints to growth. This argument has been pointed out by Prebisch and other authors who deal with export-led growth models. The aim of this paper is to theoretically demonstrate the role of technological progress in changing external constraints to growth. Empirical evidence and a Granger Causality Test are presented and do not reject the core argument of the paper.

Keywords: Technological Progress, Trade Elasticities, Economic Growth

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1- Introduction

Prebisch's works (2000a; 2000b) and those of authors who deal with export-led growth models (ELGM), consider that differentials in growth rates between economies result from differences in their income-elasticities of imports and exports. Such differences in elasticities bring as a consequence different degrees of external constraint to economic growth.

Prebisch's explanation for this phenomenon relate to the differences in international insertion between agrarian/peripheral and industrial/central economies. Authors who work with ELGM, in turn, refer to Prebisch only to explain why such elasticities differ between products and between countries. However, several economies still face external constraints to growth, even after undergoing industrialization processes.

The core argument of the paper is that technological progress plays a relevant influence on the size of a country's trade elasticities and, therefore, on the external constraints to growth. The aims of this paper are two: i) to demonstrate in a theoretical way the role of technological progress in the existence of income-elasticity differentials among industrial economies; and ii) to show some empirical evidence about the causal relationship between technological progress and current account balances – the greater the latter the lower the external constraint to growth will be.

To do so, the paper contains four sections beyond this introduction. Next section presents the explanations and their limitations for the thesis about the external constraints to growth given by Economic Commission for Latin America and the Caribbean (ECLAC) and the authors who deal with the ELGM. In section 3, the role of technological progress for the existence of income-elasticity differentials among industrial economies and for improvements on the current account balances is theoretically discussed here. Some empirical evidences about the relationship between technological progress and current account balances are presented in Section 4. Last section brings the conclusions of this work.

2 – ECLAC, Export-Led Growth Models and the Peripheral Economic Growth

According to ECLAC the Center-Periphery dynamics referred to the structure determining a specific pattern of international insertion: in the Center the income-elasticity of demand for primary goods imports would be less than one, whereas the income-elasticity of demand for imports in the Periphery would be greater than one (Prebisch, 2000b). This pattern of international economic insertion would denote another peripheral specificity: a structural external vulnerability, which would bring about an external constraint to economic growth. Such external vulnerability would occur via the deterioration of terms of trade between Center and Periphery over time, harming the latter. The solution proposed by Prebisch would be thus the industrialization of the peripheral economies, a process that would break up with their underdevelopment and with the Center-Periphery dynamics.

Later on, Fajnzylber (1983, 2000) contributed to the debate by arguing that the central feature of underdevelopment is the insufficient incorporation of technical progress. According to the author, industrialization without the constitution of endogenous core of production of technology does not lead to the overcoming of the peripheral specificities of an economy. Fajnzylber (1983, p.281) understands a core of technological dynamization as a scientific-technological infrastructure closely inserted and related to the productive apparatus, in the way proposed by the Evolutionary literature.

Despite the important contribution of Fajnzylber, the author is not clear about the reasons for the competitiveness differential that would appear between the economy specialized in technology-intensive goods and the economy specialized in goods with low technological intensity. Why do technological innovations increase the competitiveness of an economy?

In the same way, although Prebisch (2000b, p. 181-185) explained why primary products present lower income-elasticity of demand in comparison with the income-elasticity of demand for industrialized products, his solution for the overcoming of the external vulnerability of peripheral economies did not show to be promising. After the industrialization of Latin American economies, the problem with the elasticities was not eliminated. In addition, the thesis of terms of trade deterioration is not consensual (McCombie and Thirlwall, 1994).

On the other hand, authors such as Thirlwall (1979), Dixon and Thirlwall (1975), Thirlwall and Hussein (1982), McCombie and Thirlwall (1994), Moreno-Brid (2003) formalized export-led growth models. According to these models, the performance of exports and imports play a decisive role in growth since current account deficits may constrain economic growth.

According to McCombie and Thirlwall (1994), the fact that economies export and import goods with different elasticities impairs growth with balance-of-payment equilibrium in developing countries. These authors conclude that countries with lower income-elasticities of exports and higher income-elasticities of imports, in comparison with the rest of the world, will have lower growth rates in the long run. In order to reach such conclusion, the authors are based on Prebisch's (2000b) arguments.

In sum, different growth rates among countries (particularly between developed and developing countries) may be justified by the tendency of a more severe external constraint to growth in the case of the latter group of countries, due to the characteristics of its growth. However, this literature does not explain the reason for differences in income-elasticities of exports and imports between countries. According to McCombie and Thirlwall (1994, p. 244),

> "(…) why the balance-of-payments equilibrium growth rate differs between countries. This must be primarily associated with the characteristics of goods produced which determine the income elasticity of demand for the country's exports and the country's propensity to import. For countries with a slow rate of growth of exports, combined with a relatively high income elasticity of demand for imports, the message is plain: the goods produced by the country are relatively unattractive at both home and abroad (…) the argument probably has even greater relevance for developing countries."

But why would the attractiveness of goods produced in developing countries be lower than the ones produced in developed countries? In order to answer to this question, the authors just mention Prebisch's (2000b) thesis about the income-elasticity of demand differentials. However, this thesis was built for the case of Latin America before industrialization. It only refers to differences in international insertion between the agrarian economy and the industrialized economy. Why do trade elasticities differ among industrialized economies? Next section intends to answer this question, taking into account the role of technological progress for competitiveness of an economy.

3 – National Innovation System and Competitiveness

The purpose of this section is to theoretically show that there is a causal relation between an economy's National Innovation System (NIS) and its competitiveness. It is argued that the competitiveness of an economy depends on macroeconomic policies, particularly those to do with the real exchange rate, domestic interest rates and the government's fiscal balance.

However, there is no consensus regarding the definition of the term "competitiveness of an economy" (Porter, 1990, p 3). There are economies such as Sweden and Canada, where the real exchange rate evaluated in the 1990's, but which were still considered to be competitive. Israel and The United States present high interest rates and fiscal deficits respectively. However, it cannot be argued that these economies are uncompetitive. It is also argued that competitiveness is the result of low unit labour costs and abundant natural resources but these factors are not characteristic of competitive economies such as Germany or Japan.

In this paper, an economy's competitiveness will be defined on the basis of its ability to compete with the rest of the economies in the world in both the international and domestic markets. Therefore, the definition of competitiveness should be related to the relative capacity of a country to generate surpluses in its trade balance.

However, measuring an economy's level of competitiveness is no easy task. There are a bunch of variables relating to the overall economic situation which influence trade balance. Amongst these variables are those that depend on domestic economic policy, such as the real exchange rate and policy regarding trade and subsidies. There are also those variables which are exogenous in relation to political decision-making, such as the world economic growth rate. These general factors exhibit short-term fluctuations but there are also structural factors which only present long-term changes and which also influence trade balances, such as the educational level of the workforce, the rate of technological progress and productivity and the institutional structure of the financial system, etc.

These factors that are dependent on the economic policies adopted may lead to consecutive trade surpluses in economies with low competitiveness. The opposite may also occur. In uncompetitive economies trade surpluses are often generated by the contraction of economic activity and devaluation of the real exchange rate, with the aim of balancing the CA. During these periods their CA balances tend to be lower than their trade balances. In the very competitive economies, on the other hand, the tendency to generate high trade surpluses may lead to the adoption of macroeconomic policies which cause deterioration in the trade balance. However, since these economies tend to be creditors in the international scenario, their CA balances tend to be higher than their trade balances. Therefore, the CA balance seems to reflect more accurately the competitive level of an economy than the trade balance.

Therefore, the competitiveness of an economy is defined as its relative capacity to generate surpluses in CA. Thus, the size of the average CA balance over a fixed period of time is taken as the index of an economy's competitiveness. This index is not valid only for economies which are the centre of the international financial system. The net capital inflows in the country where the main international financial market is located tends to be high and persistent and brings about economic policies that are associated with the occurrence of chronic CA deficits, even when the economy is competitive. This seems to be the case of the United States and the United Kingdom during the last few decades.

Once defined the concept and the index of an economy's competitiveness, we now intend to analyse the effects of technological progress on the level of an economy competitiveness. Initially, the relationship between technical progress and exports will be explained. The value of an economy's exports depends on three characteristics of the markets of the products exported, namely:

i) Market Structure of the export industries: The closer the exports to oligopoly, the greater the ability of the exporting company to fix the prices of its products, and, the higher the profitability and value of its exports tends to be.

ii) Dynamism of the market: The higher the rate of growth in demand in the market, the greater the value of exports to that market tends to be.

iii) Level of market protectionism: The less the market is subject to protectionist policies, the greater tends to be the value of exports to that market.

In addition, the value of exports depends on a fourth factor:

(iv) Diversification of the economy's industrial structure.

Concerning the three aforementioned characteristics of a market, we argue that in international trade, the greater the level of technological sophistication of products (LTSP), the closer the structures of their markets resemble oligopoly, the more dynamic are their markets and the less they are subject to protectionist measures.

Technological progress and its diffusion in an economy occur in the context of the development of that economy's NIS whose concept is elaborated in the Evolutionary literature (Freeman, 2004; Nelson, 2005; Fagerberg, 1994; Dosi et alli, 1994). Therefore, NIS affects the level of technological sophistication of economy production and this, in turn, affects its exports.[1]

The positive correlation between the LTSP and the degree of oligopoly is due to the fact that a product that is in the technology frontier, or close to it, cannot be produced in countries which do not possess a developed NIS. Production cannot just simply be transferred to other countries, given that few economies possess an NIS that is developed enough to enable them to manufacture such products. That means no heavy competition for these products in world markets and tacit or explicit agreements concerning price fixing for the goods in the international market is made possible. This situation supports an increase of the income elasticity of demand for the country's exports.

The positive correlation between the LTSP and the level of dynamism of its markets is due to the fact that a product which is in the technology frontier, or close to it, cannot be produced in a country which does not have a developed NIS. In this case, the demand for such a product can only be satisfied by means of imports from the few countries where the NIS is able to produce it, thus guaranteeing a world-wide market with increasing (dynamic) demand for this type of leading edge technology product. The higher the dynamism of the country's exports markets, the higher the income elasticity of demand for this country's exports tends to be.

The inverse correlation between the LTSP and the degree of protectionism in its domestic market is due to the fact that a product made by low level of technological content can be produced by many countries, even if the production costs are high in comparison to the world average. Domestic production is made viable by erecting barriers to importation of this type of product. However, if the technological content of the product is of a high level, it cannot immediately be produced even though barriers have been established if the country's NIS is not sufficiently developed to make it possible. In such cases, the domestic demand for the product can only be satisfied by imports and this would imply a low level of protectionism (in the domestic markets of a wide range of countries) and a high level of the income elasticity of export demand for high technology products.

Concerning the diversification of an economy's industrial structure, the more developed its NIS, the greater is the possibility of reaching the technological frontline in various areas of production. Therefore, the greater the degree of diversification of the industrial structure tends to be. Consequently, there is greater diversification in the range of its export goods, which favours growth in the value of exports, due to three factors, namely, i) domination of new markets that will be even more diversified to the extent that the range of exports becomes even more diversified; ii) stability of growth in the value of exports, since, the more diversified exports are, the greater the chance that a drop in price and/or demand for exports will be compensated for by an increase in the price and/or demand of another product in the range of exports; iii) increase in the income elasticity of export demand since the export opportunities will be greater to the extent that there is greater diversification of the range of export goods.

Therefore, the four items examined – level of oligopoly, market dynamism, level of protectionism and diversification of the industrial structure – suggest that the more developed an economy's NIS, the greater its export coefficient and the value of its exports should be. Thus, the level of development of the NIS is positively correlated with the performance of the Trade Balance and the CA balance.

The relationship between the level of a country's NIS development and imports is also associated with these four items. Countries with a low level of NIS development are not capable of producing goods with high technology content and need to import such goods from high priced markets where there is oligopoly. In addition to this, the more dynamic a market for a particular good, the greater will be the demand in this market, thus favouring an increase in prices and making its imports more expensive – the positive correlation between LTSP and the degree of market dynamism has already been explained. Also, the lower the import barriers, the greater the value of imports. As already argued, there is an inverse correlation between the degree of a product's technological sophistication and the level of protectionism in its domestic markets.

Finally, the less developed the NIS, the less diversified an economy's industrial structure will be. Therefore, the more diversified its range of imports, the greater the proportion of internal demand that will be satisfied by means of imports. This leads to growth in both the income elasticity of import demand and the value of imports.

Therefore, in a country where the NIS is relatively less developed, the income elasticity of export demand tends to be lower than the income elasticity of import demand, leading to external structural vulnerability, as postulated initially by ECLAC-UN and Thirlwall.

It may be concluded that the more developed an economy's NIS, the greater will be the range of its sophisticated (technological) products, and that will cause an increase in the value of exports and reduce the value of imports. The opposite situation is also true. Therefore, countries whose NIS is developed tend to have a high level of competitiveness while countries that present undeveloped NIS tend to be uncompetitive.

4- Empirical Evidence

The level of development of a country's NIS can be measured on the basis of that country's per capita production of patents compared to the per capita production in the world as a whole. According to Bernardes and Albuquerque (2003, p. 873) and Albuquerque (1999), patents are not an infallible means of measuring the level of technological development but, nevertheless, it is the method used in the literature and is useful in achieving this objective. Using data relating to science and technology indicators, Albuquerque (1999) concluded that the countries which have a developed NIS are: Germany, France, Italy, Japan, the United States, the United Kingdom, Denmark, Belgium, the Netherlands, Ireland, Austria, Switzerland, Canada, New Zealand, Australia and Israel. Countries which are at the stage of catching up are: South Korea, Taiwan and Singapore. All the other countries are in the category of Undeveloped NIS.

Therefore, in this article Albuquerque's (1999) classification was used to collect data on the international trade of two groups of countries: countries with a developed NIS (DIS) and those with an undeveloped NIS (UDIS). The following countries were selected to represent the DIS group: Germany, France, Italy, Japan and Canada[2] and for the UDIS 16 countries from Latin America, Asia and Africa were chosen: Brazil, Argentina, Bolivia, Colombia, Chile, Ecuador, Mexico, Peru, Uruguay, Venezuela, Malaysia, Thailand, India, Indonesia, The Philippines and South Africa.

Table 1 shows the CA balance for the DIS and UDIS groups. An economy's average CA balance in any specific period is an indicator of its competitiveness during that period. For the period between 1966 and 2006 when data was available, the DIS group had an average CA surplus of US$68.2 billion and the UDIS group had an average deficit of US$16.4 billion. These figures are evidence that the economy's level of NIS development exercises a positive influence on its competitiveness.

(Table 1 HERE)

The products that are at the leading edge of technology are capital goods and manufactured goods in general. The former materially incorporate technological progress (Faynzylber, 1983), and the latter require more complex production processes and more aggregate value compared to primary and intermediate goods. Table 2 shows the average balance of the total trade balance in capital goods (CG), manufactured goods (MG) and primary goods (PG) for the DIS and UDIS groups of countries between 1980-2005. The different results obtained by these two groups suggest the importance of the level of development of an economy's NIS as regards the increase of competitiveness of an economy. In both groups, the trade balance average was in surplus but was much higher for the DIS group than for the UDIS group. In the case of the UDIS group the average CG and MG balance was in deficit, while the average PG trade balance was in surplus. In the DIS group, exactly the opposite situation was found.

(Table 2 HERE)

Picture 1 presents the percentage share of total exports, capital goods, manufactured goods and primary goods in total world exports and by type of good, during the period 1980-2005. In all the categories described here, the share in world exports from countries in the DIS group is always larger than the share from countries in the UDIS group. Even more, this gap is much larger for manufactured goods and capital goods, as compared to primary goods.

(Picture 1 HERE)

When analyzing foreign trade from DIS and UDIS groups according to factor-and technology-intensity, it is expected that the trade balance in technology-intensive goods will be in surplus in countries where the NIS is more developed. The opposite should be the case in countries with a relatively less developed NIS. Table 3 presents the average trade balance in primary commodities, labor-intensive and natural-resource-intensive goods, as well as goods with high, medium and low technological level between 1980-2004.[3] The average trade balance for the UDIS group was in deficit for high, medium and low technology goods and in surplus for basic commodities and labour-intensive and natural-resource-intensive goods, while the result was exactly the opposite in the case of the DIS group.

(Table 3 HERE)

These results can still be explained by the low share of technology-intensive goods in the total exports from the UDIS, which is quite lower than the share for countries in the DIS group, characterized by larger export shares of goods with higher technological intensity. The largest share in total exports from the UDIS group (table 4) is primary commodities (42.54% of total exports), followed by exports of goods with high technological intensity (20.71%). In the DIS group, exports of goods with high and medium technological intensity represent around 30% and 37%, respectively, whereas export share of commodities in total exports from this group is only 14.35%.

Exports of high and medium technological intensity altogether represent 34,9% of total exports from the UDIS group, against almost 70% of exports share of these goods in total exports from the DIS group. Picture 2 complements the argument by showing strict dominance of countries from the DIS group in world exports of goods with higher technological intensity, as compared to the UDIS group. Such difference is smaller in the case of primary commodities and labor-intensive and natural-resource-intensive goods, where the group UDIS is more competitive.

(Table 4 HERE)
(Picture 2 HERE)

The argument that technological innovation plays an important role in the external insertion of the economies is corroborated by the correlation coefficient between the share of each of the 23 countries of both UDIS and DIS groups (including USA and UK) in the world production of per capita patents and the share of each country in world exports of goods with high technological intensity (table 5). These coefficients are high and positive, showing an average of 0.95 for all the periods analyzed, and suggesting a high correlation between the level of development of the NIS in a country and its performance in exports of high technology goods.

Last of all, Table 6 shows the coefficients of correlation between the CA balance and the share in the world per capita production of patents in the 21 countries which make up the DIS and UDIS groups. The correlations are high and positive: 0.71 and 0.68 for the periods 1980-2005 and 1990-2005 respectively and confirm the importance of NIS development for the performance of these economies' current account transactions.

(Table 5 HERE)
(Table 6 HERE)

The empirical evidence presented above suggests a correlation between the development of the NIS and the competitiveness of the economy. To investigate whether causal relationships exist between these variables the temporal precedence test will be applied in the sense of Granger (1969) for 21 countries through the analysis of an unbalanced panel – USA and UK were excluding from our sample of 23 countries for the reasons previously indicated. It is expected that the share of the country in the world per capita production of patents (PAT) Granger causes its current account (CA).

In the context of panel data there does not yet exist a methodology generally adopted to test the causality between variables, although some procedures appear in the literature. In this work the procedure of Carroll and Weil (1994) and Judson and Owen (1999) has been adopted, that make use of the AH estimator (Anderson and Hsiao, 1981) starting from panel data. It is necessary to estimate two distinct dynamic relations between PAT and CA:

$CA_t = \alpha + \beta\, CA_{t-1} + \gamma_1 PAT_{t-1} + u_t$ (1)

$PAT_t = \alpha + \beta\, PAT_{t-1} + \gamma_1 CA_{t}.1 + u_t$ (2)

Initially, the existence of a long-term relationship between CA and PAT through unit root tests and of cointegration for panels is checked. Stationarity tests consider the possibility of structural breaks in the series. The test proposed by Andrews and Zivot (1992) was adopted.[4] If the unit root hypothesis is not rejected, the hypothesis of structural break is tested. The identification of the structural break is done where the statistical t test presents a maximum value. Should the null hypothesis of structural break be rejected, the methodology proposed by Maddala and Wu (1999) will be applied, for unbalanced panels, that permits estimates and inferences to be made on unit roots in all the countries.

In the presence of structural break the normal cointegration tests may generate inaccurate results. The approach of the cointegration method with structural break is an extension of the unit root test with structural break developed above. According to Andrews and Zivot (1992), the model considers only one endogenous break in the cointegration relationships.

In accordance with GREGORY and HANSEN (1996), evidence of structural break and the co-integration relationships is provided by three models: level shift (C), level shift with trend (C/T) and the régime shift model (C/S). In all the models structural change is tested by the presence of a dummy variable. We estimate the three models for the set of panel countries on those dates where the structural break was shown to be significant. After the models were estimated, the Augmented Dickey-Fuller Unit Root Test is applied (ADF) on the residuals of the equations, using the critical values tabulated by GREGORY and HANSEN (1996). There is a cointegration relationship between the series if the residuals of the estimated equations are stationary.

The causal relationship between the variables will be checked by the separate estimation of equations (1) and (2) by means of the methodology proposed by Anderson and Hsiao (1981). Thus, applying the method of instrumental variables on the first difference, proposed by the authors, we rewrite, for example, equation (1) as follows:

$$CA_t - CA_{t-1} = \beta_1 (CA_{t-1} - CA_{t-2}) + \delta_1 (PAT_{t-1} - PAT_{t-2}) + (u_t - u_{t-1}) \qquad (1.1)$$

Observe that, in (1.1), the disturbance ($u_t - u_{t-1}$) is now correlated with the independent variable ($CA_{t-1} - CA_{t-2}$). Anderson and Hsiao (1981) recommend as instrument ($CA_{t-2} - CA_{t-3}$) or (CA_{t-2}). Granger's causality, in the sense that PAT causes CA, is demonstrated if the null hypothesis, $\delta_1 = 0$, is rejected.

Finally, for the purpose of analysing the robustness of the results obtained by the application of the dynamic estimators of Anderson and Hsiao (1981), we present the results of the LSDVC estimator proposed by Bruno (2005), known as corrected fixed effects models.

Tests and Results

The results of the unit root tests with structural break of Andrews and Zivot (1992) for 21 countries during the period 1975-2005, are presented in table 7. The unit root null hypothesis for the CA series in 20 of the countries of the panel cannot be rejected. For the PAT series, most of the countries possess unit root, with the exception of Chile, Colombia and Indonesia.

(TABLE 7 HERE)

For the countries where the unit root null hypothesis in the CA and PAT series (Ecuador, Chile Colombia and Indonesia) was rejected, we applied the methodology of Vogelsang (1997), that permits inferences to be made on structural breaks. The null hypothesis of absence of structural change was rejected in favour of the option of a broken trend for these countries in both the series, at the level of 5% of significance. For the countries in which the unit root hypothesis was not rejected we tested the significance of the structural break. In accordance with the details given in table 7, the null hypothesis of structural break to the level of significance of 5% is rejected for most of the countries researched in both the series, CA and PAT, with the exception of Brazil, Indonesia, Malaysia, Germany and Italy, in the case of the first series, and Japan, for the PAT series. The results of these tests conjointly with the results of the unit root tests of Maddala and Wu (1999), applicable in panel for the set of countries (table 8), indicate that the CA and PAT series are integrated of order one, that is, I(1).

(TABLE 8 HERE)

As regards cointegration, all the estimations of the cointegration model of GREGORY e HANSEN (1996) were carried out with the first difference of the CA and PAT series and with the structural date break endogenously determined. The null hypothesis was rejected to the level of 1% of statistical significance, in all the models (table 9).[5] It is concluded that the series are cointegrated.

TABLE 9 HERE

The causal relationships between PAT and CA were tested starting from the estimation of equations (1) and (2) by applying the AH estimators (Anderson and Hsiao, 1981). Table 10 shows the results of the estimations, including those obtained by corrected fixed effects (LSDVC) to analyze the robustness of the dynamic model. The sample used involves data from 1975 to 2005. Due to the loss of degrees of freedom due to the small size of the temporal sample, equations (1) and (2) were estimated with only two lags. In addition, the introduction of many lags, although it diminishes the serial autocorrelation, can generate a colinearity problem among the explanatory variables.

We find that PAT causes CA, seeing that in equation (1), where ΔCA is the dependent variable, the first lag of ΔPAT is significant. The results obtained by AH for equation (2), where ΔPAT is the dependent variable, show that ΔCA presents significance only in the second lag, but the value of the estimated coefficient is almost null.

TABLE 10 HERE

To test the robustness of the results obtained by the application of the AH dynamic estimator, we utilized the LSDVC dynamic estimator. The results of the LSDVC estimator are consistent with the results of the AH model, as there does not exist substantial change in parameter magnitude or in its statistical significance, except for the loss of significance of the second lag of ΔCA, where ΔPAT is the dependent variable (table 10).

All these results (tables 1 to 10 and pictures 1 and 2) endorse the argument that the relative level of development of an economy NIS is an important determinant of its level of competitiveness (CA). Countries with more (less) developed NIS have a higher (lower) level of competitiveness. Given that the concept of competitiveness refers to the capacity of an economy to generate CA surpluses, economies with a developed NIS tend to have a relative abundance of foreign exchange and, therefore, a lower level of external constrains to growth. In countries with a less developed NIS there is a chronic shortage of foreign exchange and a higher level of external constrains to growth.

5- Conclusions

Authors from ECLAC, such as Prebisch and Fajnzylber, and from the Kaldorian tradition, like Thirlwall and McCombie, converge to the same explanation regarding the differences in economic growth rates among countries. These differences would derive from different levels of external constraint to growth of the economies. The external constraint to growth, in turn, would depend on the country's income-elasticities of imports and exports.

However, Prebisch's (2000a; 2000b) explanations for differences in trade elasticities among countries are not adequate when all countries under study are industrialized. In addition, his thesis on the deterioration of terms of trade is not consensual in the literature. The arguments by authors in the Kaldorian tradition only refer to Prebisch in order to explain why those elasticities differ among goods and among countries.

For Fajnzylber (1983; 1990), the industrialization of an economy, when accompanied by the constitution of an "endogenous core of technology production", would affect its competitiveness and its trade balance, relaxing its external constraint to growth. That would only be possible, thus, if the constitution of this "endogenous core of technology production" modified the income-elasticities of trade in the economy. However, Fajnzylber does not analyze this issue, i.e. he does not explain how the "endogenous core of technology generation" of an economy would affect its income-elasticities of imports and exports.

In order to fill this gap, this paper built theoretical causal links between the development of a National Innovation System (NIS), changes in income-elasticities of trade and competitiveness of an economy. For that, we initially discussed the concept of competitiveness of an economy and how to measure it. Afterwards, the correlations between relative development of the NIS, income-elasticities of trade and competitiveness of an economy were theoretically demonstrated. Finally, the theoretical arguments were supported empirically through the construction of several indicators and Granger Causality Test. We found that countries where the NIS is more developed dominate world trade and present structurally positive external balances. The opposite is the case for countries where the NIS is less developed.

The empirical evidence presented in this paper support the argument that the relative development of the NIS in an economy is relevant to explain its competitiveness, its degree of external vulnerability and the intensity of its external constraint to growth. In this sense, it reaffirms the importance of stimulating the development of the NIS in developing economies as a way to consistently reduce the gap in growth rates between countries.

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Table 1 – Total and Average Current Account Balance, 1966–2005 (US$ billion)

	Sum of CA balances in the period: 1966-2006	Average in the Period: 1966-2006	Standard Deviation
DIS	2.548	63,7	78,4
UDIS	-690	-17,3	30,4

Source: Author's elaboration using data from World Development Indicators database, 2007.
DIS = countries with a developed NIS – G7 countries excluding USA and UK were taken as proxy;
UDIS = countries with an undeveloped NIS: Brazil, Argentina, Bolivia, Colombia, Chile, Ecuador, Mexico, Peru, Uruguay, Venezuela, Malaysia, Thailand, India, Indonesia, Philippines and South Africa.

Table 2 – Total Trade Balance in Capital Goods, Manufactured Goods and Primary Goods, 1980-2005(US$ billion)

Period	**UDIS**				**DIS**			
1980-2005	TTB	CG*	MG	PG	TTB	CG*	MG	PG
Average	14	-42.5	-55.1	38.2	146.9	137.4	337	-58.6

Source: Author's elaboration using data from United Nations Statistics Division, World Trade Organization, 2007.
DIS = see table 1; UDIS = see table 1. TTB = total trade balance; CG = capital goods trade balance; MG = manufactured goods trade balance; PG = primary goods trade balance.
*For CG data is available only for 1995 and for the period 1998-2005.

Table 3 – Trade balance in primary commodities, labor-intensive and natural-resource-intensive goods, and goods with high, medium and low technological intensity (US$ billion)

Period	**UDIS**					**DIS**				
1980-2004	PC	LNRI	HT	MT	LT	PC	LNRI	HT	MT	LT
Average	51.0	22.8	-24.8	-42.1	-7.8	-79.2	-4.7	56.4	218.6	42.3

Source: Author's elaboration using data from United Nations Statistics Division, World Trade Organization, 2007.
DIS = see table 1; UDIS = see table 1. PC = primary *commodities*; LNRI = labor- and natural-resource-intensive goods; HT, MT and LT are, respectively, goods with high, medium and low technological intensity.

Table 4 – Export Composition by Factor Intensity-1980-2004-(%)

Period	UDIS						DIS					
1980-2004	PC	LNRI	HT	MT	LT	Total	PC	LNRI	HT	MT	LT	Total
Average	42.54	16.36	20.71	14.20	6.20	100.0	14.35	9.80	30.38	37.26	8.20	100.0

Source: Author's elaboration using data from United Nations Statistics Division, World Trade Organization, 2007.
DIS = countries with a developed NIS – G7 countries were taken as proxy; UDIS = see table 1. PC = primary *commodities*; LNRI = labor-and natural-resource-intensive goods; HT, MT and LT are, respectively, goods with high, medium and low technological intensity.

Table 5 – Correlation Coefficient between the share of each country in world production of per capita patents and the share of each country in world exports of high technology goods–sample of 23 countries

Period	1980	1985	1990	1995	2004	1980-2004	1990-2004
Correlation coefficient	0.95	0.96	0.96	0.95	0.93	0.94	0.93

Source: Author's elaboration.The 23 countries are: Germany, France, Italy, Japan, Canada, USA, UK, Brazil, Argentina, Bolivia, Colombia, Chile, Ecuador, Mexico, Peru, Uruguay, Venezuela, Malaysia, Thailand, India, Indonesia, Philippines and South Africa.

Table 6 – Correlation Coefficient between Current Account Balance and the share of 21 countries in the per capita world production of patents

Period	1970-2005	1980-2005	1990-2005
Correlation coefficient	0.74	0.71	0.68

Source: Author's elaboration.The 21 countries are: Germany, France, Italy, Japan, Canada, Brazil, Argentina, Bolivia, Colombia, Chile, Ecuador, Mexico, Peru, Uruguay, Venezuela, Malaysia, Thailand, India, Indonesia, Philippines and South Africa.

Table 7 - Tests for Unit Roots, 1975-2005

Countries	CA Séries		PAT Séries	
	Date of the Break	*t* statistics - I(1)	Date of the Break	*t* statistics - I(1)
Argentina	1996	-3,639	1982	-2,072
Bolivia	2000	-5,042	1989	-3,828
Brazil	1995**	-3,778	1983	-4,051
Chile	1996	-4,205	1998	-7,525*
Colômbia	1993	-4,028	1997	-7,170*
Ecuador	1998	-7,744*	1999	-3,639
India	1998	-3,392	1996	-3,989
Indonesia	1994**	-3,947	1996	-6,830*
Malaysia	1998**	-4,829	1995	-2,011
Mexico	1987	-3,081	1990	-3,716
Peru	1993	-4,827	1989	-3,550
Philippines	1991	-4,381	1994	-4,709
South Africa	1985	-3,122	1987	-5,264
Thailand	1991	-3,240	1999	-3,552
Uruguay	1990	-3,891	1998	-5,732
Venezuela, RB	1998	-4,657	1999	-4,278
Canada	1989	-3,832	1982	-2,524
France	1997	-1,533	1987	-2,446
Germany	1991**	-2,591	1990	-2,792
Italy	1993**	-5,090	1998	-2,691
Japan	1994	-5,276	1989**	-2,854

Source: Author's elaboration.
Model with Constant and time trend. * Significant at 1% level. Critical values are given in Andrews and Zivot (1992). ** H_0 should not be rejected, i.e. $\theta = 0$, at 5% level of significance, according to F statistic.

Table 8 - Results from Maddala and Wu (1999) Test

Variables	Test	Lags Values	Statistic Value	P-value	Critical Values (t)	P-value
			with Time Trend		with Constant and Time Trend	
CA	MW	2	46.8575	0.2800	25.4907	0.9792
D(CA)	MW	2	57,9538	0,0516	52.6390	0,0000
PAT	MW	2	32.4769	0.7467	41.6855	0.4847
D(PAT)	MW	2	-167,3360	0,0000	155.9892	0,0000

Source: Author's elaboration.
MW = Maddala e Wu. D = first difference of the variable. Chi-squared statistic: Ho = existence of unit root in all countries.

Table 9 – Cointegration Test

Date of the Break	Models		
	C	C/T	C/S
	ADF of the Residuals		
1991	-5.77*	-5.87*	-5.64*
1993	-5.87*	-5.98*	-5.62*
1995	-5.86*	-5.96*	-6.06*
1998	-5.89*	-6.01*	-6.02*
1991/93/95/98	-5.75*	-5.84*	-5.52*

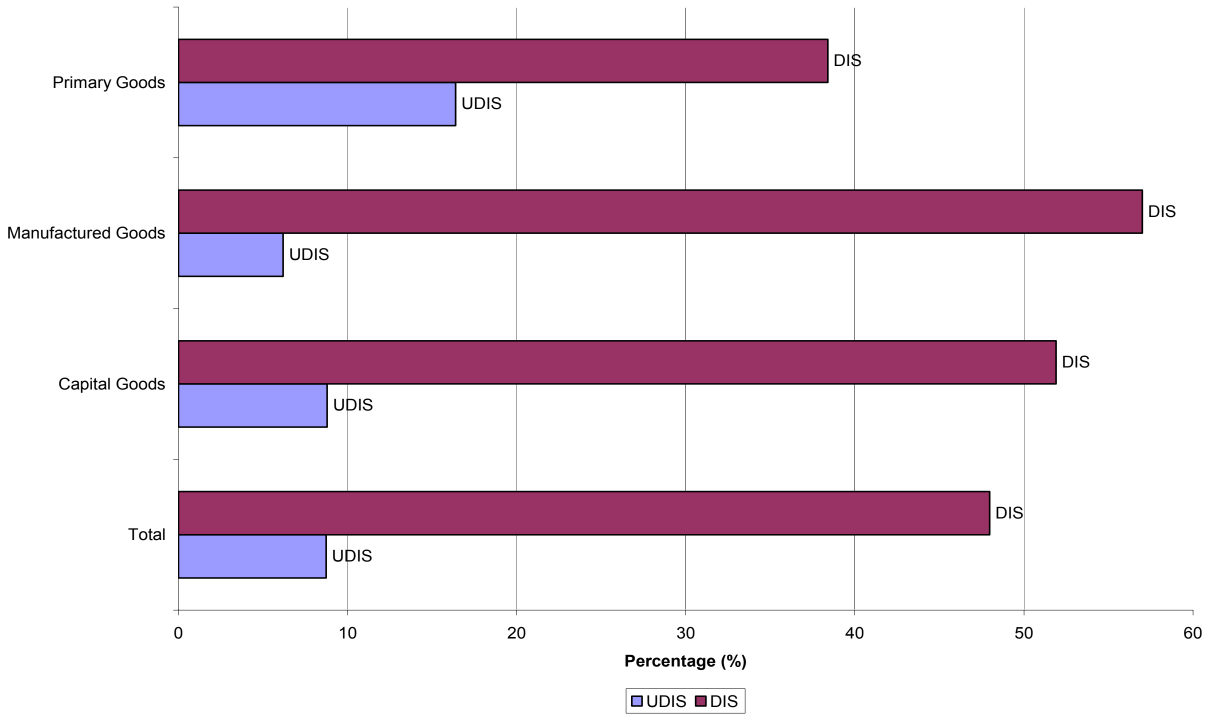
Source: Author's elaboration.
Note: * Significant at 1% level. Critical values are given in GREGORY e HANSEN (1996).
C = model *level shift*; C/T = model *level shift with trend*; C/S = model regime *shift.*

Table 10 – Granger Causality for Panel Data

Dependent Variable	D.CA		D.PAT	
Technique / Independents Variables	Corrected Fixed Effects	Anderson Hsiao	Corrected Fixed Effects	Anderson Hsiao
L_1D. CA	1.043725 (0.000) ***	1.192794 (0.011) **	-0.0000402 (0.109)	-0.0000293 (0.256)
L_2D. CA	(dropped)	(dropped)	-8.47e-06 (0.753)	-0.0001288 (0.001) ***
L_1D. PAT	283.918 (0.000) ***	201.8297 (0.089) *	0.8532561 (0.000) ***	0.338908 (0.006) **
L_2D.PAT	-89.35352 (0.263)	-180.1259 (0.305)	(dropped)	(dropped)
Observations	563	563	563	563

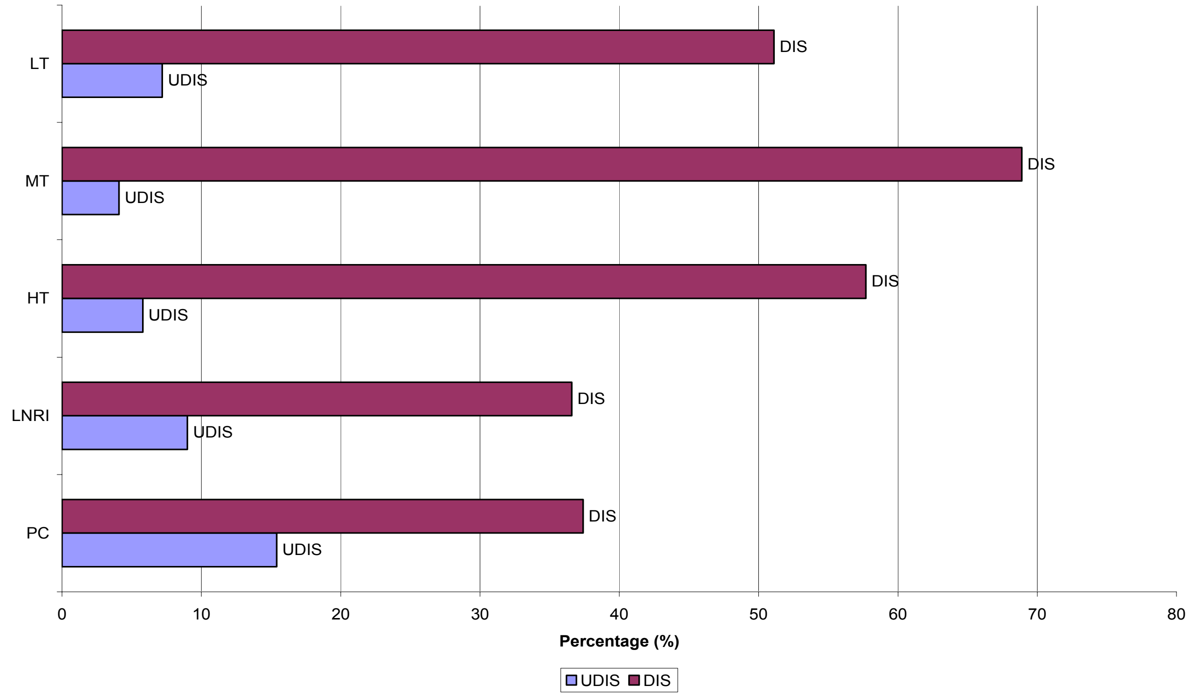
Source: Author's elaboration.
P-values are in brackets. D.VAR = VAR(t)-VAR(t-1), L_1D.VAR = VAR(t-1)-VAR(t-2), L_2D.VAR = VAR(t-2)-VAR(t-3). *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Picture 1 – Exports share in world exports, by type of goods-1980-2005-(%)*



Source: Author's elaboration. Data from United Nations Statistics Division, World Trade Organization, 2007.
DIS = countries with a developed NIS – G7 countries were taken as proxy; UDIS = see table 1.
Total = total exports of goods;
*For Capital Goods data is available only for 1995 and for the period 1998-2005.

Picture 2 – Share of exports in world exports according to the degree of factor intensity-1980-2004(%)



Source: Author's elaboration. Data from United Nations Statistics Division, World Trade Organization, 2007.
DIS = countries with a developed NIS – G7 countries were taken as proxy; UDIS = see table 1.
PC = primary *commodities*; LNRI = labor-and natural-resource-intensive goods; HT, MT and LT are, respectively, goods with high, medium and low technological intensity.

[1] Nelson (2005), Freeman (2004), Fagerberg (1994), Dosi et al. (1994) highlight the positive effects of the NIS on an economy's productivity and competitiveness. They also consider the impossibility of substituting the NIS by the importation of technology, given that technology has a local feature. Therefore, in spite of the recent process of globalization, the NIS remains central in the development of technical progress and its dissemination (Freeman, 2004). As argued by Fagerberg (1994, p. 1155-1161), "Although writers in this tradition accept the argument that technology has some public-good characteristics, they do not see these as essential. Rather they stress that technology, or know-how on how to do things, is embedded in organizational structures (firms, networks, institutions, etc.) (…) firms, characterized by different combinations of intrinsic capabilities (including technological know-how) and strategies are seen as key players. Technological change is analyzed as the joint outcome of innovation and learning activities within organizations, especially firms, and interactions between these and their environments. The cumulative – or path dependent - character of this process is often stressed. Country-specific factors are, through various channels, assumed to influence the process of technological change, and thus give the technologies – and the process of technological change – of different countries a distinct national flavor. Thus, as an analytical device, many writhers in this area - explicitly or implicitly – view countries as separate (technological) systems, each with its own specific dynamics. Bengt-Ake Lundvall (1992) and Nelson (1993) both use the concept national system of innovation for this purpose (…) studies on technological spillover emphasize that these are, in large measure, geographically located (…)"

[2] The exclusion of this group of two countries that are important in the world scenario, the Unites States and the United Kingdom, was justified above.

[3] This classification was made by United Nations Conference on Trade and Development (UNCTAD, 2002).

[4] For more details see Andrews and Zivot (1992) and Vogelsang (1997).

[5] We also carried out the Westerlund Test (2007) for the panel set. From one Westerlund statistic z: Ho = not cointegration, it was possible to reject Ho, to the level of 5% of probability for the CA and PAT series.