STRUCTURAL CHANGE, TECHNOLOGY AND INCOME DISTRIBUTION: A MODEL OF ECONOMIC DEVELOPMENT

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RESUMO:

O objetivo desse artigo é desenvolver um modelo capaz de incorporar os principais problemas enfrentados pelos países periféricos, formalizando sua estrutura e descrevendo seu processo de desenvolvimento. Embora o foco do trabalho seja a dinâmica de funcionamento das economias subdesenvolvidas, é possível verificar que o modelo é também capaz de ser utilizado para analisar economias desenvolvidas. O modelo é uma extensão do modelo apresentado por Rada (2007), expandido para incorporar temas centrais do processo de desenvolvimento da periferia que não foram abordados no modelo original, como a restrição do balanço de pagamentos e a dinâmica inovativa. Algumas mudanças são também introduzidas visando incorporar a desigualdade de renda como uma variável endógena ao modelo. Através desse modelo, por fim, busca-se ressaltar que apenas através do desenvolvimento de um Sistema Nacional de Inovação (NIS) eficiente é possível superar consistentemento as restriões que impedem o desenvolvimento da periferia. Como resultado final, o artigo contribui com um modelo de desenvolvimento econômico mais completo e relativamente simples, no qual os diversos aspectos da dinâmica de desenvolvimento dos países periféricos são incorporados.

Key-words: Restrição do balance de pagamentos, distribuição de renda, Sistema Nacional de Inovação, mudança estrutural, Lei de Thirlwall.

ABSTRACT:

The aim of this paper is to develop a model to encompass the main problems faced by peripheral countries, formalizing its structure and the process of development. Furthermore, although we focus the dynamics of underdeveloped economies in this paper, one can verify that the model can also be used to analyze a developed economy. The model is an extension of that presented by Rada (2007). The model is expanded to incorporate central issues for periphery development that are not addressed in the original model, such as the balance of payments constraint and the innovation dynamics. Some changes are also made in order to incorporate income inequality as an endogenous variable. Through that model we argue that only by developing an efficient National System of Innovation (NIS) the constraints on periphery development are consistently surpassed. The end result is a more complete and relatively simple model of economic development which incorporates the various aspects of the working dynamics of peripheral economies.

Key-words: Balance of payments constrained growth, income distribution, National System of Innovation, structural change, Thirlwall's Law.

1.Introduction

Since its inception in the 1940s, development economics has dedicated a great deal of effort to shed light on the key role of investment in enabling economic development in backward economies (Rostow, 1958; Nurkse, 1958; Rosenstein-Rodan, 1958). In spite of the many different views and aspects stressed by the authors of the 'high development theories' (Krugman, 1997), the process can be largely understood as the *structural and institutional changes that allow for continuous productivity growth, resulting in an adequate level of material wealth for most of (if not all) the country's population* (Furtado, 1961; Kuznets, 1958). In its turn, investment not only reduces employment in low-productivity backward sectors (both agrarian and urban) of peripheral economies due to structural change, but also elevates productivity within sectors, thus bringing up average productivity in the economy and reducing its structural heterogeneity (Lewis, 1958; Furtado, 1961).

Nevertheless, due to the productive specialization that characterizes peripheral economies in face of the high necessity of imports of capital goods, higher rates of industrialization did not led to the alleviation of balance of payments disequilibria, which in times of low international liquidity imposed a slower pace of capital accumulation (Prebisch, 2000a; 2000b; Thirwall, 1979; McCombie & Thirwall, 1994). Therefore, the continuous dependence on imports coupled with the low rates of exports growth caused by the low diversification of periphery's production made imperative the adoption of state planed industrialization (Rodriguez, 2009). Moreover, the low ability to invest and innovate of periphery's entrepreneurs provided a further constraint on investment, calling once again for state intervention (Hirschman, 1958).

At first, these interventions were focused on the so called import substitution strategy, but soon development economists understood that this process generates a dynamic reproduction that always leads to new balance of payments pressures if not coupled with exports growth and diversification (Tavares, 2000; Fajnzylber, 1990).

Last but not least, problems stemming from the high income inequality associated with the process of industrialization were also addressed by ECLAC's authors like Furtado (1961) and Fajnzylber (1990). On the other hand, although Kaleckian models of income distribution state that different accumulation regimes could theoretically lead to growth if certain conditions are verified, tests of those models have not yet been conclusive (Bahduti & Marglin, 1990; Gala, 2007; Hein & Vogel, 2008). Nevertheless, peripheral economies structural and institutional characteristics indicate that those economies would be more often marked by the so called wage-led regime. Therefore, the negative impacts that income inequality has on market size, innovation and learning are considered crucial in restricting underdeveloped countries' technological development (ECLAC, 1990; Albuquerque, 2007).

Hence, in the literature on development economics it is possible to identify four main constraints on peripheral economies development: (i) structural heterogeneity; (ii) low private capacity of investment and innovation; (iii) balance of payments constraint; (iv) income inequality. Therefore the title of the paper, which highlights that the model does not focus only growth, but also other aspects related to the more complex concept which is development.

In this paper we argue that the fundamental way to overcome those four constraints is by developing an efficient National System of Innovation (NIS) (Nelson, 1993; Freeman, 1995; Fagerberg, 1994; Albuquerque, 1999).In order to increase and diversify exports it is necessary to improve non-price competitiveness of locally produced goods and services (McCombie and Thirlwall, 1994). On its turn, sectors producing goods with high technological content are more

prone to the acquisition of higher non-price competitiveness, and therefore present higher income elasticity of demand (Fagerberg, 1988; Gouvêa & Lima, 2010). Thus, increases in the share of the high-tech sector in the economy would generate simultaneously a reduction in structural heterogeneity and a relaxation of the balance of payments constraint. The higher growth rates resulting from this process would increase employment, elevating wages and then progressively reducing income inequality. Throughout this process the institutions of seek for investment and seek for innovation would be created and reinforced, and abilities to invest and innovate would be continuously improved. Hence, the four main constraints to development would be gradually surpassed.

The aim of this paper is to develop a model to encompass the main problems faced by peripheral countries, formalizing its structure and the process of development. Through this model we want to convey that the fundamental way to overcome underdevelopment is by developing an efficient National Innovation System. The length of the model results from the wide range of problems it incorporates. However, it is important to emphasize that with a few simplifying assumptions a large reduction of the model is achieved. Furthermore, although we focus the dynamics of underdeveloped economies in this paper, one can verify that the model can also be used to analyze developed economies.

The model developed here is an extension of that presented by Rada (2007) and Ocampo, Rada and Taylor (2009). The model is expanded to incorporate central issues for periphery development that are not addressed in the original model, such as the balance of payments constraint and the innovation dynamics. Some changes are also made in order to incorporate income inequality as an endogenous variable.

As a result, there is a crucial difference between the original model and ours. In Rada's (2007) the economy is divided into two sectors: a subsistence sector producing nontradable goods and a the modern sector producing tradable goods. In the new model, the economy is divided into a sector that produces low-tech goods and a sector that produces high-tech goods. In both models, however, there are differences in productivity among sectors, which characterizes the structural heterogeneity. Here, it is possible to assume a lower productivity in the low-tech sector given that it includes backward, low productivity and informal subsectors (i.e., subsistence agriculture, mining, informal services, underemployment, etc.).

Nonetheless, classifying the economy according to the technological content of goods produced opens the possibility of incorporating its non-price characteristics. Through that perspective we introduce the balance of payment constraint into the model to show how the sectoral composition of the economy affects the rate of growth compatible with balance of payments equilibrium. On the other hand, the innovation process is included to explain the growth in the high-tech sector. The debate thus shifts from the focus on the production of tradable or non-tradable goods to the discussion of *which* tradable goods sould be produced in order to boost development and overcome its constraints.

A second important difference concerns the role of income distribution in the model. Unlike the original model, in the new version income inequality is endogenous and influences investment indirectly. Once workers and capitalists present different propensities to consume, changes in the patterns of income distribution have distinct impacts on total and sectoral demands, which are assumed to influence investment and growth.

For last, it is important to emphasize that the model presented here is a long term model. Hence, shot term fluctuations are ruled out of the model, as will be discussed later.

The paper is divided in five sections besides this introduction. In section two we describe the first part of the model, which focuses on structural change and income distribution. In section

three we introduce the external constraint to the model. In section four the determinants of innovation are discussed. Finally, section five presents the conclusions of the paper.

2. A model of structural heterogeneity with income distribution

One of the most striking features of underdevelopment is the structural heterogeneity observed in those economies. This feature is represented here by dividing the economy into two sectors: one sector produces low-tech goods (LT), using labor as the only input; the other sector produces high-tech goods (HT), using both capital and labor inputs. The product in each sector is given by:

(1) $P_i Y_i = P_i \varepsilon_i L_i$

where P_i is the price level of production in each sector $i=BT, HT$, Y_i is the output of each sector, $\varepsilon_i = Y_i / L_i$ is the labor productivity, and L_i is the number of workers. Differentiating (1) and assuming the price level to be fixed[1], we have:

(2) $y_i = \xi_i + l_i$

where y_i represents the output growth rate, ξ_i the growth rate of labor productivity, and l_i the rate of employment growth in each sector. Thus, from equation (2) we obtain the growth rate in the high-tech sector (Rada, 2007):

(3) $y_{HT} = \xi_{HT} + l_{HT}$

In the low-tech sector workers' remuneration is given according to labor productivity. However, since labor is the only input in the low-tech sector, its output is equal to its wage mass, i.e., $y_{LT} = w_{LT}$.

(4) $w_{LT} = \xi_{LT} + l_{LT}$

Regarding wages, in the high-tech sector, following the description of Lewis (1958) and Furtado (1961), wages depend on the wages of the low-tech sector, and therefore also on the level of productivity prevailing in that sector. This assumption is justified by the fact that an increase in employment (underemployment) in the low-tech sector promotes a downward pressure on the wage rate of the economy. Wages growth rate in the high-tech sector, therefore, depends on the rate of growth of low-tech wages:

(5) $W_{HT} = P_{HT} \chi \varepsilon_{LT} L_{HT} < \varepsilon_{HT} L_{HT}$

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[1] For ease of exposition, the prices are considered constant, although they can be incorporated into the model. Price movements are incorporated solely to address the terms of trade, to analyze the results relating to international trade, but are then considered fixed in the long run, as argued by Thirlwall (1979). The focus of the model, therefore, is on changes in real variables. Ocampo, Rada and Taylor's (2009, chap.8) model also consider price movements as fixed. Nevertheless, Rada (2007) consider short term price adjustments in her model. The same analysis posed by Rada (2007) could be incorporated here, but we prefer not to in order to reduce the complexity of the model.

where $\chi > 1$ is a fixed parameter, which indicates a surplus to attract workers to the high-tech sector, coming from the low-tech one (Lewis, 1958)[2].

Differentiating (5) and assuming that the price level is constant we get:

$$(6) \quad w_{HT} = \xi_{LT} + l_{HT}$$

Hence, from (6) we are brought to examining both the growth dynamics of employment in the high-tech sector and productivity in the low-tech sector. Regarding the growth of employment in the economy as a whole, we have:

$$(7) \quad \lambda l_{HT} + (1-\lambda)l_{LT} = n$$

where $\lambda = L_{HT}/L$ represents the share of workers in the high-tech sector on the total of the economy, and n is the exogenous growth rate of the workforce as a whole.[3] Rearranging terms of equation (7) we obtain:

$$(8) \quad l_{LT} = (n - \lambda l_{HT})/(1-\lambda)$$

In (8) then we have the growth rate of employment in the low-tech sector depending on the employment growth rate in the high-tech sector[4]. We shall see later that the rate of employment growth in the high-tech sector depends on the investment in the sector.

In its turn, the rate of productivity growth in the low-tech sector depends positively on the introduction of technological innovations in the sector and negatively on the employment growth rate of this sector:

$$(9) \quad \xi_{LT} = \overline{\xi}_{LT} + \alpha_{LT} t_{LT} - \eta l_{LT} .^{5}$$

where $\overline{\xi}_{LT}$ is the growth rate of autonomous productivity, t_{LT} is the innovation growth rate in low-tech sector, and l_{LT} is its employment growth rate.

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[2] Regarding the wage rate of each sector, both are determined by the productivity of the low-tech one: $\omega_{LT} = P_{LT}\varepsilon_{LT}$, $\omega_{HT} = P_{HT}\chi\varepsilon_{LT}$, where ω_i is the wage rate in each industry.

[3] As one can verify, we implicitly consider that every worker is either working in a sector, or in the other. Nonetheless, it is important to highlight that it is not possible to infer in what activity this worker is going into. Therefore, once a worker is dismissed from the HT sector and goes to the LT sector, he might actually engage in an underemployed activity. Thus, in the model we introduce a *virtual* full-employment situation in order to keep the same characteristics of Lewis' (1958) subsistence sector. On the other hand, one can also consider that through this assumption we indicate that maintaining full employment is not enough to a country to develop. It is also important to take into account in what activity is employment concentrated at.

[4] This characteristic of the model stems from the fact that the income elasticity of demand for LT goods is lower than for HT goods. Hence, in the long term we expect the demand growth for the HT goods to drive the increase of that sector, while reducing the LT sector. Therefore, although in reality increases in the LT sector could be promoted by short term increases in commodity prices (as have been seen nowadays), in the long run this short term distortions would be counteracted, and the income elasticities would perform the dominant effect.

[5] It could be assumed that the value of η varies according to the stock of employment in the sector, but for simplification we assume here that the parameter is fixed and less than one.

It should be noted that the negative sign in the rate of employment growth in the sector follows the assumption that the low-tech sector is characterized by decreasing returns to scale (Kaldor, 1966) related to structural underemployment, as described for the subsistence sector in Rada's (2007) model[6].

Substituting (3) in (8), and then (9), we have:

$$(10) \quad \xi_{LT} = \bar{\bar{\xi}}_{LT} + \alpha_{LT} t_{LT} - \eta \left[\frac{n - \lambda (y_{HT} - \xi_{HT})}{(1 - \lambda)} \right]$$

Equation (10) shows that the rate of productivity growth in the low-tech sector depends positively on the introduction of innovations in the sector, the output growth in the high-tech sector, the share of the labor in the high-tech sector in the total employment of the economy (λ), and negatively on the rate of growth of productivity in the high-tech sector. With an increase in productivity in the high-tech sector the same output can be reached with less labor. These workers are transferred to the low-tech sector, which hinders its productivity due to the diminishing returns to scale characteristic of the sector.

Nevertheless, since the factor that characterizes the structural heterogeneity is the difference in productivity between the sectors of the economy, it is still necessary to describe what determines the rate of productivity growth in the high-tech sector. Thus one can understand what drives a dynamic reduction of heterogeneity[7]:

$$(11) \quad \xi_{HT} = \bar{\bar{\xi}}_{HT} + \gamma y_{HT} + \alpha_{HT} t_{HT}$$

Equation (11) represents an extended version of the Kaldorian relationship that indicates the presence of increasing returns to scale in the manufacturing industry. Through (11) it is observed that the rate of productivity growth in the high-tech sector depends on an autonomous growth ($\bar{\bar{\xi}}_{HT}$, which could be attributed to organizational changes, among others), the rate of output growth in the sector (y_{HT}) and the rate of growth of technological innovations in the sector (t_{HT}). The parameter γ, therefore, indicates the so-called Verdoorn coefficient, which represents a first channel of cumulative causation within the model.

Having described the relationships between employment growth, productivity growth and wage growth in both sectors, the determinants of income distribution and its implications must be examined.

The rate of growth of the wage mass in the economy as a whole is given by:

$$(12) \quad w = \varphi_{LT} w_{LT} + (1 - \varphi_{LT}) w_{HT}$$

where $\varphi_{LT} = W_{LT} / W$. Substituting (4) and (6) in (12), we obtain:

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[6] Although this hypothesis be strong, the inclusion of sectors such as mining, agriculture and informal sectors to the low-tech sector justifies it. However, this simplification can be relaxed without great difficulty, and without substantive change to the model results.

[7] It must be clear that besides the differences in the rates of productivity growth in each sector, in level we have the initial condition that $\varepsilon_{HT} > \varepsilon_{LT}$.

(13) $w = \varphi_{LT}(\xi_{LT} + l_{LT}) + (1 - \varphi_{LT})[\xi_{LT} + l_{HT}]$.

Substituting the rate of employment growth in the high-tech sector (3) in (13), we have:

(14) $w = \varphi_{LT}(\xi_{LT} + l_{LT}) + (1 - \varphi_{LT})[\xi_{LT} + y_{HT} - \xi_{HT}]$.

Equation (14) shows that the rate of growth of the wage mass in the economy depends positively on the growth rate of the output in the high-tech sector and on the productivity growth rate in the low-tech sector; and negatively on the productivity growth rate in the high-tech sector (i.e., it is positively related to the employment level of the high-tech sector).

For the distribution to change, however, it is required that w grows faster than r, which denotes the rate of growth of the profit mass. Following the Kaleckian models, we assume that income is distributed only among workers (wages) and capitalists (profits). Therefore, we have that:

(15) $P_{HT}Y_{HT} = P_{HT}R_{HT} + P_{HT}W_{HT}$

Substituting (5) in (15) we have:

(16) $P_{HT}Y_{HT} = P_{HT}R_{HT} + P_{HT}\chi\varepsilon_{LT}L_{HT}$.

Differentiating this equation and assuming that prices are fixed, by rearranging its terms we find the growth rate of the profit mass:

(17) $r_{HT} = \dfrac{y_{HT} - \psi_{HT}(\xi_{LT} + l_{HT})}{1 - \psi_{HT}}$

where $\psi_{HT} = W_{HT}/Y_{HT}$. Substituting (3) in (17) we have:

(18) $r_{HT} = \dfrac{l_{HT} + \xi_{HT} - \psi_{HT}(\xi_{LT} + l_{HT})}{1 - \psi_{HT}}$

In short, the rate of growth of profits depends positively on the productivity growth rate and the employment growth rate in the high-tech sector, and negatively on the productivity growth rate in the low-tech sector. Increasing productivity in the later increases the wages in both sectors, reducing profit. Employment growth in the high-tech sector also has a negative impact on profit growth, since it raises production cost.

From equation (5) we observe that if the output growth rate in the high-tech sector results from increased employment and not from productivity, then there will be a growth in the wage mass. Moreover, the impact of employment growth in the high-tech sector on the productivity in the low-tech sector will be positive[8] if $\xi_{HT} < l_{HT} \geq n/\lambda$ [9], which implies growth of wages in both sectors, resulting in further increase in the wage mass. However, to determine if $w > r_{HT}$ one must

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[8] Equation (10).
[9] Equation (7).

determine the values of the other parameters of the equations (14) and (18). Hence, it is not possible to make *a priori* inferences in that matter.

Finally, regarding the output growth rate in the economy as a whole, it is important to emphasize that its main determinant is the rate of growth of the high-tech sector. From (2), we see that the growth rate of the sector is determined by its productivity growth rate, i.e., equation (11), and its employment growth rate. Regarding the employment growth rate in this sector, since the production of the high-tech sector uses both capital and labor as inputs, the number of workers in this sector is associated with the amount of existing capital:

$$(19)\ K_{HT}* = (K_{HT}*/K_{HT})(K_{HT}/L_{HT})L_{HT}$$

where $K_{HT}*$ denotes the stock of capital in the economy and K_{HT} is the amount of capital actually used in current production. Thus, differentiating (19) and rearranging its terms we have:

$$(20)\ l_{HT} = i_{HT} - \hat{k}_{HT} - g_{HT}$$

where $\hat{k}$ indicates the rate of growth of the amount of capital per worker, i_{HT} is the investment growth rate, and g_{HT} the growth rate of idle capacity[10]. Equation (20) highlights, on the one hand, that an increase in the employment growth rate in the high-tech sector can result from higher investment, or lower (negative growth rate) idle capacity or capita-labor ratio. On the other hand, it can be seen that higher investment growth rate can either result in higher employment, or in higher capital-labor ratio, or even in higher idle capacity. Thus, by substituting (20) in (3) we have that $y_{HT} = \xi_{HT} + i_{HT} - \hat{k}_{HT} - g_{HT}$, which shows that investment and capacity utilization ultimately determine the rate of output growth in the high-tech sector.

Considering that the growth rate of idle capacity is inversely related to the growth rates of demand and profit share in income $(r_{HT} - y)$[11], we have:

$$(21)\ g_{HT} = -v_1 \mu_{HT} y - v_2 \mu_{HT} z - v_3(r_{HT} - y)$$

where v_i are proportionality parameters that indicates the magnitude of the response of the idle utilization to changes in demand and profits.

Investment, in its turn, is determined by an autonomous component (i_{HT0}), a component driven by technological innovation that opens up profit opportunities in new markets (t_{HT}), and another two components induced by increases in domestic demand (y) and external demand (z). It is also assumed that both industrial policies (q) and the availability of credit (f) have positive impacts on investment. On the other hand, the existence of idle capacity (g_{HT}) provides a disincentive to investment[12]. Lastly, increases in the share of profits in the income would

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[10] Such a structure carries the assumption that each level of technological development (or machines) implies a fixed capital-labor ratio, i.e., there is no perfect substitution of factors. An alternative is to assume a constant capital-labor ratio and total capacity utilization, so that employment growth in the high-tech sector depends only on increasing investment, which determines the growth rate of capital stock, i.e., : $i_{HT} = l_{HT}$.

[11] Bhaduri and Marglin (1990) demonstrate that using the rate of profit is equivalent to using the share of profits in the income, once the profit rate derives from the profit share: $r = R/K = (R/Y)(Y/Y*)(Y*/K)$.

[12] One can consider that investment will only be encouraged by demand pushes if idle capacity is near to zero.

positively   impact   the   investment   growth   rate
$(r_{HT} - y)$[13]:

$$(22)\ i_{HT} = i_{HT0} + \phi_1 \mu_{HT} y + \phi_2 (r_{HT} - y) + \phi_3 \mu_{HT} z + \beta_1 q + \beta_2 t_{HT} + \beta_3 f - \beta_4 g_{HT}.\text{[14]}$$

where μ_{HT} represents the income elasticity of consumption of high-tech sector's goods, considered similar for internal and external income growth. Moreover, the introduction of the rate of output growth as a determinant of investment indicates a second channel of cumulative causation (Fagerberg, 1988). The introduction of innovations on the right hand side of equation (22), on its turn, represents its influence on the non-price competitiveness of high-tech goods.

To understand the effects of income distribution, the demand is divided to consider the impulse given by profits and wages separately:

$$(23)\ y = \psi w + (1 - \psi) r_{HT}$$

where $\psi = (W_{LT} + W_{HT}) / Y$. Substituting (23) and (21) into (22) we have:

$$(24)\ i_{HT} = i_{HT0} + \vartheta_1 w + \vartheta_2 r_{HT} + \vartheta_3 z + \beta_1 q + \beta_2 t_{AT} + \beta_3 f$$

Where for simplifying the notations we call $\vartheta_1 = \{[\phi_1 + (\upsilon_1 - \upsilon_3)\beta_4]\mu_{wHT} - \phi_2\}\psi$, $\vartheta_2 = \{[\phi_1 + (\upsilon_1 - \upsilon_3)\beta_4]\mu_{rHT} - \phi_2\}(1 - \psi) + \phi_2 + \upsilon_3\beta_4$ and $\vartheta_3 = (\phi_3 + \upsilon_2\beta_4)\mu_{HT}$.

In this model it is assumed that the income elasticities of consumption are different for workers' consumption and capitalists' consumption, i.e., $\mu_{wHT} > \mu_{rHT}$, as traditionally addressed in Kaleckian models (Hein and Vogel, 2008). This assumption has some implications. First, growth coupled with better income distribution has greater impact on demand. Secondly, the different income elasticities influence the determination of the pattern of demand in the economy. One can expect that higher workers' demand will lead to a more than proportional increase in demand for less sophisticated goods. This would be a pattern of consumption closer to the profile of domestic production structure of an underdeveloped country. The opposite occurs with increased capitalists' consumption, who consume proportionally more sophisticated goods. Such goods are usually not yet all domestically produced, which can result in a proportionately greater increase in imports. A pattern of growth predicated on increasing income inequality, therefore, facilitafacilitates the verification of external imbalances[15].

Substituting then (24) in (20):

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[13] The inclusion of this component reflects some short-sightedness of businessmen, who for his investment decision can evaluate both demand and/or profits.

[14] Hein and Vogel (2008) estimate an investment function where $I = f(y, r, i)$, where i represents the interest rate, trying to measure the opportunity cost of investment. However, this variable shows no significance. An alternative to capture effects of the money market on investment we include the credit (f) in our equation. In the authors' model, y represents a proxy for the level of capacity utilization. Regarding the impact of expectations on investment, stressed by post-Keynesian theorists, it is assumed here that changes in expectations impact the magnitude of parameters. In estimations with time series changes in expectations can be analyzed by testing for structural breaks.

[15] Although the model described here contemplates only two sectors, when dealing with an economy with multiple sectors the growth of workers' or capitalists' consumption will impose an even more differentiated pattern of cross-sector demand, which would encourage distinct trajectories of structural change.

$$(25) \quad l_{HT} = (i_{HT0} + \vartheta_1 w + \vartheta_2 r_{HT} + \vartheta_3 z + \beta_1 t_{HT} + \beta_2 q + \beta_3 f) - \hat{k}_{HT} - g_{HT}$$

It can be seen, therefore, that the innovations have an ambiguous impact on the employment growth rate in the high-tech sector. If the incentive for investment via potential profits is greater than the disincentive on employment by increasing the productive capacity of the machinery (with increased capital-labor ratio), then its impact will be positive. If the opposite is verified, however, the impact of innovations on the employment growth rate in the high-tech sector will be negative[16].

Moreover, from (25) we see that w_{HT} has a positive effect on investment through its impact on demand (through w) and a negative effect through its impact on the rate of profit[17]. The net effect will depend on the initial distribution of income, the income elasticities of demand of each class, and the profit elasticity of investment (ϕ_2).

Suppose, for ease of understanding, that there is an increase in productivity due to an innovation in the low-tech sector, which determines an increase in both sectors' wages, and therefore implies a reduction in the profit mass (negative growth). If $\vartheta_1 > \vartheta_2$, then the growth impulses coming from wages will provide further impetus to investment. Such a framework characterizes what Bhaduri and Marglin (1990) called the *wage-led* growth regime (which may or may not be based on cooperative capitalism: when the mass of both wages and profits are growing[18]). On the other hand, if $\vartheta_1 < \vartheta_2$, then the negative effect of the increased wages on profits will prevail, so that profit mass growth will be the most important factor in determining investment, which characterizes the *profit-led* regime. Similarly, this scheme may also be cooperative or not, since productivity growth in high-tech sector may or may not be associated with the growth of wages.

Once wage growth in the high-tech sector is related to productivity growth in the low-tech sector, then the productivity growth rate in the high-tech sector can be transferred completely to the profit mass (uncooperative *profit-led* regime) unless this increase in productivity is more than offset by an employment increase in the sector, which causes an increase in productivity in the low-tech sector, raising wages in both sectors (cooperative *profit-led* regime).

Substituting (12) in (24) so that w is replaced by the sum of the wage growth in each sector (w_i), then we have a system composed of ten equations - (3), (4), (6), (8), (9), (11), (17), (20), (21) and (24) - determining ten endogenous variables. For the high-tech sector we have its (i) output growth rate (y_{HT}); (ii) employment growth rate (l_{HT}); (iii) productivity growth rate (ξ_{HT}); (iv) wages growth rate (w_{HT}); (v) profits growth rate (r_{HT}); (vi) investment growth rate (i_{HT}); and (vii) idle capacity growth rate (g_{HT}). For the low-tech sector we have its (viii) wages growth rate ($w_{LT} = y_{LT}$); (ix) employment growth rate (l_{LT}); (x) productivity growth rate (ξ_{LT}).

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[16] In classical structuralist literature this problem is approached through a discussion of the introduction of labor saving technologies in the periphery.

[17] Equation (15).

[18] One must remember that to have wage growth in the high-tech sector productivity of the low-tech sector needs to grow, and for that we need to raise the work in the high-tech sector (excluding the possibility of innovations in the low-tech sector). That is, the rate of growth in the high-tech sector must necessarily increase, and therefore also the mass of profits. It is also important to note that this model only considers changes in the distribution of income as a result of an better distribution of the income obtained through the production process. Another possibility, which involves no increase in the amount of profits, is an increase in the rate of growth of productivity in the low-tech sector.
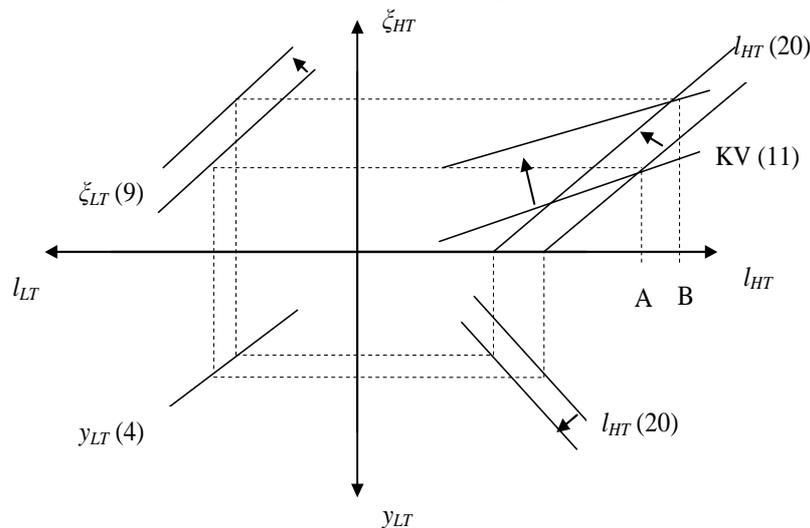
2.1. Productivity gains in the high-tech sector

To analyze the general implications of the model it is interesting to take as a starting point the analysis of the impact of productivity gains on the output growth rate, as described by Ocampo, Rada and Taylor (2009). As will be seen, although the model described here presents several changes, the theoretical relationships between the variables is maintained, so that the same framework used by Ocampo, Rada and Taylor (2009) can be used to describe the movements of this model.

First, if the income elasticity of investment ($\vartheta_1 < \vartheta_2$) is high, then the productivity growth that creates higher profits increase the rate of growth of output – equation (24). This framework characterizes the *profit-led* regime of growth, depicted in Figure 1. What characterizes this situation in the figure is the positive slope of the curve l_{HT} in quadrant northeast, which demonstrates that there is a positive relationship between the productivity growth rate and the employment growth rate in the high-tech sector. Thus, increases in productivity motivate increases in investment and in utilization of idle capacity that elevate employment in the sector.

The starting point is given by the equilibrium between the rates of productivity growth and employment growth in the high-tech sector (northeast quadrant - determining the rate of employment growth A). This equilibrium determines the rate of employment growth in the low-tech sector (northwest quadrant), which gives us the output growth rate in this sector (southwest quadrant), finally determining the magnitude of the impact of the demand growth rate of the low-tech sector on the employment growth rate of the high-tech sector (southeast quadrant).

An increase in the productivity growth rate in the high-tech sector shifts the Kaldor-Verdoorn curve (KV) upwards, increasing profitability, boosting the growth of investment and reducing idle capacity, which increases the employment growth rate (from A to B in the northeast quadrant). This new equilibrium implies reducing the employment growth rate in the low-tech sector (northwest quadrant), which results in reducing its rate of growth[19].

FIGURE 1: The model of structural heterogeneity with a *profit-led* regime

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[19] The shift in curve (9) results from the upward shift in KV curve. Now, for the same rate of growth of employment in the low-tech sector, a higher rate of growth of productivity in the high-tech sector is achieved.

If on the one hand a reduction in the employment growth rate in the low-tech sector has a negative impact on the output of the sector (southwest quadrant), on the other hand it generates an increase in its productivity growth rate which has a positive impact on output. Hence, for a reduction in employment to reduce its output it is necessary that this reduction effect be predominat, i.e., we need the employment elasticity of the productivity in this sector to be low. In other words, it should present only slightly decreasing returns in the sector - $\eta < 1$ in equation (9) - which is a very realistic assumption, adopted also in Rada's (2007) model[20].

Finally, a fall in the growth rate in the low-tech sector reduces the demand growth rate stemming from this sector to the high-tech one, thus slightly reducing the growth rate in the later[21]. Furthermore, the reduction in the employment growth rate in the low-tech sector raises its productivity growth rate, resulting in higher wages in both sectors - equation (4). On the one hand, this increase raises demand and generates a positive impact on investment. On the other hand, higher wages reduce profits in the high-tech sector - equation (18) - which has a negative impact on investment. Thus, since we are considering a *profit-led* accumulation regime, then the dominant effect would be that on profits, which results in a leftward shift of the l_{HT} curve in the southeast quadrant. This shift indicates that for a given output growth rate in the low-tech sector, employment in the high-tech sector will be lower due to lower investment and capacity utilization resulting from the compression of profits in face of rising wages. The same effect would be observed for the l_{HT} curve in the northeast quadrant[22].

Turning then to the effects of an increase in productivity growth rate in a *wage-led* regime, we observe that the characterization of the situation in Figure 2 is given by the negative slope of the curve l_{HT} in northeast quadrant. As in Figure 1, in Figure 2 an increase in the productivity growth rate in the high-tech sector shifts the KV curve upwards, increasing profitability.

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[20] For a deeper discussion on the slopes of the curves of the northeast and southwest quadrants, see Rada (2007) and Ocampo, Rada and Taylor (2009). It is also interesting to highlight that innovations in the low-tech sector – equation (9) – would induce a downward shift of the curve y_{LT} in the southwest quadrant.

[21] The effect becomes clear through the intercepts of the curve l_{AT} in the northeast quadrant. These intercepts are determined by the rate of growth of the low-tech sector (Ocampo, Rada and Taylor, 2009).

[22] For a given level of productivity growth rate, employment growth rate in the high-tech sector would now be smaller due to the reduction in investment/capacity utilization resulting from profit squeeze.

FIGURE 2: The model of structural heterogeneity with *wage-led* regime
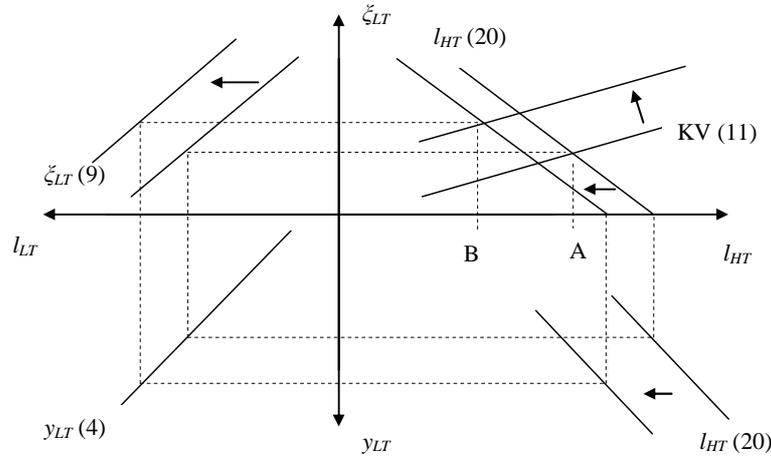
Source: Authors' elaboration based on Ocampo, Rada and Taylor (2009, chapter 8, p.129).

Nevertheless, the weak response of investments and capacity utilization to increases in the profits growth rate ($\vartheta_1 > \vartheta_2$) causes a reduction in the employment growth rate (from A to B in the northeast quadrant). This new equilibrium implies higher employment growth rate in the low-tech sector (northwest quadrant), which leads to a higher growth rate in the sector (southwest quadrant). On the one hand, it increases the demand growth rate stemming from this sector to the high-tech one. On the other hand, a higher employment in the low-tech sector reduces its productivity, reducing wages in both sectors - equation (4). This reduction raises profits, but once we are considering a *wage-led* regime, the predominant effect on investment is the negative impact of reduced wage mass growth rate. Considering that this effect outweighs the demand push stemming from the low-tech sector growth, once wages are reduced in both sectors, it will generate a leftward shift in the l_{HT}, thus deepening the employment reduction in the high-tech sector[23].

Therefore, in a country characterized by a *wage-led* regime (low profit elasticity of investment, $\vartheta_1 > \vartheta_2$), increases in the productivity growth rate in the high-tech sector lead to a structural change which is inverse to the one required for achieving higher average productivity, increasing the share of the low-tech sector in the economy at the expense of the high-tech sector. Such a framework would undermine not only the average productivity of the economy, but also the distribution of income, since it undermines productivity in the low-tech sector, thus lowering wages in both sectors.

This case of sectoral productivity growth associated with a structural change toward low-tech sectors represents the exactly same frame described by McMillan and Rodrik (2011) for the Latin American economies in the recent years, which corroborates the implications of the model described here. McMillan and Rodrik (2011) find that the opposite is verified for the Asian countries.

3. Introducing external constraint to the model

The model developed in the previous section addresses the problems of weak capacity of capital accumulation (low ability to invest which results in a low profit elasticity of investment),

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[23] Again the effect becomes apparent when considering the intercepts of the curve l_{HT} in the northeast quadrant.

structural heterogeneity, and income distribution. For the model to address all the barriers on periphery development, we must now introduce the problems of external constraint on growth and of low innovation capacity. The starting point is a sectoral division of the domestic economy[24]:

$$(26) \quad y = \delta_{LT} y_{LT} + (1 - \delta_{LT}) y_{HT}.^{25}$$

where $\delta_{LT} = Y_{LT} / Y$. Thus, the growth rates of demand for imports and exports coming from the sectors of low and high technology are given by:

$$(27) \quad m = [\sigma_{mLT} \mu_{mLT} + (1 - \sigma_{mLT}) \mu_{mHT}] y + [\sigma_{mLT} \theta_{mLT} + (1 - \sigma_{mLT}) \theta_{mHT}] e_r.$$

$$(28) \quad x = [\sigma_{xLT} \mu_{xLT} + (1 - \sigma_{xLT}) \mu_{xHT}] z + [\sigma_{xLT} \theta_{xLT} + (1 - \sigma_{xLT}) \theta_{xHT}] e_r$$

where m denotes total imports, x total exports, e_r the real exchange rate[26], μ_{mLT} and μ_{mHT} the income elasticities of demand for imported goods from the low-tech and high-tech sectors respectively; μ_{xLT} and μ_{xLT} the income elasticities of demand for exported goods from the low-tech and high-tech sectors respectively; and $\theta_{xLT}, \theta_{xHT}, \theta_{mLT}, \theta_{mHT}$ are the price elasticities of demand for exports and imports of goods from each sector. Still, $\sigma_{mLT} = M_{LT} / M$ and $\sigma_{xLT} = X_{LT} / X$.

Considering then, as in Thirlwall's (1979) model, that the balance of payments equilibrium is given by:

$$(29) \quad m + e_r = x$$

then we can find the equilibrium of the balance of payments by substituting equations (27) and (28) in equation (29):

(30)

$$y = \frac{[\sigma_{xLT} \mu_{xLT} + (1 - \sigma_{xLT}) \mu_{xHT}] z + [\sigma_{xLT} \theta_{xLT} - \sigma_{mLT} \theta_{mLT} + (1 - \sigma_{xLT}) \theta_{xHT} - (1 - \sigma_{mLT}) \theta_{mHT}] e_r - e_r}{[\sigma_{mLT} \mu_{mLT} + (1 - \sigma_{mLT}) \mu_{mHT}]}$$

If we assume that changes the terms of trade do not affect the long-term output growth rate, then we have what we call the Multi-Sectoral Thirlwall's Law (MSTL)[27]:

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[24] For simplification we do not include the subdivision of the international economy.

[25] Extensions of this model may also include differences in income elasticities of demand of different social strata (workers and capitalists), although this will sharply increase model's complexity. Since this approach is beyond the more direct interest in this work, these expansions are left for future studies. It should be noted that by disaggregating y in equation (26) it is possible to analyze the interaction between sectoral composition and income distribution.

[26] We consider here the effects of terms of trade according to the general price level. Although it is possible to incorporate sectoral price changes to the model, such inclusion would complicate the analysis as well. Such an extension is also left for future work.

[27] This term was proposed by Araujo and Lima (2007). Although the derivation of the model is different, the implications and interpretation of the final outcome of the model are the same.

$$(31) \quad y = \frac{[\sigma_{xLT}\mu_{xLT} + (1 - \sigma_{xLT})\mu_{xHT}]z}{[\sigma_{mLT}\mu_{mLT} + (1 - \sigma_{mLT})\mu_{mHT}]}$$

Equation (31) shows the long-term growth rate consistent with balance of payments equilibrium. Since the international income (z) is an exogenous variable, considering elasticities as constant[28], then the central factor to be examined is the evolution of the sectoral composition in the economy, i.e., the direction and pace of structural change. Once Gouvêa & Lima (2010) show that high-tech goods present higher income elasticity of demand, an increase in the share of the high-tech sector in the economy generates higher growth rates according to the MSTL.

Regarding the sectoral composition in the economy, we observed in the model described in the previous section that a higher share of high-tech output is obtained when its output growth rate is superior to the one in the low-tech sector. This pattern is observed when there is an acceleration of the productivity growth rate in the high-tech sector in the case of a *profit-led* regime; or in face of higher wage growth rate in a *wage-led* regime.

Since $\delta_{LT} = Y_{LT}/Y$, linearizing this equation and substituting (26) in it we have:

$$(32) \quad \hat{\delta}_{LT} = y_{LT} - \delta_{LT}y_{LT} - (1 - \delta_{LT})y_{HT} = (1 - \delta_{LT})(y_{LT} - y_{HT})$$

where $\hat{\delta}_{LT}$ is the growth rate of the share of the low-tech sector in the economy as a whole. This growth rate determines the sectoral division of the economy, i.e., determines the direction and magnitude of the ongoing structural change. From (32) one can observe that structural change is determined by the difference between the growth rates of the two sectors.

Substituting (20) in (3), and then (32), we now have:

$$(33) \quad \hat{\delta}_{LT} = (1 - \delta_{LT})(y_{LT} + \hat{k}_{HT} + g_{HT} - i_{HT} - \xi_{HT})$$

Equation (33) shows that the higher the growth rates of investment and productivity in the high-tech sector, the lower the growth rate of the share of the low-tech sector in the economy. On the other hand, the higher the capital-labor ratio growth rate and the higher the idle capacity growth rate in the high-tech sector, the greater the share of the low-tech sector. An increase in capital per worker makes it possible to achieve the same output with lower employment, which increases employment in the low-tech sector, increasing its production and hence also its participation in the economy. If productivity and investment growth rates in the high-tech sector are higher than the growth rate of the low-tech sector plus the capital-labor ratio and idle capacity growth rates, then the rate of growth of the low-tech sector will be negative, i.e., there will be an increased participation of the high-tech sector in the economy. We could represent it by showing that $\delta_{BTt+1} = \delta_{BTt} \pm \hat{\delta}_{BTt}$, where the subscript t denotes time.

Finally, if we consider that the share of each sector in the economy determines also its participation in exports, and that it is inversely related to the share of imports of each sector's goods in total imports, then we have:

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[28] If found that the elasticities vary from country to country, so they can be linked to institutional factors specific to each. These institutional factors can encourage or restrict short term and long term growth. Although this model extension is possible in the present work we chose to focus only on structural change as a determinant of the MSTL.

(34) $\delta_{LT} = \rho_x \sigma_{xLT}$

(35) $\delta_{LT} = -\rho_m \sigma_{mLT}$

where ρ_x, ρ_m are parameters of proportionality. Thus, it becomes possible to incorporate the growth rate of the sectoral share of exports and imports directly into the model. Substituting (34) and (35) in (33) we have:

(36) $\hat{\sigma}_{xLT} = (1 - \rho_x \sigma_{xLT})(y_{LT} + \hat{k}_{HT} + g_{HT} - i_{HT} - \xi_{HT})$.

(37) $\hat{\sigma}_{mLT} = (1 + \rho_m \sigma_{mLT})(-y_{LT} - \hat{k}_{HT} - g_{HT} + i_{HT} + \xi_{HT})$.[29]

In sum, considering a *profit-led* economy, it is clear that increasing the productivity growth rate exert a direct positive effect on the growth rate of the share of the high-tech sector in the economy by boosting investment and capacity utilization, and reducing the output in the low-tech sector.

Regarding a *wage-led* economy as it is expected that an underdeveloped economy be (where the ability to invest is low), an increase in the rate of growth of the share of the high-tech sector in the economy is driven by increases in demand, which elevates the output growth rate in the high-tech sector due to increases in investment and in capacity utilization, raising its productivity growth rate and therefore reducing the output growth rate in the low-tech sector.

The variables included in equations (36) and (37), in turn, are determined by the structural heterogeneity model presented in the previous section. Therefore, by substituting (34) and (35) in (31), the equations are incorporated into the model of structural heterogeneity as a restriction on equation (26):

(38) $y = \delta_{LT} y_{LT} + (1 - \delta_{LT}) y_{HT} \leq \dfrac{[(\delta_{LT} / \rho_x)\mu_{xLT} + (1 - \delta_{LT} / \rho_x)\mu_{xHT}]z}{[(1 + \delta_{LT} / \rho_m)\mu_{mHT} - (\delta_{LT} / \rho_m)\mu_{mLT}]}$

Equation (38) shows that changes in the sectoral composition of the economy (δ_{LT}) also imply changes in sectoral composition of imports and exports, making both sides of the inequality to change. Assuming then that $\mu_{xHT} > \mu_{xLT}, \mu_{mHT} > \mu_{mLT}$, as done by Prebisch (2000a) and confirmed by Gouvêa & Lima's (2010) tests, a reduction in δ_{LT} causes an increase in the right handside of the inequality, representing a relaxation of the external constraint on growth, which allows for greater economic growth over time – determined by the left handside of the inequality.

4. Determinants of innovation

The last point to be addressed in order to cover all the constraints on peripheral development refers to the determinants of technological innovations that, according to equations (9), (11) and (20), not only influence the rate of productivity growth in both sectors, but also - and most importantly - the rate of investment growth in the high-tech sector. However, beyond the direct effects highlighted, the consolidation of an effective NIS impacts the parameters ϕ_1, ϕ_2

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[29] Linearising equations (34) and (35) we have: $\hat{\delta}_{LT} = \hat{\sigma}_{xLT}$, $\hat{\delta}_{LT} = -\hat{\sigma}_{mLT}$.

and ϕ_3 in equation (20), and the income elasticities of demand for imports and exports in both sectors through the increase of the non-price competitiveness of the economy as a whole.[30]

First, it is crucial to highlight the concept of NIS used here. Neo-Schumpeterian theorists usually emphasize the role of organizations (universities, research centers, firms, technological parks, etc.) that integrate what they call NIS (Nelson and Winter, 2002). Nevertheless, lately, Nelson (2002; 2008) has been trying to expand this analysis to incorporate a broader concept of institutions. Following that trend, we take into account the concept of institutions stated by Hodgson (2006)[31], which is also compatible with North's (1990) approach. In that sense, government policies normally create formal institutions by changing "the rules of the game". Through the constitutive role of institutions (Chang, 2006a), those policies create motivations and habits, which with time are incorporated as informal institutions. Through the habit of seeking and implementing investment and innovation the abilities and institutions necessary for the development process to take place are consistently created.

Taking into account the well succeeded experience of the East Asian counties (Chang, 2006b; Lall, 2006) we consider that the four most important state policies that integrate an effective NIS are: (i) industrial policy; (ii) education policy[32]; (iii) credit policy; (iv) income inequality reducing policy. By taking effective measures on those areas underdeveloped countries governments cope with all the four constraints on the development of a peripheral economy.

$$(39) \ t_i = \zeta_1 + \zeta_2 q + \zeta_3 educ + \zeta_4 GAP$$

where $GAP = \dfrac{T}{T*}$, which represents the ratio of the productivity of the leading country ($T *$) and the peripheral country (T). The variable *educ* represents the influence of education on the rate of growth of innovations. The variable q, in its turn, seeks to measure the impact of the industrial policy.

The impact of investment on the innovations (usually associated with *learn-by-doing*) is incorporated in the *GAP*. In the model presented in the previous section we find that increases in investment drive increases in output, which elevate productivity in the high-tech sector. This productivity gain reduces the *GAP,* and thus has a positive impact on the growth of innovation,

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[30] The parameters would be positively influenced by an increase in the ability to invest of entrepreneurs. Investment in the high-tech sector would also require accumulated knowledge on the sector, therefore the emphasis on knowledge accumulation as one of the pillars of an effective NIS. In sum, variations of the three above mentioned parameters are given by shifts in innovations, which represent a proxy for the level of development of the NIS. Regarding the income elasticities, the increase in non-price competitiveness would increase the income elasticities of demand for exports in both sectors, while reducing the income elasticity for imports of goods of both sectors. Nevertheless, it is important to highlight that the effects would be higher in the HT sector, which is more prone to such gains. Moreover, the effects on exports and imports would also be asymmetrical due to the preference for variety, Hence, the decrease of imports would be lower than the increase of exports elasticities.

[31] Hodgson (2006, p. 2) defines institutions as "the system of established and prevalent social rules that structure social interactions", or simply social rules that guide the behavior of individuals.

[32] It is noteworthy to mention that education is crucial not only to increase innovations in the economy, but also to make it possible for workers to transfer from the LT sector to the HT sector. This is another channel that stresses the importance of the development of the NIS to promote structural change and development.

since knowledge approaches the technological frontier[33]. Moreover, once changes in income distribution[34] and in credit availability influence investment and idle capacity – equations (24) and (21) – they would also be captured by the *GAP* variable. Hence, those variables present an indirect[35] effect on innovations.

Thus, it is clear that the generation of innovations, which is the result of NIS development, represents a strong impact on the speed of development of a country. It not only provides productivity gains in both sectors of the economy[36], but also influences investment[37] and the profit and demand elasticities of investment[38]. Therefore, building an efficient NIS is fundamental to the development of underdeveloped countries, given the impetus it provides for growth.

Nevertheless, it is important to stress the difference between a dual model and a multi-sectoral model. In a model with many sectors, although investment be linked to structural change, it is not necessarily associated with an increased level of high-tech output. On the contrary, it can represent an increase of already existing traditional manufacturing sectors. In a dual model as the one presented here, it is considered that investment and/or reduction in idle capacity represent (i) structural change, (ii) productivity growth and (iii) increase of the technological content of production (non-price competitiveness). Such a framework is a result of the high aggregation of the model, which has only two sectors. Higher division, however, would imply an enormous increase in model's complexity.

In this sense, it is considered that the development of the NIS is essential for these three factors actually to occur simultaneously. In general, it is arguable that without the development of the NIS investment will not be able to reach sufficient magnitude to create the necessary structural change[39]. Moreover, the NIS development guarantees that investment will not only modernize the existing machinery, but also increase the technological content of the goods produced.

Hence, the development of the NIS is considered crucial to the success of the development strategies and ensures that the investment is associated with structural change and technological upgrading.

5. *Final Considerations*

The model developed in this paper extends the original formulation of Rada (2007) with the aim to describe in more detail the working dynamics of peripheral economies. In particular, for describing periphery's characteristics listed in the introduction – i.e., (i) structural heterogeneity; (ii) low private capacity of investment and innovation; (iii) balance of payments constraint; (iv) income inequality – the most profound changes were implemented in the

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[33] In Fagerberg's (1988) model the GAP is used to demonstrate the possibility of acquiring free knowledge and is negatively related to the technological frontier. That is, the lower the GAP, the less a country can incorporate free knowledge. Here the link is to innovation: therefore, the lower the GAP, the closer a country is to the technological frontier and the greater the possibility of creating innovations.

[34] Income distribution policies would appear in the model as artificial increases in the wage mass growth rate.

[35] Another possibility is to consider that the reduction of the income inequality has a positive impact on the level of education of the population.

[36] Equation (9) and (11).

[37] Equation (24).

[38] Equation (37).

[39] It is important to remember that it is necessary that the investment be large enough not only to substitute capital that depreciates, but also to incorporate population growth and part of the low-tech workers.

investment equation, and with the introduction of the equations of the Multi-Sectoral Thirlwall Law and of the growth rate of innovations.

Although these changes have increased the apparent complexity of the model, detailed analysis of its implications made throughout the paper sought to demonstrate that the new specification has been successful in formalizing relations and concepts that were scattered in the economic literature. The model keeps the same results found in the models of Bhaduri & Marglin (1990), Rada (2007) and Fagerberg (1988), and highlights the peculiar characteristics of investment in underdeveloped countries, so dear to classical theories of economic development. Therefore, concepts and intuitions from the Kaldorian-Keynesian traditions are integrated to the contributions of ECLAC-structuralist, institutionalist and neo-schumpeterian approaches.

Nonetheless, the main idea of this paper is to show that the development of an efficient NIS accelerates investment/capacity utilization and innovations, which are the engines of structural change towards a sectoral composition of local production more technologically intensive. This process would make it possible to simultaneously overcome the four constraints mentioned. This idea is introduced to the model through the impacts of innovations in the productivity of both sectors and in investment in the high-tech sector. Innovations are then made endogenous by introducing an equation with its determinants.

However, the broad concept of NIS adopted in the paper takes into account other elements that indirectly affect innovations, such as inequality reducing policies and industrial policies (Albuquerque, 2007; Chang, 2006b). The reduction of inequality, understood as increasing the share of wages in national income, provides new impetus to investment in *wage-led* economies as underdeveloped ones are expected to be, contributing to the acceleration of structural change and learning. On its turn, structural change leads to the relaxation of the balance of payments constraint on output growth according to the MSTL, thus enabling these transformations to continue.

Therefore, only through the development of an efficient NIS becomes possible to overcome the various constraints on periphery's development. Hence, the concept of development implied by the model is compatible with the various approaches in the literature of development economics. The end result is a more complete and relatively simple model of economic development which incorporates the various aspects of the working dynamics of peripheral economies.

Finally, it is important to emphasize that the model provides explanation for the Latin American and East Asian development experiences described by McMillan and Rodrik (2011) and Cimoli, Porcile and Rovira (2010). Hence, although the relationships presented in the model need yet to be tested, evidences indicate their validity. Moreover, the model is also capable of illustrating the dynamics that led to the recent European crisis. The current account problems faced by the south countries (Greece, Portugal and Spain, as well as Ireland in the north) could be understood as the result of a yet inefficient NIS configuration, which resulted in lower non-price competitiveness of production (and incomplete structural change) and led to BP problems. These deficits conducted to the increase of their debt while it was possible to finance growth that way. These brief considerations only seek to illustrate how this model presents itself as important tool for analyzing development dynamics in general, with great possibilities of expansion and application.

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