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A Kaldorian Approach to Catch-up and Structural Change in Economies with a High Degree of Heterogeneity

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1. Introduction

The long tradition of Keynesian growth models emphasizes distributional aspects as well as capital accumulation and the endogenous incorporation of technical progress associated to it to explain differences in growth trajectories among economies. In this tradition, demand-driven growth models are built based on the assumption that the dynamics of capital accumulation follow profit incentives that firms foresee in the long run, which, in turn, depend on the functional distribution of income. In this context, growth of aggregate demand and how it is distributed between wages and profits has an important influence on long-term growth.

The aim of this paper is to develop a simple growth model, based on Kaldor's main contributions, to discuss the specificities in the catch-up process[1] of developing economies with high degrees of structural heterogeneity, as observed in late industrialized economies in Latin America.[2] We argue that modernizing the domestic stock of capital can reduce the technological gap and thus obtain a faster growth rate without

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[1] The catch-up will be understood as the process that allows an economy to narrow its technological gap in relation to the leader.

[2] For a historical analysis of industrialization in Latin America see Bertola and Ocampo (2010).

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producing disequilibrium in the balance of payments in the long run. From Kaldor and Mirrlees' (1962) writings, we mainly consider the hypothesis of endogenous technical progress, as it is incorporated in the machines, and so the rhythm with which it is introduced in an economy depends on capital accumulation. In a competitive environment, capitalist firms will innovate in order to sustain profits and keep market share. From Kaldor (1966; 1970) we consider the contributions to the development of a demand-led growth model with cumulative causation, which provided the bases for the latter export-led growth models.[3] The more recent generation of models, following Thirlwall's contributions, stress that the difference between the import and export income elasticity of demand represents an external constraint to growth for any economy. In order to reduce this constraint, economies should promote structural change, that is to say, should aim at increasing the export income elasticity and reducing its import counterpart. In succeeding in doing so, they would increase non-price competitiveness.

The literature on growth models takes as its reference a typical capitalist economy and generally does not assume that there are important structural differences between groups of capitalist economies, allowing for the identification of 'central' and 'peripheral' countries in global capitalism. The central economies are those where the most advanced production techniques penetrate first, while the periphery is made up of economies whose production lags behind, both in terms of technology and organization (Rodriguez, 2009, p. 81). Hence, important technological asymmetries can be assumed to exist between capitalist economies, asymmetries that may be characterised as a technological gap.[4] This technological gap is seen as the basic reason why growth of productivity – and consequently of per capita income – is lower at the periphery than the centre, leading to unequal development between the two.

[3] In his writings, Kaldor focused on different components of aggregate demand and on their role in the growth process, by using several descriptive analytical methods. A multiplicity of ideas and analyses shows the fertility of Kaldor's line of thought (Commendatore *et al*., 2003, p. 134).

[4] On the concept of technological gap, see Fagerberg (1988).

In this context, the elimination of the technological gap is a necessary condition for a peripheral economy to catch up with the developed or central economies. Since technical progress is largely incorporated in new machinery and equipment, the reduction of the technological gap presupposes a greater effort to accumulate capital by peripheral rather than by central economies. The presence of a heterogeneous productive structure, observed among other things through a high number of informal workers in peripheral economies, may turn the accumulation process less dynamic than it would be required in order to close the technological gap. According to Cimoli *et al*. (2006), economies with a large informal sector will display low levels of productivity and a greater technological gap.[5]

This paper is organized in six sections including this introduction. In section 2 we present the relation between capital accumulation and technological progress based on the Kaldor-Mirrlees growth model. In section 3 we present a model that integrates the external restriction and investment in the modernization of capital equipment in a context of structural change, based on the post Keynesian literature on balance of payments constrained growth. In section 4 we introduce the discussion about catch-up, income distribution, structural heterogeneity and the technological gap, based on the structuralist literature. In section 5 we analyze stylized facts in the Latin American industrialization process based on the model developed in order to illustrate its analytical potential. Finally, in section 6 we summarize our conclusions.

2. Investment in modernizing the stock of capital and the generation of profits: Kaldor-Mirrlees' assessment

Given that our interest is in building a simple theoretical model that explains the technological gap and structural change in highly

[5] Lewis, in his classic work ([1954] 1969), argued that in the presence of a large informal sector, increases in average productivity are not passed on to wages. Only a change in the productive structure of the economy, increasing the weight of the modern capitalist sector, would accelerate the rate of growth and the increase in average productivity, and the wage rate.

heterogeneous economies, we should be able to show that there is a meaningful relation between the technological gap and the productive structure and that capital accumulation can reduce any technological gap by promoting structural change. We start advancing the theoretical hypothesis that investment in the latest generation of capital equipment should precede structural change. This is so because we assume, following Kaldor and Mirrlees (1962), that technological progress is incorporated in new machinery and equipment.[6] If we consider also that there is a not negligible technological gap between developed and developing countries, we can conclude that structural change results in a faster process of capital accumulation, in which companies of the developing countries acquire new capital goods and thus enhance their technological qualifications, which works to close the technological gap.

The growth model developed by Kaldor and Mirrlees starts from the traditional Keynesian approach, in which companies' investment decisions play a fundamental role in output growth. In *A New Model of Economic Growth*, technical progress is treated explicitly as a rate of modernization of the machines, that is to say, the introduction of a new 'vintage' of machines, and it is assumed to be the main determinant of economic growth. According to the Kaldor-Mirrlees model, in each period, machines that are newly produced will be more productive than ones produced in the previous period. Therefore, the machines produced today are technically better than those from the past. In other words, the machines in use from a determined vintage have the same efficiency over their useful lifetimes, but machines from the most recent 'vintage' are more productive than those from before. This assumption derives from the fact that the latest technology is incorporated in the most recent vintage.

However, a machine can be retired before it reaches the end of its useful life due to 'technological obsolescence.' This term is employed by Kaldor and Mirrlees to explain when the machine's profitability becomes zero. Thus the capital good will be in operation only as long as its

[6] See, for instance, Targetti (1992, chapter 5), for a discussion about technical progress in Kaldor's growth models.

revenue is greater than or equal to its variable costs. In the words of Kaldor and Mirrlees (1962, p. 179):

> "[…] since equipment will only be employed so long as its operation more than covers prime costs, the profits on the oldest yet surviving machinery must be zero, hence $P_{t-T} = W_t$."

Defining (P_{t-T}) as profits, the income appropriated by the machine owners, and (W_t) as the wage bill, the authors assume that $P_{t-T} = Q_t - W_t$ where (Q_t) is the revenue generated by the sale of the output. If the wage bill is higher than the revenue generated by output, profits will be negative. Following Kaldor and Mirrlees, the subscript (*t-T*) means the number of years the machine has been used until today, and so *T* means the number of years the machine is designed to operate, that is, its lifetime So, the minimum condition to keep the machine in operation is given when:

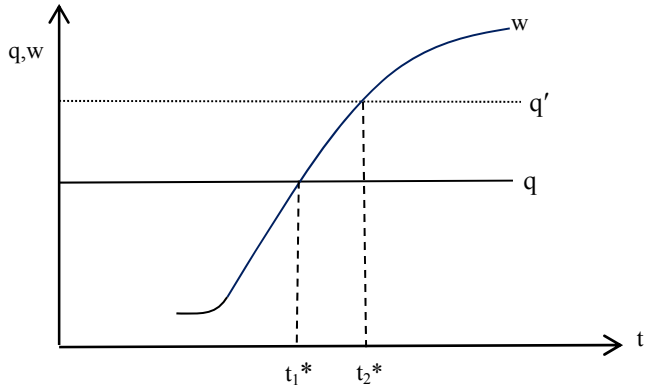
$$Q_t = W_t \tag{1}$$

Assuming equation (1) in real terms, it indicates the moment the machine ceases to be profitable, that is to say the economic profit becomes zero. When the revenue generated by the machine reaches this point in time, it means that it has become technologically obsolete. Given these suppositions, the authors conclude that (1962, p. 174), "[…] obsolescence [is] caused by the fact that the profitability of plant and equipment of any particular vintage must continually diminish in time owing to competition of equipment of superior efficiency installed at subsequent date." In this context, profit is the stimulus for the entrepreneur to invest in new and more modern machines, to replace unprofitable ones and boost productivity, and consequently national income. This process throughout the economy represents investment in modernization of capital that increases labour productivity.[7]

[7] Kaldor and Mirrlees (1962), as well as Kaldor (1957), argued that the rate of productivity growth, as well as that of technical progress itself, is endogenous to the growth rate of the investment per worker. However, technical progress is due in part to improvement in human capital. In this case, the improvement in human capital can occur through a worker's experience with new machines such as Kaldor's learning-by-doing and Myrdal's cumulative causation approach.

To explain why less productive machines should be replaced, the model considers that the average wage will tend to rise, due to the assumption of increasing marginal productivity of labour,[8] while the efficiency of the machine is assumed to be constant throughout its lifetime. This is illustrated in Figure 1, where t_1* is the moment in time when the rate of growth of the wage (*w*) equals the rate of growth of productivity (*q*). At this point, according to (1), the machine is technologically obsolete. The entrepreneur must replace the machine to recover its profitability, as the investment in new and, it is assumed, more advanced machinery will increase capital productivity above the average wage. After the replacement, illustrated by *q'*, profits are increased until the point when *w* matches *q'* in t_2*.

Figure 1 - *Productivity and wage movements due to economic growth*



[8] Kaldor and Mirrlees (1962, p. 176) assume "[…] that machines of each vintage are of constant physical efficiency during their lifetime, so that the growth of productivity in the economy is interlay due to the infusion of new machines into the system through gross investment. [So] a technical progress function makes the annual rates of growth of productivity per worker operating on new equipment a function of the rate of growth of investment per worker [… because of this] a constant rate of investment per worker overtime will itself increase productivity per worker."

So, the process of replacing machines is profit-driven, and the modernization of the stock of capital can speed up when either (i) the real wage increases faster than productivity; this can happen when wage goods become relatively more expensive than capital goods and, in an open economy, when the local currency appreciates, or (ii) the 'technology incorporation rate' accelerates, i.e. more new machines appear in the market in a shorter period of time because of faster incorporation of the latest technical innovations. The inverse of the latter would lengthen the average economic lifetime of capital (by delaying the technological obsolescence of capital).[9] From the standpoint of international competition, a longer economic lifetime of the domestic stock of machines could impair competitiveness relatively to foreign competitors. Also, economies with a large informal labour market, where the wage pressure is not strong enough to push the capitalist sector to replace capital stock, could delay structural change towards more technologically advanced sectors.

In sum, for Kaldor and Mirrlees the introduction of machinery and equipment of the latest generation is fundamental to determining the pace of economic growth. If, on one hand, these investments expand productive capacity and increase aggregate productivity, on the other hand, they boost demand for capital goods and so can accelerate the incorporation of innovations in the machines the capital goods sector produces. In this way, the capital goods sector, due to its dynamic nature, plays an important role in determining economic growth and the country's international position. Hence, the process of industrialization towards more dynamic sectors can also permit technological progress to be reflected in an increase in wages instead of just a reduction in prices and a reduction in the degree of informality in the labour market.

In the development of the model presented in section 3, the technological gap is represented by the difference in the average age of

[9] Also, the rate of incorporated new technology depends on the nature of the capital good in to which it is incorporated. Capital goods with low technological intensity tend to have a slower incorporation rate than those that have greater technological content. For example, the rate of technology incorporation in the machinery used in the food industry is comparatively slower than that in the aeronautical industry.

the stock of capital between the less technologically developed country and those at the technological frontier,[10] assuming that the internal economy's stock of capital is older than that of the frontier. Our aim with this model is to show how modernizing the domestic stock of capital in relation to the external stock of capital can reduce the technological gap and thus obtain a faster growth rate without producing disequilibrium in the balance of payments.

3. A model of capital accumulation with an external constraint: endogenizing the income elasticities of Thirlwall's model

The aim of this section is to introduce the analytical perspective of the Kaldor and Mirrlees (1962) model to the context of growth models with a balance of payments constraint. In this sense, the idea of investment in the latest-generation of capital equipment derived from the Kaldor-Mirrlees model can be introduced into the model of balance of payments constraints by Thirlwall (1979), associating the dependence of the income elasticities of imports and exports with the average age of the economy's stock of capital. Elaborating this association in analytical form, we will draw a connection between the growth rate compatible with balance of payments equilibrium and the guaranteed growth rate, the latter being defined as the rate of growth that guarantees the full utilization of the productive capacity as capital accumulation and savings grow at the same rate. Therefore, we will show that an effort to accumulate capital can relax the external constraint, if it promotes structural change.

A simple formalization of the concept of growth rate compatible with balance of payments equilibrium can be found in Thirlwall (1979) and McCombie and Thirlwall (1994), among others. As in Thirlwall

[10] According to Verspagen (1993, p. 128), the technological gap is a ratio between the technological capacities of a certain country and the technological frontier. In this form, for Verspagen, G (technological gap) is: $G = Tn/Ts$, where T is the technological capacity of the North (n) and South (s). Observe that in this paper, below, we define T/T^* as the measure of the technological gap, which is represented by the ratio between the useful lifetimes of capital goods in domestic and foreign economies.

(1979, p. 49), considering that the Marshall-Lerner condition is satisfied or the relative price measure in a common currency does not change over the long run, we define the growth rate of real output that is compatible with balance of payments equilibrium as:[11]

$$y_t = \frac{\varepsilon_t}{\pi_t} y_t^* \tag{2}$$

Where y_t is the growth rate of output, ε_t is exports income elasticity, π_t is imports income elasticity and y_t^* is the rate of growth of the rest of the world's income. Equation (2) is the well known Thirlwall's Law. This law, as represented, points out that international mobility of capital is irrelevant to long term equilibrium, as countries cannot borrow indefinitely to finance their deficits in current account.[12] We will assume in this paper that the current account deficit has a negligible impact on the rate of growth consistent with the balance of payments (see McCombie and Roberts, 2002, p. 94, for an explanation of the limits of current account deficits accepted by financial markets). Thus, Equation (2) can be considered a good approximation of the external constraint to economic growth in the long run. By assumption, capital accumulation does not affect Thirlwall's Law since the income elasticities of exports (ε_t) and imports (π_t) depend on the productive structure, which is considered to be independent of the pace of capital accumulation.

However our objective is to endogenize the income elasticities of Thirlwall's model to make them dependent on the average age of the stock of capital in the economy, following Kaldor and Mirrlees (1962). We assume that the more modern or newer an economy's capital goods are, the greater will be the technological content of its output, and hence the greater the income elasticity of its exports and the lower the income

[11] According to Thirlwall (1979, p. 52), within limits, demand can generate its own supply by encouraging investment, absorbing underemployment, raising productivity growth, and so on.

[12] An extension of Thirlwall's model for an economy with capital flows can be found in Moreno-Brid (1998-1999), among others. It should be observed that in this paper, direct investment, that includes mainly the financing of imported capital goods, will be considered relevant to the catch-up process. See also section 4.

elasticity of its imports. Therefore, it is possible to associate the growth rate compatible with the equilibrium in the balance of payments and the guaranteed growth rate. An increase in the effort to accumulate capital, with an impact on the productive structure, will lead, through modernization of the industrial sector, to an increase in the technological content of exports and hence an increase in the income elasticity of exports and the growth rate compatible with balance of payments equilibrium.

Thus, we assume that the ratio between these elasticities is linked to the technological gap and has an inverse relation to the ratio between the useful lifetimes of capital goods in domestic and foreign economies:

$$\frac{\varepsilon_t}{\pi_t} = f_1\left(\frac{T_t}{T_t^*}\right), \qquad f_1^{'} < 0 \tag{3}$$

where T_t is the average useful life of domestic capital goods, T^*_t is the average useful life of foreign capital goods, and the ratio between the two variables is a measure of the technological gap (see Verspagen, 1993). Thus, the productive structure of both economies (domestic and foreign) will depend on the average age of the stock of capital in each one.

If $T > T^*$, that is if the time interval after which the domestic equipment is replaced is greater than that abroad, the pace of substituting domestic capital equipment is slower than it is abroad, meaning that technical progress occurs faster abroad. This causes the technological gap between the two economies to widen.[13] With this reasoning, we can assume there is an inverse relation between the variation of the income elasticities of exports and imports and the ratio T_t / T^*_t. Suppose that a fall in the income elasticity of exports (ε) occurs relative to the income elasticity of imports (π). Then we assume this decline indicates that the rate of substitution of capital equipment in the domestic economy has become slower than that in the external economy, i.e., the ratio T_t / T^*_t has increased. Therefore, if $T > T^*$, then $\varepsilon < \pi$. The inverse reasoning also applies.

[13] As in Cimoli (2005).

Based on equation (1) and on Foley and Michl (1999, p. 25), and assuming full utilization of productive capacity as in the Kaldor-Mirrlees model, we can associate the rate of growth of wages (w_t) and the rate of growth of productivity (q_t) to express the rate of growth of profits (p_t) as:

$$p_t = f_2\left(\frac{w_t}{q_t}\right), \qquad f_2^{'} < 0 \tag{4}$$

Equation (4) shows that the profit growth rate depends on the functional distribution of income and it establishes a negative relation between the growth rate of profits and the growth rate of wages, adjusted by the growth of productivity. When wages grow faster than productivity, profits will decrease and entrepreneurs will be stimulated to invest in new machinery in order to increase productivity and the share of profits. So, in full employment, increase in the profit share signals that investment in new machinery, with higher productivity, has been made and part of the capital stock has been renewed. This means to say that the average age of the capital stock depends on the functional distribution of income and we can write:

$$T_t = f_3\left(\frac{w_t}{q_t}\right), \qquad f_3^{'} < 0 \tag{5}$$

Then, substituting equation (4) in (5) we have,

$$T_t = f_4(p_t), \qquad f_4^{'} < 0 \tag{6}$$

Equation (6) shows that the average useful lifetime of domestic capital goods depends on the rate of profitability. From equation (6) we can consider an international relation:

$$\frac{T_t}{T_t^*} = f_5\left(\frac{p_t}{p_t^*}\right), \qquad f_5^{'} > 0 \tag{7}$$

Equation (7) shows that the ratio between the average useful lifetime of domestic capital equipment relative to that of foreign capital equipment depends on the ratio between the domestic and foreign rates of profit. Therefore, the technological gap depends on this difference. The reduction in the differences between the rates of profit decreases the

technological gap.[14] If this is the case, when wage costs are growing faster in the domestic economy than they are abroad (decreasing domestic rate of profit), then domestic capitalists will accelerate the investment to modernize their capital equipment to obtain higher productivity, in order to sustain profits in the face of the upward movement in wages (see Marquetti, 2004). It should be remarked that this is not often observed in economies with a high degree of informality in the labour market. In the Kaldor-Mirrlees model, wages are negatively correlated with the average useful life of machinery, making T an endogenous variable.

Assuming the existence of static and dynamic economies of scale, such as the fact that the growth of labour productivity in both economies depends on the growth rate of real output, so we can substitute equation (7) into equation (3):

$$\frac{\varepsilon_t}{\pi_t} = f_6\left(\frac{p_t}{p_t^*}\right), \qquad f_6^{'} < 0 \tag{8}$$

Then, substituting equation (8) into equation (2) leads to:

$$\frac{y_t}{y_t^*} = f_7\left(\frac{p_t}{p_t^*}\right), \qquad f_7^{'} < 0 \tag{9}$$

Equation (9) shows that the higher the domestic rate of return is vis-à-vis its external counterpart, the slower the pace of modernization of the domestic stock of capital is vis-à-vis the pace abroad, resulting in a lower growth rate of the domestic economy in relation to the more advanced one. The reason why the domestic rate of return would be greater than abroad is due to high heterogeneity in the productive structure, allowing for a relatively low wage rate in relation to abroad. With a higher rate of

[14] As profit rates in our model depend on the relation between wage cost and productivity we should remark upon the influence of technological capability on labour productivity. According to Sylos Labini (1984; 2004; Guarini, 2009), for example, the growth of labour productivity depends on two effects: the Smith effect and the Ricardo effect. In the first case, the growth of the market, stimulated by the division of labour, increases income, which affects labour productivity given the assumption of increasing returns to scale. The Ricardo effect is represented by the stimulus to invest in new machinery given the relative increase in the cost of labour. Both effects stimulate the introduction of innovations, increasing productivity, and in our model, would contribute to increase profits.

return in the domestic economy, companies feel less pressure to invest to modernize the country's stock of capital. Therefore, the model assumes induced innovation as a passive element of the investment in capital expenditure. The technological gap determines the difference between the income elasticities of exports and imports, and this in turn depends on the ratio between the useful lifetimes of domestic and foreign capital equipment.

3.1. Capital accumulation, structural change and technological gap in a dynamic setting

To evaluate the economy's growth dynamic, we start from the assumption that the growth rate of productive capacity (or potential output), $\overline{y_t}$, is proportional to the growth of the stock of capital k_t, according to Domar (1946, p. 140). Thus, we write:

$$\overline{y_t} = \sigma \cdot k_t \tag{10}$$

where σ determines the pace of growth and is defined by Domar as the potential social average productivity of capital. Domar argued that its magnitude depends to a great extent on technological progress, and is not directly affected by changes in the distribution of income. It refers to the increase in the potential capacity of the economy, and as such it varies among the economies (1946, p. 140). Applying the relation of equation (10) to the internal and external growth rates, we have:

$$\frac{\overline{y}_t}{\overline{y_t^*}} = \frac{\sigma}{\sigma^*}\frac{k_t}{k_t^*} \tag{11}$$

We assume that the growth rate of the desired stock of capital by companies has two components: one autonomous, represented by g_0, and

another dependent on the ratio between the domestic rate of return and that prevailing in the rest of the world,[15] g_1.[16] Therefore, we have:

$$\frac{k_t}{k_t^*} = g_0 + g_1\left(\frac{p_t}{p_t^*}\right) \tag{12}$$

Equation (12) shows that differences between the domestic and external rate of profit explain the differences between the domestic and external growth rate of the desired stock of capital. It is clear that both rates of desired stock of capital should converge in order that the technological gap be reduced. It should be noted that foreign direct investment, if attracted by the higher profit rate in the domestic economy compared to that abroad, could help in the modernization process of the domestic economy, helping to reduce the technological gap.

Going a step further, we can assume that for there to be balanced long-term growth it is necessary for output to grow at a rate equal to the growth of productive capacity.[17] More precisely, this means that:

$$\frac{y_t}{y_t^*} = \frac{\overline{y}_t}{\overline{y}_t^*} \tag{13}$$

From equations (11), (12) and (13), we have:

$$\frac{y_t}{y_t^*} = \sigma\left[g_0 + g_1\left(\frac{p_t}{p_t^*}\right)\right] \tag{14}$$

[15] The capital accumulation structure follows the tradition of the Harrod-Domar model, which ignores financial capital, that is, there is no external financing available to companies. Instead, companies finance themselves through retained earnings.

[16] This comes from the hypothesis of capital mobility among countries, in particular direct investment, so that an increase in the rate of return in the domestic economy relative to the rest of the world will induce an increase in foreign direct investment in the domestic economy, thus boosting growth of its stock of capital.

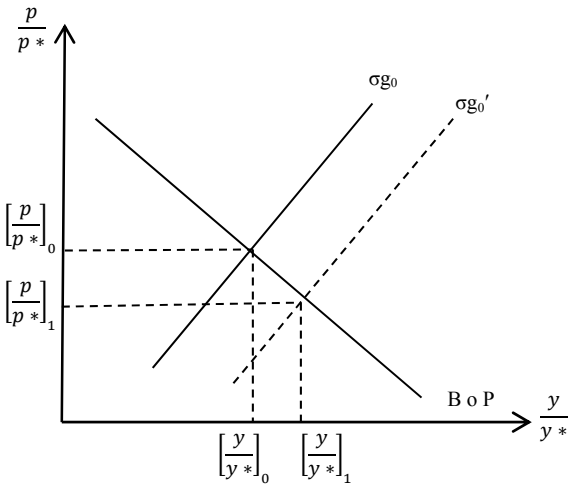
[17] It should be considered that according to Harrod (1939), it is possible to observe full productive capacity and unemployment, if the guaranteed growth rate is less than the natural growth rate. When this occurs, the increase in investment is not enough to absorb the excess labour force.

Equation (14), represented in Figure 2, gives the ratio between the growth rate in the domestic economy and its corresponding rate in the rest of the world, when the domestic economy is on a balanced growth path. On this path, output and productive capacity expand at the same rate. It is thus a concept equivalent to that of the "guaranteed growth rate" of Harrod's (1939) model.

Equations (9) and (13) form a dynamic system with two equations and two endogenous variables, namely: (i) the relative structure of the rates of profit and (ii) the relative structure of the rates of growth. Determination of the system's endogenous variables can be seen in Figure 2.

Figure 2 shows what happens to the growth dynamics if there is an exogenous increase in the pace of growth of the desired stock of capital by firms (an increase in autonomous investment). This increase will shift the locus of balanced growth downward and to the right, thus increasing the domestic economy's growth rate relative to that prevailing in the rest of the world. However, this acceleration in the accumulation of capital

Figure 2 – *Balanced growth with structural change*



will initially cause disequilibrium in the balance of payments, in the form of a current account deficit.

For the external equilibrium to be re-established it is necessary for the domestic rate of return to decline relatively to that in the rest of the world, thus inducing investments in more modern and productive capital equipment in the domestic economy to counteract the decline in profitability. It happens that the greater investment in capital equipment will act to reduce the technological gap, thus causing an increase in the ratio between the income elasticities of exports and of imports. The ratio increase should cause a structural change in the domestic economy that acts to increase its growth rate compatible with balance of payments equilibrium.

From our hypothesis, we can show that the external constraint on long-term growth can be relaxed through a structural change that narrows the technological gap between the domestic economy and the rest of the world, a change that is induced by a greater effort to accumulate capital by private domestic firms. Economies where labour market institutions are weak, due to the presence of a large informal sector, may provide fewer stimuli to the private sector to accumulate capital. It thus follows that capital accumulation is the engine that drives long-term growth in countries that are below the 'technological frontier.'[18]

[18] A word should be said about the role of institutions, which is not considered in the model. Actually, based on Kaldor, we assume that institutional changes are not enough to generate catch-up. This assumption is in sharp contrast with recent developments in growth theory, mainly the contributions by Acemoglu and Robinson (2011) and Aghion and Howitt (1998), among many others. Although Kaldor himself had not dealt with institutional change in a meaningful way, neo-Kaldorian models consider that institutional changes such as the (i) monetary financial system, (ii) State performance, (iii) competition regime, (iv) the wage relation and domestic prices, (v) exchange rate regime and (vi) capital movement, play a decisive role in growth of developing economies (among others: Setterfield, 1997; 1997a; 2010; Setterfield and Cornwall, 2002; Palley, 1996). However, neo-Kaldorian authors argue that the specific characteristics of these institutional forms cannot be defined a priori, but must be observed ex post, as a historical result. Furthermore, although institutional settings are relatively stable, such stability can be

Following a Schumpeterian line of reasoning, we can also say that the technological gap is an important determinant of the income elasticity of exports, and thus of the rate of growth compatible with balance of payments equilibrium (Dosi *et al*., 1990, p. 26). As a corollary, the growth rate that is compatible with balance of payments equilibrium tends to be higher in developed than in developing countries.[19]

4. Income distribution, structural heterogeneity and technological gap

Developed and developing countries have different productive structures reflecting the fundamental differences in their capacity both to produce their own technical knowledge and to imitate that developed in other parts of the world (Verspagen, 1993, p. 126). Also, they show marked differences in income distribution, due, among other factors, to the functioning of the labour market. So, the growth rate that is compatible with balance of payments equilibrium, which depends on the income elasticity of exports and imports, also depends on the productive structure and the functioning of the labour market, with a meaningful impact on income distribution.

In terms of the productive structure, developed economies show a greater participation of technologically more dynamic sectors in the productive structure than developing ones. Therefore, developed countries have a greater number of economic sectors in which firms operate on the so-called 'technological frontier,' and exhibit a greater productivity than developing economies. Hence, their export mix will be

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broken, by the exogenous nature of events, such as movements of the exogenous growth regime itself.

[19] Based on an econometric model of growth and North-South trade, Dutt (2003) shows that the income elasticity of exports of countries of the North to those of the South (that is, the income elasticity of imports in countries of the South) in the 1964-1995 period was 1.67, while the income elasticity of exports from the Southern countries to the Northern ones was 1.27. Therefore, the ratio between these two elasticities shows that, in long-term equilibrium, countries of the South must grow less than their Northern counterparts, thus generating a dynamic of divergence of per capita incomes over the long run.

made up mainly of products with high value added and high technological content, products for which the income elasticity of exports is high.

The low technological dynamism of developing countries explains the weakness of the growth impulses provided by the expansion of internal and external demand (Holland and Porcile, 2005, p. 42). For developing countries to reduce the external constraint to growth they must be able to make changes in their productive structure, including the reduction of the size of the informal labour market, which also causes a relatively low level of aggregate productivity. These changes must, in turn, enable changes in the income elasticity of demand for exported products so as to reduce the degree of exposure to external imbalances.

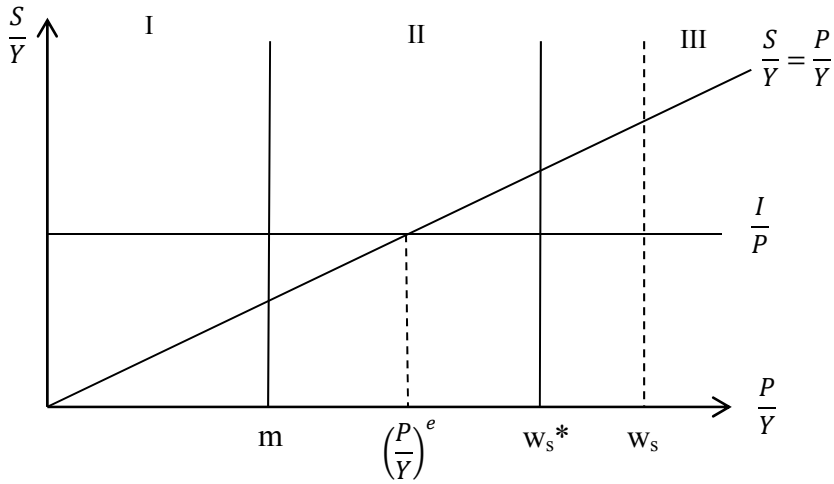
In terms of the income distribution, according to Kaldor, capital accumulation determines the generation of employment, but, as seen in section 2, it also depends on the income distribution between capitalists and workers. Kaldor (1955-1956) established that economic growth is induced by aggregate demand, and investment (assumed to be independent of the current income) under full employment would depend on the income distribution between wages and profits. Following Kaldor (1955-1956, p. 95), "[…] the model operates only if the two savings propensities differ and the marginal propensity to save from profits exceeds that from wages". Thus, the subsistence wage is a limit case where the wage earners' marginal saving is zero and the aggregate saving comes from profit earners' savings, i.e. the entrepreneurs.

The economic variables that provide the macroeconomic adjustments in the model in the short run, that is to say the variables that equal the saving rate (*S/Y*) and the investment rate (*I/Y*), are the wage rate and the margins of profit. Figure 3 shows that profit margins (*m*), represented by the degree of monopoly, and the subsistence wage (w_s^*) in the developed economy establish the boundaries in which the economy may operate until reaching the equilibrium in $(P/Y)^e$. Considering that the savings by capitalists determine profits, the flexibility of the profit rate (*P/Y*) in the developed economy would be limited by *m* and w_s^*, in region II.

In region II, when the rate of investment *(I/Y)* is greater than the saving rate (*S/Y*) (left of the equilibrium), there will be an excess of demand, pushing prices up, decreasing real wages and increasing profit margins. This will increase the participation of profits in income, which will increase the saving rate up to the point it equals the investment rate. The increase in nominal output will be the result of a re-distribution of income in favour of the capitalists. On the right side of the equilibrium, that is to say, when *S/Y* > *I/Y*, real wages will increase and profit margins will decrease, reducing *P/Y*, up to the point that it will equal the saving to income rate. So according to the early Kaldorian models, income distribution is the mechanism that adjusts both saving and investment, re-establishing the equilibrium in the product market.

Figure 3 also illustrates what might happen in economies with a high degree of structural heterogeneity and high informality in the labour market. These economies will show higher profit margins, as these can be sustained at levels above that of investments (region III). This can happen because there is no strong mechanism to push capitalists to invest their

Figure 3 – *Limits and strength of the adjustment mechanism of the profit rate in developed (region II) and developing economies (region III)*



profits in adopting new technology, as the subsistence wage rate (w_s), in this case, is located to the right of w^*_s. As a consequence, the profit rate in the developing economy will be higher than the developed one. In this sense we conclude that the greater the structural heterogeneity, the lesser the incentives to structural change towards more technological sectors occur. It is worth reminding that Kaldor deemed region II the stage of developed capitalism where wages would rise above the subsistence level. In our interpretation, the part of region III that corresponds to the distance between w^*_s and w_s represents the stage that a developing economy, with a high degree of structural heterogeneity, must overcome to become developed.

According to the structuralist tradition, the presence of a large informal labour market in developing economies contributes to keeping wages at a low level in the formal sector. Rodriguez (2009, p. 80) explains that as a result, high profit margins are sustained as the productivity gains of technological improvements are appropriated by firms. As a consequence, domestic markets are small in relation to the working population, and in such a context, the manufacturing sector can only be competitive when keeping wages relatively low (*ibid.*, p. 150). So, the existence of structural heterogeneity is explained by the persistence of the informal labour market that works as a structural barrier to a higher rate of long-term growth in developing economies. The co-existence of a formal and a large informal labour market increases disparities between the remunerations paid in both sectors of the economy and between wages paid in the domestic economy and abroad. This translates to a lower aggregate productivity in less developed countries. In terms of our model:

$$q < q^* \rightarrow w < w^*, \quad \text{however} \quad p > p^* \quad \text{and thus} \quad T > T^*.$$

In sum, countries where the profit rate is relatively higher than abroad will show a relatively lower level of wages in relation to that abroad. In Kaldorian terms, this means a weak incentive to incorporate technical progress, and the economy will show a relatively low rate of long-term growth, as its external constraint will be higher than that of economies at the technological frontier.

Before concluding this section, it is interesting to recall that Kaldor (1970) describes the growth process as a 'chain-reaction' path between demand and supply-side conditions, through a logical scheme of circular and cumulative causation. This logical scheme can be illustrated by developing economies that can overcome the barrier imposed by the high degree of heterogeneity in the productive structure and in the labour market, and reach a growth path that will promote the catching up.

As shown in section 3, in less developed economies, ones assumed to have a high degree of structural heterogeneity, the acceleration of the rhythm of investment in capital stock may be delayed in relation to developed economies because the domestic profit rate tends to be relatively higher than in developed economies. This implies that the rhythm of growth of production and aggregate productivity is relatively low. In this case, economic policy should be employed to raise autonomous investment, which should have a positive impact in the modernization of the capital stock, and promote structural change towards more technological sectors, consequently increasing aggregate productivity. The chain of causation running from an autonomous increase in demand, increasing production, to aggregate productivity is known as Verdoorn's law, which explains how demand and supply conditions interact to increase aggregate productivity. The increase in aggregate productivity should be the result of changes in the productive structure, which should improve the performance of the export sector, which, in turn, should improve aggregate income. The increase in aggregate demand and in productivity should increase real wages, which would induce private investment in the modernization of capital stock, and so on. A virtuous circle emerges as the increase in demand and in aggregate productivity is sustained by a structural change that increases the long-term growth rate that is compatible with the balance of payments equilibrium. It is assumed that the incentive to increase aggregate investment should work to stimulate the development of a local capital goods industry, and to consolidate a national system of innovation.

We should finally consider international direct investment. In this case, the greater profit rate in the peripheral countries should attract foreign investment. If this is the case, it would contribute to the catching

up process of developing economies, as foreign investment can contribute to reduce the average age of the domestic stock of capital, and so making p and p^* converge. However, it should be noted that this is true only if the foreign investment increases capital stock with the latest technology, implying that q and q^* and w and w^* will also converge. As a consequence, the informal sector should be reduced in size, implying the absorption of labour by the formal sector. If this process is well succeeded, the specialization of the formal sector could be increased and move in the direction of industries with higher technological content. Productive diversification favours extra-price competitiveness. According to Thirlwall and McCombie (1994), differences among export and import demand elasticities are related to disparities in non-price competitiveness (*ibid*., p. 265).

5. Catching up and structural change in highly heterogeneous economies: the Latin American industrialization experience until 1980

In this section, we shall consider the Latin American industrialization process since the Second World War as an illustrative case of our simple growth model to explain stylized facts of the catch-up process in latecomers with a high degree of heterogeneity in their productive structure. According to the structuralist literature, the economic history of Latin American economies has been marked by adjustments in the growth rate caused by external constraint. The external restriction is associated with the specialization pattern observed in most economies based on the economic exploitation of endowed natural resources. As established by Thirlwall's Law, it is the low income elasticity of exports of goods with low technological content with respect to imports that limits the growth potential of the economies. Therefore, the reduction of the external restriction would depend on the capacity of the economies to promote structural change with the intent of forming more dynamic technological sectors. From this analytical perspective,

industrialization emerges as a strategic tool to reduce external restriction and the technological gap.

The period covering the end of the Second World War until 1980 corresponds to the highest levels of growth in Latin America history (5.5% yearly). This is the time of 'state-led industrialization', which was characterized by increased focus on industrialization as the core of development and greater intervention by the state in order to accelerate the industrialization process via import substitution.

In terms of the model represented in Figure 2 (section 3.1), these characteristics mean that the increase in the accumulation rate driven by the state increased the potential of growth of the Latin American economies and, in this sense, reduced the technological gap. Indeed, according to Bertola and Ocampo (2010, table 4.6), industrialization flourished after the war in the region[20] as the share of manufacturing sector increased from 19.9% in 1950 to 26.7% in 1980. Industrialization was also followed by significant diversification in the productive structure, as non-traditional sectors totalled 60% of total value added for the manufacturing sector in South American economies in 1974 *(ibid*., table 4.7). Considering the ε/π ratio as a proxy for the evolution of the technological gap, Table 1 shows that for Brazil, Colombia, Mexico and Venezuela, technological gap narrowed during the period of rapid industrialization (1945-1980) when compared with the subsequent period (1980-2008). From the sample of countries, Argentina was the only major economy in the region that showed an opposite trend.

Table 1 – *Ratio of income elasticities of exports (ε) and imports (π) Sample of Latin American countries: 1945-80 and 1980-08*

	Argentina	Brazil	Chile	Colombia	Mexico	Uruguay	Venezuela
1945-80	0.3	9.0	0.7	1.5	1.6	0.3	2.1
1980-08	0.7	0.4	2.3	1.0	0.4	0.9	0.0

Source: extracted from Bertola and Ocampo (2010), table 1.8.

[20] Considering 18 Latin American countries: Brazil, Mexico, Argentina, Chile, Colombia, Peru, Uruguay, Venezuela, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Bolivia, Ecuador, Panama, Paraguay and Dominican Republic.

Although the catch-up process were successful during the state-led industrialization period for most Latin American economies, as described by the model proposed, the acceleration in the accumulation of capital causes disequilibrium in the balance of payments in the form of current account deficits. To re-establish the foreign equilibrium in order for it to become compatible with the greater growth potential, it is necessary that the external sector becomes more competitive, as a result of the structural change. Considering the Latin American industrialization process, greater productive diversification should have implied increased export competitiveness, which should result in a higher market share of global trade. Actually, the market share of Latin American exports decreased from 10.1% in 1953 to 4.8% in 1980, according to Bertola and Ocampo (2010, table 4.10). This means that the state-led-industrialization process, although responsible for the highest rates of capital accumulation and in promoting significant structural change in most of the economies in the continent, did not succeed in completing all the stages of industrialization, according to Kaldor (1970).[21]

One interpretation of this outcome, following the model proposed, is that the import substitution strategy should have reached more technologically intense sectors in order to increase the income elasticity of exports and, in that way, contribute to increase the share for Latin American exports. However, as suggested by Figure 3 (section 4), the high degree of heterogeneity in the labour market in Latin America implied a weak stimulus to induce the introduction of technical progress through capital accumulation. According to the Kaldor-Mirrlees model, the private incentive to invest in new and more productive equipment would come only from the fall in the domestic rate of return relative to the developed economies. Our model suggests that, in the Latin American case, domestic rates of return were kept higher than in developed countries. Two reasons can be pointed out to explain why this might have happened: the high degree of protectionism of the domestic market

[21] For a description of Kaldor's stages of industrialization, see Argyrous (1996).

(following the import substitution industrialization process), on the one hand, and the existence of a high degree of informality in the labour market, helping to keep urban wages relatively low, on the other. In this sense, the relatively higher rate of return in Latin American economies did not contribute to induce private capital accumulation to reduce the technological gap. As a consequence, as shown in several studies based on the neo-Schumpeterian literature,[22] Latin American economies did not succeeded in developing an endogenous system of innovation, an important step in the strategy to complete the industrialization process.[23]

It is exactly the relative failure to develop national innovation systems, an important condition to relax the external constraint to growth, which largely explains why Latin American economies are nowadays behind East Asia in terms of their degree of industrial development. In the early 1980s, after the Mexican default in 1982, Latin American economic growth came to a standstill. During the decade, it exhibited falling rates of capital accumulation, and, according to the model proposed, the decrease in capital accumulation implies a decrease in the balance-of-payments equilibrium growth rate. Low growth rates were accompanied by high inflation and, because of that, real wages showed high volatility, productivity stagnated and long-term investment was strongly discouraged.

6. Final remarks

Based on the contributions of Kaldor and his followers, in this paper we analyzed the relationship between capital accumulation, the technological gap and the long-term external restriction to growth of peripheral economies with high heterogeneity in their productive structure and in their labour market. Our hypothesis is that capital accumulation, under certain conditions, can overcome the external constraint on growth, as long as the accumulation effort is able to

[22] See for example Fajnzylber (1983).
[23] For a discussion about the stages of industrialization in Brazil, according to Kaldor's Laws, see Feijo and Lamonica (2012).

engender a structural change in these economies, i.e., to induce a transformation in the productive structure that increases the relative participation of more technologically dynamic sectors. This transformation should imply a reduction in informality in the labour market, increasing the share of wages in aggregate income. In this sense, based on the principle of circular causation, we have argued that a virtuous circle of growth will emerge when the structural shift will result in a gradual increase in the income elasticity of exports and a reduction in the income elasticity of imports, thus boosting the more technologically advanced sectors of the economy and the real output growth to a level compatible with long-term equilibrium in the balance-of-payments. However, the heterogeneity of the labour market may delay the introduction of technical progress, allowing the productive structure to be based solely on less dynamic sectors.

Based on the structuralist literature we proposed that a country's pattern of specialization is related to its level of technological development. Developed countries have a greater number of economic sectors where firms operate on the 'technological frontier' because they have a broader base (benchmark) of technological development than developing countries. Thus, the exports of developed countries mainly consist of products with higher added value and technological content. The technological development embodied in the production of consumer and capital goods leads to a structural composition of industry where sectors with greater technological intensity prevail. As a conclusion, for long-term growth, the local development of technology is more reliably consistent than importing it, as it reflects in a reduction in the degree of heterogeneity in labour market.

From this perspective, to close the technological gap, peripheral economies must be able to transform their productive structures, shifting toward sectors whose earnings are derived more from exploiting knowledge, in detriment to sectors whose earnings come mainly from the abundance of a production factor. The industrialization process of Latin American economies from the end of the Second World War until the end of the 1970s was an attempt to promote the catching up of these economies. The 'state-led industrialization,' according to ECLAC's

terminology, was rather successful in diversifying productive structures, with the growth in the share of the manufacturing sector. However, the presence of a highly heterogeneous labour market allowed for a relatively high rate of return, delaying the introduction of technical progress and the development of national systems of innovation.

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