Cumulative Causation in a Structural Economic Dynamic Approach to Economic Growth and Uneven Development

Araujo, Ricardo

University of Brasilia

29 March 2011

Cumulative Causation in a Structural Economic Dynamic Approach to Economic Growth and Uneven Development*

Ricardo Azevedo Araujo

Departament of Economics

University of Brasilia, Brazil

Abstract

The Structural Economic Dynamic approach is distinguished by its simultaneous approach to demand and supply sides of economic growth. However, the idea that growth itself can transform an economy, which became known in the literature as cumulative causation, cannot be properly studied by this framework because technological progress is treated in the same manner as in the traditional Neoclassical model, that is, it is exogenous. Besides, it is the only source of economy growth with no role played by demand in the pace of economic growth but only in the sectoral composition of the economy. Here we introduce Verdoon's Law in the Pasinetti's model of structural change thus making it able to study cumulative causation and thus rendering structural changes endogenous in this model.

JEL Classification: O19, F12

Keywords: Cumulative causation, structural change, Verdoon's law.

---

*Departament of Economics, University of Brasilia, Campus Universitário Darcy Ribeiro, Brasília, DF, Zip code 70910-900. E-mail: rsaaraujo@unb.br. I would like to thank Gilberto Tadeu Lima and John Hall for useful comments. The usual disclaimer applies. Financial support from the CNPq is acknowledged.

1. Introduction

Although cumulative causation and structural change are alien concepts to the mainstream economics they are central tenets of post-Keynesian growth theory and play an important role in explaining the contemporaneous process of economic development. A number of economists acknowledge that the quest for economic growth is related to the challenge of performing the proper structural changes fostering the growth of sectors that produce goods with potential high elasticity of demand [see Ocampo (2005), Cornwall and Cornwall (2002) and Fagerberger (2000)]. It is also acknowledged that economic growth has strong historical dependence linkages in which laggard countries faces struggles to catch up to the technological frontier and to shrink the income gap with the advanced ones.

The concept of cumulative causation was systematically developed by Kaldor[1] (1966, 1972) and has been addressed by a number of authors such as Skott (1988), Thirlwall and McCombie (1994), and Setterfield (1997) to describe one of the logical effects of what became known in the literature as the Verdoon's Law. According to Kaldor the disparities in the growth rates of advanced countries rely on a large extent to the effect of increasing returns to scale in industry, together with a fast growth of this

[1] In May 1983, the *Journal of Post Keynesian Economics* published a Symposium on Kaldor's growth law. According to Hall and Whybrow (2008, p.354) the notion of cumulative causation was firstly discussed by Veblen in his inquiry into the dynamic interplay of the material and immaterial in economic and social processes, and thus serves as the foundation for his efforts to develop an evolutionary theory for Economic Science. The roots of this idea may be found in the writings of Adam Smith for whom the division of labour is limited by the extent of the market. Young (1928) is also referred as pioneer in this tradition pointing out that many of the economies of scale results from greater differentiation, the emergence of new processes, etc.

sector. According to this view the growth rate of productivity is strongly determined by the growth rate of output, a view that reverts the direction of the causality posed by the Neoclassical model and gives demand a central role in the process of economic growth. The view that manufacturing plays a special role in terms of backward and forward linkages is related to economies of scale and explains why a faster growth of output led to faster growth of productivity. In this view economic growth is demand induced rather than resource constrained.

Intrinsically related to this process is structural change, which was formally studied by Pasinetti (1983, 1991) in his Structural Economic Dynamic – SED hereafter – approach. According to Pasinetti, it refers to changes in the sectoral structure of the economy due to the existence of particular rates of technological progress and variation of demand for each final consumption good. His emphasis on demand composition brings out an important qualitative improvement in relation to the aggregated models that cannot possibly take into account the composition of consumption demand since any increase in per capita income is transformed into a higher level of consumption of the same kind[2]. The importance of the structural change in the study of economic development cannot be minimized and some authors such as Ocampo considers that (2005, p. 8) "success in structural change is the key to economic development." Fagerberger (2000) goes a step further considering that structural changes play a very important role for overall productivity growth.

Although the Pasinettian approach has some advantages over the aggregated Neoclassical model, technological change is treated essentially in the same manner as in

[2] It is implicit in these models a well-known and strict definition of balanced growth: growth of a non-inflationary, full-capacity utilisation with all sectors growing at the same rate [Solow (1956)].

the mainstream view, with the exception that for each sector is assigned an exogenous rate of technological progress. Some attempts of providing a better treatment of technological progress in the Pasinettian framework were provided by some authors. Reati (1998) for instance have introduced long wages in this model to explain technological revolutions and have obtained a more complex dynamics for prices, output and employment level. Araujo and Teixeira (2010) have introduce investment specific technological progress in the this framework along with the traditional Harrod neutral technological progress and have conclude that the former have important effects not only on the structure of the economy but also on the composition of employment, challenging the view that embodied technological progress does not produce structural unemployment. Araujo and Teixeira (2011) also have tried to endogenize technological progress in the Pasinetti's framework by considering an evolutionary view of dynamic capabilities as fundamental driving forces of technological changes. In the same vein, D'Agata (2010) adopts evolutionary theory to endogenize technological progress and consumption dynamic with bounded rational firms and consumers in the Pasinetti's framework.

Despite the fact that these approaches were shown to be useful to endogenize technological progress they were not able to overcome one of the limitations of the Pasinetti's analysis which is its lack of dealing with cumulative causation. This happen because earlier attempts to endogenize technological progress built no links between productivity growth and output growth as pointed out by the Verdoon's Law. We believe that this is an important point to be tackled in the Pasinetti's approach since one of the main messages carried out by this model in relation to the Neoclassical one is that economic growth is a multidimensional process that cannot be studied by simplistic models that ignores the complexity of this phenomenon. By ignoring cumulative causation, the Pasinettian structural change model overlooks some important dimensions of economic growth mainly related to its determinants.

Besides, although cumulative causation and structural change are acknowledged as playing key roles in the process of economic growth there is no formal model for the best of our knowledge that bring together the contributions of Kaldor and Pasinetti on these matters[3]. This is surprising since the rationale for cumulative causation entails structural change once the reallocation of resources from low productivity activities to that ones with increasing returns of scale play a central role in the generation of economic growth. And one of the engines of structural change, namely technological progress is widely known to be affected by demand considerations in the post-Keynesian tradition as emphasized by the Kaldorian view.

Cornwall and Cornwall (2002) for instance develops a model of demand and supply analysis of productivity growth in which they show that the growth experience of 16 OECD economies after 1973 and the US in the nineties may be explained in terms of the change of demand factors and change of structure, concluding that the prime benefit of a strong aggregate demand is its effects on investment and technological change. According to them "[w]hile the type and pace of technological progress cannot be predicted, we are confident in predicting that strong demand will increase the rates of innovation and of diffusion of available technologies, and in doing so will increase productivity growth." [Cornwall and Cornwall (2002, p. 204)].

Although their model emphasizes the main channels of interdependence between growth of demand, technological progress and structural change, it is not formally built

---

[3] Of course we are not referring here to the models related to the Cambridge Equation that became generally known in the literature as the Kaldor-Pasinetti model.

and for this reason they are not able to determine either the type or the pace of technological progress. By introducing cumulative causation in the Pasinetti's framework allows us to treat these issues in a formal framework in which the pace of technological progress can be determined. Another advantage of this approach is that one of the most important outcomes of the process of economic growth, namely structural change is also tacked formally. Then it is possible to demonstrate formally that disequilibria is the most probable result of economic growth and cumulative causation, a result that has been called to attention by a number of economists. [Young (1928), Kaldor (1978), Boyer and Petit (1991)].

Hence in the present paper, by embedding cumulative causation in the Pasinettian analysis through Kaldor-Verdoorn sectoral laws, we are able to endogenize technological progress in the Pasinettian analysis and to show how the demand plays an important role not only in the structural changes but also on determination of the pace of technological progress. In this vein a multi-sector model of cumulative causation is built and its implications over the process of economic growth and structural change are studied. By following this approach we intend to capture the main channels of interactions between demand, technological progress and structural change.

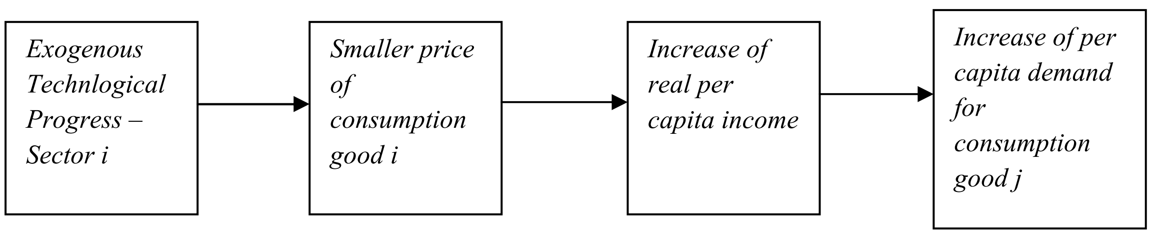
This paper is structured as follows: In the next section we present what we consider to be a Pasinettian version of a cumulative causation in his structural change model. In section 3, we endogenize technological progress in the Pasinetti's model by introducing sectoral versions of the Verdoon's law. Section 4 applies the results obtained in the previous section to study uneven development. Section 5 summarizes the results.

2. Pasinetti's Model

Pasinetti's model is distinguished by its focus on economic growth from supply and demand side simultaneously rendering the model capable of performing an analysis of structural change in a multi-sector economy. In this model, exogenous technological progress increases real per capita income through lower prices. The higher per capita income is translated into higher consumption of goods but this increase of consumption is not evenly spread across all goods. Those with a higher elasticity of demand receive higher shares of consumer expenditures and this process gives rise to structural changes. It is important to note that in this model the only role played by demand is to determine an unevenly expenditure of the increasing per capita income. This view contrasts with other models in the Post-Keynesian tradition in which the demand plays an important role not only in the short run but also on the long run determination of equilibrium growth rate. [citações]

It is possible to roughly summarize the working of the Pasinetti's model through the following scheme. First exogenous technological progress hits sector *i* inducing smaller price of the consumption good due to its effect on the labour coefficient. The smaller price does not mean that consumers will spend higher fractions of their per capita income in this consumption good. The gain in real per capita income can be transferred for other consumption goods, mainly those with higher elasticity income of demand. The outcome of this process is structural change.

Structural Change in the Pasinetti's Model



From this scheme it is possible to conclude that structural changes in the Pasinetti's model are not endogenous since they are powered by the exogenous technological progress; while the forces that driven structural change are exogenous the ones that driven it, namely sectoral demand, are endogenous but also affected by technical coefficients.

In order to develop our extension of the Pasinetti's model to cumulative causation let us consider an open version of this model following Araujo and Teixeira (2003). To establish the basic notation, it is useful to choose one of the countries, let us say *U*, to express physical flows. Consider that X_i denotes the domestic physical quantity produced of consumption good *i* and X_n represents the quantity of labour in all internal production activities; per capita demand of consumption goods is represented by a set of consumption coefficients: both a_{in} and $a_{i\hat{n}}$ stand for the demand coefficients of final commodity *i*. The former refers to domestic and the latter to foreign demand. In the same vein, $a_{ki,n}$ and $a_{ki,\hat{n}}$ stand for the investment coefficients of capital goods *ki*. The production coefficients of consumption and capital goods are respectively a_{ni} and a_{nki}. The family sector in country *A* is denoted by $\hat{n}$ and the size of population in both countries is related by the coefficient of proportionality ξ. The physical system may be written as follows:

$$\begin{cases} X_i - (a_{in} + \xi\ a_{i\hat{n}})X_n = 0 \\ X_{ki} - (a_{ki,n} + \xi\ a_{ki,\hat{n}})X_n = 0 \\ X_n - \sum_{i=1}^{n-1} a_{ni} X_i - \sum_{i=1}^{n-1} a_{nki} X_{ki} = 0 \end{cases} \tag{1}$$

A sufficient condition to ensure non-trivial solutions[4] of the system for physical quantities in country *U* is:

$$\sum_{i=1}^{n-1}(a_{in} + \xi\ a_{i\hat{n}})a_{ni} + \sum_{i=1}^{n-1}(a_{ki,n} + \xi\ a_{ki,\hat{n}})a_{nki} = 1 \tag{2}$$

This is also a condition for full employment of the labour force. The solution of the system for physical quantities may be expressed as:

$$\begin{cases} X_i = (a_{in} + \xi\ a_{i\hat{n}})X_n \\ X_{ki} = (a_{ki,n} + \xi\ a_{ki,\hat{n}})X_n \end{cases} \tag{3}$$

The set of solution for prices may be expressed as:

$$\begin{cases} p_i = (a_{ni} + \pi_i a_{nki})w \\ p_{ki} = a_{nki}w \end{cases} \tag{3'}$$

Where p_i is the price of commodity *i* country *U* (i = 1,2,...,n-1), w is the wage rate (uniform), and π_i is the rates of profit. Let us assume that the dynamic path of the per capita demand coefficient for commodity *i*:

$$a_{in}(t) = a_{in}(0)e^{r_i t} \tag{4}$$

$$a_{i\hat{n}}(t) = a_{i\hat{n}}(0)e^{r_{\hat{i}} t} \tag{5}$$

[4] As pointed out by Pasinetti (1981, p. 33), fulfilment of (1) is a sufficient condition for the system for physical quantities to have non-trivial solutions. However, non-fulfilment does not imply any meaningful solution. The particular form of the coefficient matrix (all its entries are zeros, except those in the last row, those in the last column, and along with the main diagonal) means that the solution of the system can be derived directly, without substitution, from the first $2n-1$ equations. Therefore, relative quantities are determined independently of condition (2).

The term r_i determines the growth rate of demand for commodity i . According to Pasinetti (1981) this rate is endogenously determined by technical conditions, which may be expressed by:

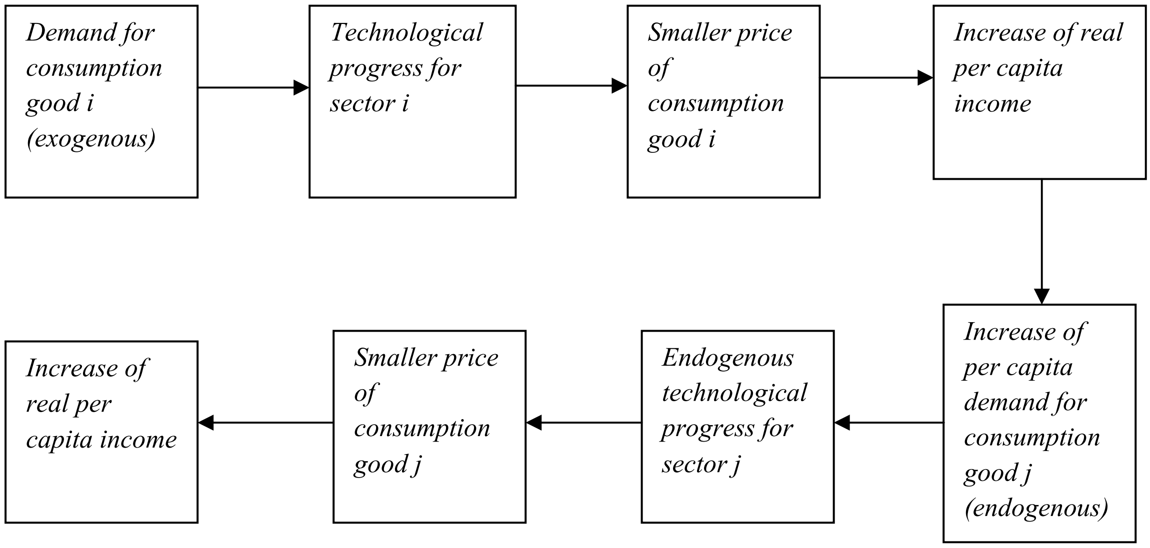
$$r_i(t) = f_i\{a_{n1},...,a_{n,n-1}, a_{nk_1},...,a_{nk_{n-1}}; \frac{d}{dt}[a_{n1},...,a_{n,n-1}, a_{nk_1},...,a_{n,k_{n-1}}]\} \quad (6)$$

By considering that effective demand condition is fulfilled in the first time, Pasinetti shows that in general it will not necessarily be fulfilled later on, related to the existence of particular growth rates of demand and productivity in each of the model's sectors, that is:

$$\sum_{i=1}^{n-1}(a_{in} + \xi\ a_{i\hat{n}})a_{ni} + \sum_{i=1}^{n-1}(a_{ki,n} + \xi\ a_{ki,\hat{n}})a_{nki} < 1 \quad (7)$$

In the Pasinettian analysis, the natural growth rate in each sector is given by $\rho_i + g$. Note that the natural rate is exogenously given in the Pasinetti's model. In the alternative reading presented in this article we assume that technological progress is endogenous rather than exogenous and is induced by the exogenous demand for consumption good *i*. Following Kaldor we assume that autonomous demand play an important role in the long run, so the demand for consumption good *i* is assumed to be exogenous due to foreign demand. But once demand takes places technological progress in sector *i* occurs leading to smaller price of this consumption good. The smaller price means an increase in real per capita income which may be translated into higher consumption for consumption good *j*. The increase of demand for consumption good *j* induces endogenous technological progress in this sector and in this vein the process tends to be self-sustained, presenting cumulative causation.

Cumulative Causation and Structural Change in the Pasinetti's Model



According to this scheme, structural changes are triggered by exogenous demand that through increasing returns of scale and learning-by-doing induce technological progress and, an increase in per capita demand that latter will turn into an increase into per capita demand that may also induce more technological progress. In this vein in some moment of this virtuous cycle, structural changes are made endogenous and happen due to endogenous changes in the per capita demand. This fact has strong implications in terms of theory and practice of economic development. First, it shows that the role played by demand in the process of economic growth cannot be limited to drive structural changes, but demand is also one of the engines of economic growth via its effect on stimulating the creation and diffusion of technological progress. Second, it stresses that the triggering point of this virtuous cycle is external demand, but once it is under way, indigenous demand may expand and may also be an important component to spur growth. In this vein a vigorous strategy of export led growth may play an important role to trigger the virtuous cycle motioned by cumulative causation.

Suppose for instance a change in the sectoral structure of the economy due to a change in the composition of demand – i.e. a change in the distribution of the growth rate of industry demand, because the Verdoorn's Law is a dynamic relationship. That is, the rate of output growth of some sectors will fall, while the rate of growth in other sectors will rise. Thus, for the Verdoon's Law, the rate of productivity growth will fall in the sectors where growth has fallen and will rise in sectors where the growth rate went up. Therefore, it is easy to see that again the question of the weight of each sector matter. That is, the cumulative causation – positive, say – will be greater when more change in the composition of demand affect positively – negatively – sectors with higher weight – lower – ceteris paribus. Or, ceteris paribus the weights of the sectors, the cumulative causation – positive, say – will be greater when more change in the composition of demand affect positively – negatively – sectors with higher – lower – Verdoorn coefficient – i.e., as a variation in growth rate of the product results in variation in the rate of productivity growth. An interesting implication of this analysis is that cumulative causation created by Verdoorn's Law could be connected with the phenomenon of Schumpeterian creative destruction. That is, the cumulative causation created by Verdoorn's Law triggers, basically, an evolutionary process of disappearance of sectors with lower productivity than average. In the next section we approach this model formally by introducing cumulative causation in the Pasinetti's model of structural change.

3. The Extended Model to Accommodate Cumulative Causation

In the Pasinetti's model technological progress is exogenous and is particular to each sector. The production coefficients of consumption a_{ni} convey the effect of technological progress in the sector of final goods:

$$\frac{\dot{a}_{ni}(t)}{a_{ni}(\mathrm{t})} = -\rho_i \tag{8}$$

where the rate of technical change for sector i is denoted by ρ_i. Let us define productivity in each sector, $q_i(t)$ as the inverse of labour coefficient, namely:

$$q_i(t) = \frac{1}{a_{ni}(t)} \tag{9}$$

Besides let us consider, following Kaldor, Thirlwall and McCombie (1994) and Setterfield (1997, p. 367), that the productivity varies according to a Verdoorn law. The novelty here is that we assume a Verdoorn law particular to each sector.

$$\frac{\dot{q}_i}{q_i} = \gamma_i + \lambda_i \frac{\dot{X}_i}{X_i} + \varphi_i \frac{\dot{K}_i}{K_i} \tag{10}$$

Where γ_i stands for exogenous influences on productivity growth, $\frac{\dot{X}_i}{X_i}$ is the growth rate of output of i-th sector and $\frac{\dot{K}_i}{K_i}$ is the growth rate of the stock of capital in the i-th sector. We measure capital goods in terms of units of productive capacity, that is, in terms of the quantity of final goods that could be produced by a specific amount of capital goods. By adopting this convention the sectoral equilibrium condition in the Pasinetti's model could be stated as:

$$K_i = X_i \tag{11}$$

where X_i is the quantity of final commodity i that is produced in this sector and K_i is the quantity of capital goods installed in the final goods' sector. In order to fulfil the dynamic equilibrium similar changes are introduced to sides of equation (11), and these changes through differentiation, yield:

$$\dot{K}_i = \dot{X}_i \tag{12}$$

Then in the Pasinettian model we can rewrite expression (10) as:

$$\frac{\dot{q}_i}{q_i} = \gamma_i + \alpha_i \frac{\dot{X}_i}{X_i} \qquad (10)'$$

Where $\alpha_i = \lambda_i + \varphi_i$ is the Verdoorn coefficient. It captures the extent to which output growth generates subsequent productivity growth via dynamic increasing returns. But from expression (3) the production of sector i is given by the internal and foreign demand for this consumption good. Let us assume following Araujo and Lima (2007) that foreign demand is given by the foreign demand coefficient:

$$a_{i\hat{n}} = \begin{cases} \left(\dfrac{p_i}{p_{\hat{i}}}\right)^{\eta_i} y_A^{\beta_i} X_{\hat{n}}^{\beta_i - 1} & \text{if } p_{\hat{i}} \geq p_i \\ 0 & \text{if } p_{\hat{i}} < p_i \end{cases} \tag{13}$$

With p_i being the price of commodity i in country U, and y_A being the per capita income of country A. η_i is the price elasticity of demand for export of commodity i, with $\eta_i < 0$, while β_i is the income elasticity of demand for exports. This specification follows Setterfield (1997). According to him Kaldor treat exports as the key source of autonomous demand The importance of export growth is also emphasized by Cornwall and Cornwall (2002, p. 206). According to them the importance of this issue to productivity growth is twofold: firs it allows the larger scale production methods to improve productivity and second it encourages the adoption of the best available technologies spurring productivity. The growth rate of the foreign demand is then given by:

$$\frac{\dot{a}_{i\hat{n}}}{a_{i\hat{n}}} = \begin{cases} \eta_i\left(\sigma_i^U - \sigma_i^A\right) + \beta_i\sigma_y^A + (\beta_i - 1)\hat{g} & \text{if } p_i \geq p_{\hat{i}} \\ 0 & \text{if } p_i < p_{\hat{i}} \end{cases} \tag{14}$$

The internal demand is assumed to grow exponentially according to expression (4). The available labour force grows at rate *g*. By adopting the following convention: $\frac{\dot{p}_i}{p_i} = \sigma_i^U$, $\frac{\dot{p}_{\hat{i}}}{p_{\hat{i}}} = \sigma_i^A$, $\frac{\dot{y}_A}{y_A} = \sigma_y^A$, $\frac{\dot{X}_{\hat{n}}}{X_{\hat{n}}} = \hat{g}$ and $\frac{\dot{y}_U}{y_U} = \sigma_y^U$ we can write the growth rate of demand for the *i*-the consumption good as:

$$\frac{\dot{X}_i}{X_i} = \theta r_i + (1-\theta)\left[\eta_i(\sigma_i^U - \sigma_i^A) + \beta_i\sigma_y^A + (\beta_i - 1)\hat{g}\right] + g \tag{15}$$

Then expression (15) gives us the growth rate of the demand for the *i*-th final consumption good. If we assume Purchase Power Parity[5] – PPP hereafter – $\sigma_i^U = \sigma_i^A$ so the above expression reduces to:

$$\frac{\dot{X}_i}{X_i} = \theta r_i + (1-\theta)\left[\beta_i\sigma_y^A + (\beta_i - 1)\hat{g}\right] + g \tag{16}$$

By replacing this result into expression (10)' one obtains:

---

[5]According to the PPP hypothesis the exchange rate between two currencies will move in line with relative price levels in the two economies. PPP is supported by a number of empirical studies. Alonso and Garcimartin (1998-99)

$$\frac{\dot{q}_i}{q_i} = \gamma_i + \alpha_i \left\{ \theta r_i + (1-\theta)\left[\beta_i \sigma_y^A + (\beta_i - 1)\hat{g} \right] + g \right\} \qquad (17)$$

But from (2) we know that:

$$\frac{\dot{a}_{ni}(t)}{a_{ni}(\mathrm{t})} = -\frac{\dot{q}_i}{q_i} = -\gamma_i - \alpha_i \left\{ \theta r_i + (1-\theta)\left[\beta_i \sigma_y^A + (\beta_i - 1)\hat{g} \right] + g \right\} \qquad (18)$$

Hence the technological progress growth rate is now obtained as a function of parameters of demand:

$$\rho_i = \gamma_i + \alpha_i \left\{ \theta r_i + (1-\theta)\left[\beta_i \sigma_y^A + (\beta_i - 1)\hat{g} \right] + g \right\} \qquad (19)$$

From expression (19) it is possible to conclude that technological progress in *i*-th sector is a function of the growth rate of internal demand and of the elasticity of foreign demand. The essence of the Pasinettian analysis remains but now technological progress is endogenous and there is cumulative causation. This result confirms what was reported by Cornwall and Cornwall (2002, p. 204) "[w]hile the type and pace of technological change cannot be predicted, we are confident in predicting that strong demand will increase the rates of innovation and of diffusion of available technologies, and in doing so will increase productivity growth."

In order to provide a complete characterization of the effects of the endogenous technological progress on structural changes it is important to focus on its effects of the labour shares amongst the various sectors. From the definition of technical coefficient for *i*-th sector it is possible to obtain the following relation:

$$\frac{\dot{a}_{ni}(t)}{a_{ni}(\mathrm{t})} = \frac{\dot{x}_{ni}}{x_{ni}} - \frac{\dot{X}_i}{X_i} = -\rho_i \qquad (20)$$

By substituting expressions (16) and (19) into the above expression and after some algebraic manipulation it is possible to conclude that the growth rate of the labour force employed in *i*-th sector is given by the following expression:

$$\frac{\dot{x}_{ni}}{x_{ni}} = \frac{\dot{X}_i}{X_i} - \rho_i = -\gamma_i + (1-\alpha_i)\left\{\theta r_i + (1-\theta)\left[\beta_i \sigma_y^A + (\beta_i - 1)\hat{g}\right] + g\right\} \qquad (21)$$

Expression (21) shows that the absorption of labour in the *i*-th sector is an endogenous variable that is strongly affected not only by technological progress but also by demand considerations expressed by the growth rate of demand and elasticities of demand and by the Verdoorn coefficient. In the original Pasinetti's model while the demand coefficients are endogenously driven by the rate of change of demand, technical coefficients are exogenously determined by the rate of technological progress. Then it is possible to say that the structural changes that happen in the Pasinetti's model are not endogenous but exogenous. Here by endogenizing the rate of technological progress we are able to make the structural changes completely endogenous. This view stresses the importance of the demand, particularly the foreign demand which is one the only exogenous variables of our extension of the Pasinetti's model.

The importance of the manufacturing sector in the present model can be grasped by considering that in general tradable goods are manufactured ones. In this case, the external demand exerted on these goods may induce technological progress in the maufacturing sectors yielding smaller prices for internal consumption. Thirlwall (1983, p. 347) has emphasized "that a fast rate of growth of exports and output will tend to set up a cumulative process, or virtuous circle of growth, through the link between output growth and productivity growth."

In order to fully characterize the working of the process of cumulative causation in Pasinetti's model consider that the smaller prices of manufacturing due to technological progress does not mean a higher share of per capita income spent in such goods since other goods with higher income elasticity of demand may benefit from the real per capita income increase that accrue from smaller prices of manufactures. In this vein, it is generated higher demand for goods in other sector other than manufactures, which may give rise to higher levels of technological progress. This rationale confirms the Kaldorian view expressed in one of his laws of growth that faster growth in manufacturing also generates faster growth in productivity outside manufacturing. In this vein the manufacturing sector becomes the flywheel of the economic growth.

4. Implications of the Cumulative Causation to a structural dynamics approach to North-South models.

One of the advantages of endogenizing technological progress in the Pasinetti's model is that a number of issues that he has treated in relation to an open economy may be approached formally and from the viewpoint of cumulative causation which was not possible to do in the original version of the model. In this vein the model can give us back some insight on the process of uneven development that is difficult to grasp in one or two sector North-South models. Araujo and Lima (2007) have derived a multi-sector version of the Thirlwall's law (1979) in which not only elasticities but also structural changes captured by changes in the coefficients may impact the growth rate.

$$\sigma_y^U = \frac{\sum_{i=1}^{n-1} \xi \beta_i a_{i\hat{n}} a_{ni}}{\sum_{i=1}^{n-1} \phi_i a_{\hat{i}n} a_{ni}} \sigma_y^A \qquad (22)$$

According to this expression higher growth rates are associated with lower sectoral income elasticities of demand for imports, given by ϕ_i, and higher sectoral income elasticities of demand for exports, given by β_i. It should be noticed, however, that these sectoral income elasticities of exports and imports are weighted by coefficients that measure the share of each sector in the total volumes of exports and imports. As it turns out, even in case these sectoral elasticities remain constant, a change in the overall growth rate can be brought about by structural change coming from the evolution of tastes and preferences according to Engel's Law.

According to expression (22) the growth performance relies heavily upon on the ability to export, which is evidence that any growth strategy that focuses exclusively on internal markets would fail. What matters in the determination of the growth rates are not only the elasticities but also the weigh that these goods have in the economy. Besides, an outward oriented view would create demand for goods with a high income elasticity of demand, which would produce structural changes in the economy that would give a higher share to these more sophisticated goods.

In his exposition of the Kaldor's law of economic growth Thirlwall (1983, p. 346) have pointed out that "[e]xport demand is the major component of autonomous demand in an open economy which must match the leakage of income to imports. The level of industrial output will adjust to the level of export demand in relation to the propensity to import, through the working of the Harrod trade multiplier."

In the original version of the disaggregated Law derived by Araujo and Lima the technological progress was exogenous so the dynamical paths of technical coefficients in expression were exogenous given. Now from expression (19) it is possible to observe that the dynamical path of technical coefficients will be also affected by the elasticities of demand mirroring the fact that technological progress is affected by the evolution of demand. Another important contribution from this analysis to tackle uneven development may be obtained by considering the endogenized technological progress in the structural economic dynamic model may be obtained from expression (19):

$$\rho_i^U = \gamma_i^U + \alpha_i^U \left\{ \theta_i^U r_i^U + (1-\theta_i^U)\left[\beta_i \sigma_y^A + (\beta_i - 1)\hat{g}\right] + g \right\} \qquad (19)'$$

Let add superscripts to this equation to emphasize the relationship between the rate of technological progress in a particular region and the rate of growth of demand and the elasticity of demand for the good produced by that region. Expression (19)' shows us that the higher the growth rate of demand the higher the rate of technological progress and accordingly the higher the elasticity income of demand the higher of technological progress. Here we can feel the flavour of cumulative causation. A region that produces a final good with high elasticity of demand will have high technological progress and thus grow faster than a region that produces a final good with small elasticity of demand.

5. Concluding Remarks

Pasinetti (1981, 1993) refers to SED as an approach that provides insights into processes of economic development, offering a synthesis between traditional supply and demand views of economic growth, with the supply side characterized by technological progress and capital accumulation, and the demand side driven by the Engel's Law. Although this model intends to tackle economic growth from both supply and demand simultaneously it is not able to study cumulative causation because technological progress is exogenous treated. In this paper we have considered cumulative causation in a structural change model of economic growth by introducing sectoral Verdoon's Law which allowed us to endogenize technological progress in the Pasinetti's model of structural change. By adopting this approach it was possible to extend the SED approach by including cumulative causation as one of the mechanisms that explain the widening per capita and technological gaps amongst rich and poor nations. It is clear that it is the Verdoorn relationship which makes the model cumulative and circular, and which gives rise to the possibility that once a region obtains a growth advantage it will keep it. The essence of the argument is that once a region gains a growth advantage it will tend to sustain that advantage through the process of increasing returns that growth itself induces – the Verdoon effect.

Here, following a SED approach embed with cumulative causation we emphasise that gains from international diffusion of technical progress are conditioned to the inherent patterns of human needs and preferences since they give rise to entirely different compositions of consumer demand, and therefore different structures of production and employment in each country. That is, the diffusion and absorption of technical progress are subject to different economic structures particular to developed and underdeveloped economies[6].

References

Alonso, J. and Garcimartin, C. 1998-99. A new approach to balance-of-payments constraint: some empirical evidence. *Journal of Post-Keynesian Economics* 21(2), 259 – 282.

[6] Of course there is some reciprocity, that is, the technological absorption is determined by the structure of the economy but when technological change is effectively added to the productivity process it affects the structure of the economy as will be shown in the next sections.

Araujo, R. and Lima, G. 2007. A Structural Economic Dynamic Approach to Balance of Payment Constrained Growth. *Cambridge Journal of Economics* 31(5), 755 – 774.

Araujo, R. and Teixeira, J. 2003. An Extension of the Structural Change Model to International Economic Relations. *Metroeconomica* 54(4), 458 – 473.

Araujo, R. and Teixeira, J. 2010. Investment Specific Technological Progress and Structural Change. *Estudos Econômicos*

Araujo, R. and Teixeira, J. 2011. Structural Change and Macrodynamic Capabilities. *Nova Economia* (forthcoming).

Boyer, R. and Petit, P. 1991. Kaldor's Growth Theories: Past, Present and Prospects for the Future. In *Nicholas Kaldor and Mainstream Economics: Confrontation or Corvergence?* Edited by Edward Nell and Willi Semmler. St. Martin Press. New York.

Cornwall, J. and Cornwall,W. 2002. A demand and Supply Analysis of Productivity Growth. *Structural Change and Economic Dynamics*, 13, 203–229.

D'Agata, A. 2010. Endogenous Adaptative Dynamics in Pasinetti Model of Structural Change. *Metroeconomica* 61(2), 333 – 363.

Fagerberger, J. 2000. Technological Progress, Structural Change and Productivity Growth: A Comparative Study. *Structural Change and Economic Dynamics*, 11(4), 393 – 411.

Hall, J. and Whybrow, O. Continuity and Continuousness: The Chain of Idea Linking Pierce's Synechism to Veblen's Cumulative Causation. *Journal of Economic Issues* XLII (2), 349 – 355.

Kaldor, N. 1966. *Causes for the Slow Rate of Growth in the United Kingdom*. Cambridge University Press. Cambridge.

Kaldor, N. 1972. The Irrelevance of Equilibrium Economics. *Economic Journal*, 82, 1237-1255.

McCombie, J. and Thirlwall, A. 1994. *Economic Growth and Balance-of-Payments Constraint*. St. Martins Press. New York.

Ocampo, J. 2005. The Quest for Dynamic Efficiency: Structural Dynamics and Economic Growth in Developing Countries. In: *Beyond Reforms: Structural Dynamics and Macroeconomic Vulnerability*. Edited by José A. Ocampo. Stanford University Press.

Pasinetti, L. 1981. *Structural Change and Economic Growth – A Theoretical Essay on the Dynamics of the Wealth of the Nations*. Cambridge University Press. Cambridge, UK.

Pasinetti, L. 1993. *Structural Economic Dynamics – A Theory of the Economic Consequences of Human Learning*. Cambridge University Press. Cambridge, UK.

Reati, A. 1998. Technological Revolutions in Pasinetti's Model of Structural Change: Productivity and Prices. *Structural Change and Economic Dynamics* 9(2), 245– 62.

Skott, P. 1988. Kaldor's Growth Law and The Theory of Cumulative Causation. Economics Working Papers School of Economics and Management, University of Aarhus.

Seterfield, M. 1997. 'History versus Equilibrium' and the Theory of Economic Growth, Cambridge Journal of Economics 21(3), 365-78.

Setterfield, M. 2010. Endogenous Growth: A Kaldorian Approach. Trinity College Deparment of Economics. Working Paper 10-01.

Solow, R. 1956. A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics* 70, 65–94.

Symposium: Kaldor's Growth Laws. *Journal of Post Keynesian Economics*. Spring 1983, Vol. V, No. 3.

Thirlwall, A. 1979. The balance of payments constraint as an explanation of international growth rates differences, *Banca Nazionale del Lavoro Quarterly Review*, 128.

Thirlwall, A. 1994. *Growth and Development*. Fifty edition, Macmillan Press Ltd. London.

Thirlwall, A. 1997. Reflections on the Concept of Balance-of Payments-Constrained Growth. *Journal of Post Keynesian Economics* 19(3), 377–86.

Thirlwall, A. 1983. A Plain Man's Guide to Kaldor's Growth Law. *Journal of Post Keynesian Economics* 345 – 358.

Young, A. 1928. Increasing Returns and Economic Progress. *Economic Journal*, 38 (52), 527 – 542.