Technical progress, economic growth and deindustrialization: the limits of the kaldorian logic.

Alain Herscovici

(**Theme 1**: Modelling the future. The future of Post Keynesian Economics)

The post-Keynesian debate on deindustrialization is focused on the implications of an over-appreciation of the national currency exchange rate, assuming that domestic industry is a leading sector and produces positive externalities for the whole economy. This paper analyzes the latter component of this problematic, i.e. the role of industry in the process of growth. Since the early 1990's, most of the developed and emerging economies have been subjected to two paradoxes: the first one, the paradox of Solow, which calls into question the relationship between ICT investment and productivity gains, and the second one, the paradox of Gordon, showing that productivity gains in the ICT sector do not propagate to all other sectors . These paradoxes lead us to question the linear nature of the cumulative mechanisms postulated by Kaldor.

Following both a theoretical and an empirical approach, such relationships are analyzed from the viewpoint of the various models of unbalanced growth built by Baumol, which express the linear relationship between growth, technical progress, labor productivity and industrial sector. Then, I will highlight the limits of such models and I will provide elements for an alternative explanation. Ultimately, the real problem is to investigate the economic nature and the role that services, including the various forms of intangible capital, may play in the new dynamic of growth, as observed by Thirlwal

Classification JEL:

O4 - *Economic Growth and Aggregate Productivity*
O47 - *Measurement of Economic Growth; Aggregate Productivity; Cross-Country Output Convergence*
O41 - One, Two, and Multisector Growth Models

Key-words: Labor productivity – Technical progress - Solow´s paradox- Unbalanced Growth.

Technical progress, economic growth, and deindustrialization: the kaldorian logic revisited in light of the "new economy".

Alain Herscovici *

This study aims at examining the problem of deindustrialization from the development of different forms of intangible capital, i.e. the so-called new economy – mainly characterized by the activities related to knowledge and information. We must then study the different components of the process of deindustrialization in the light of new macroeconomic dynamics related to the development of this "new economy". Within a Keynesian approach, the following points should be highlighted:

1) In the perspective of Keynesian developmentalists , (Oreiro 2009, Bresser Pereira, Gala, 2010), the debate related to deindustrialization has two components: the first one relates to the primordial role of industry in economic growth, and the second one to the impact of an exchange rate over-appreciation on industrial development.

The different historical conditions may explain the situation of the different countries: beyond a certain level of per capita income, income elasticity of demand for manufactured goods decreases, while demand for services increases. In this case, the deindustrialization is the inevitable result of economic development, and the nature of deindustrialization depends on the development of the country concerned. But this deindustrialization may also be the result of over-appreciation of the national currency exchange rate, regardless of income per capita. In this case, growth is held back by internal and external constraints imposed on the development of industry (the Dutch Disease). In Brazil, some authors (Oreiro, op. it.) explain the deindustrialization mainly based on this over-appreciation.

2) We can talk about deindustrialization when we observe a relative decrease in the industrial sector in terms of aggregated value created and in terms of source of employment (ibid, p.1). From a theoretical point of view, the deindustrialization allows identifying two problems: one concerns the methods of value added creation, and the other regards the level of employment and income distribution that matches it:

i) The development of services and different forms of intangible assets (especially knowledge and information) is such that, currently, the construction of aggregates to measure this type of activity is particularly difficult and incomplete (Griliches, 1994). These measurement problems are directly related to *historical changes in the systems of production and of appropriation of value in contemporary capitalism.*

* Professor and Coordinator of the Master's Degree in Economics at the Federal University of Espírito Santo (UFES), Brazil, and Researcher at the National Council of Scientific and Technological Development (CNPq), Brazil.

ii) From a Keynesian approach, we must define the different sectors based on their different employment elasticities, which allows comparing the investment and employment multiplier value in the industry with the one characterizing the other sectors (Keynes, 1936, p. 220). As I will show, based on this criterion, there are fundamental differences between the sectors linked to the production of intangibles, and those related to industrial production. These differences are explained by the economic characteristics of the objects produced and the adopted system of Property Rights, the specificity of production processes, and the nature of labor and its modalities of remuneration.

As the ICT sector, in which the major technological innovations appear, is governed by essentially speculative and financial logic, it can be assimilated to a type of casino logic: it is related to short-term logic, and the multiplier effect is smaller. Differently, in the industrial sector, the "enterprise" refers to long-term logic, and has high multiplier effect. In this regard, Keynes claims that "(....) the long-term investment is the one that best serves public interest (....) (1936, p. 130 and 131). This means that the multiplier effect is higher in that sector, namely industry.

3) *This study aims at discussing the validity of the hypothesis regarding the crucial role of industry in the process of long-term growth*. This is not about denying the importance of exchange rate appreciation, or its impact on global growth, but about studying and questioning the mechanisms that assimilate the industry to a leading sector. Depending on the economic specificities of knowledge and information, and based on a dual theoretical and empirical perspective, the first two laws of Kaldor (Feijó, Tostes Lamonica, 2007) will be studied:

(a) The first one acknowledges the existence of a positive correlation between industry growth and the growth of national product, which expresses the fact that the industry sector generates externalities that benefit all the other sectors. In other words, its multiplier effect is important. Technical progress is generated in this sector, and spreads to the rest of the economy.

(b) The second law (Kaldor-Verdoorn law) shows that the increase in output generated by the increase in demand causes an increase in productivity, which is explained by the emergence of economies of scale.

As I will show, the economic specificities of knowledge and information allow refuting the linearity of the relations mentioned by Kaldor. For this purpose, I will use different models of unbalanced growth built by Baumol (1967 and 1992). These models express, from a simple formalization, the linear relationships that exist between technical progress, productivity gains, and economic growth, i.e. they emphasize the crucial role of industry in the process of long-term growth. *I will thus study the macroeconomic implications caused by meso and microeconomic changes related to the production of intangible assets*[1].

In the first part, I will analyze the feedback model built by Baumol and Bowen (1992), which explains the mechanisms from which technical progress is endogeneized, and

[1] See Herscovici (2009)

confront the theoretical results derived from this model with the stylized facts that characterize the current phase of capitalism. In the second part, I will highlight the limits of such explanation and propose an alternative analysis, based on a reformulation of these macroeconomic relations.

I) Baumol's analysis: the different models of unbalanced growth

1) The endogenization of labor productivity gains

1.1 *The extension of the 1967 model*

Baumol uses the results of the 67 model, and writes the following:

$$y1 = cL1e^{rt}, \qquad y2 = bL2 \qquad (1)$$

$$AC1 = wL1/y1 = w/c.e^{rt} \quad e \quad AC2 = wL2/y2 = w/b \qquad (2)$$

$$AC2/AC1 = \frac{w/b}{w/c.e^{rt}} = c.e^{rt}/b \qquad (3)$$

yi represents the production of sector i, w the wage rate, Li the amount of labor used by sector i, b and c positive constants; ACi represents the unitary (or average) cost evaluated in labor. Index 1 relates to the productive sector, index 2 relates to the unproductive sector, and index 3 to the asymptotically stagnant sector.

In this model, Baumol considers that w represents the average wage rate practiced (1992, p. 245), so unlike the 1967 model, the increase in wage rate is no longer indexed to the productivity increase taking place in the productive sector.

Baumol will add a third sector, the asymptotically stagnant sector, characterized by the fact that it uses inputs from the other two sectors, in constant proportion (Baumol and Wolff, 1992, p. 251):

$$y13/y3 = k1, \; y23/y3 = k2 \qquad (4)$$

The average cost of production of this sector is equal to:

$AC3 = k1\ C1 + k2\ C2 = k1.\ w/\ e^{rt} + k2.\ w/b$ (5)

$AC3 \approx k2.\ w/b$, when $t \rightarrow \infty$

The changes in the average cost of sector 3, asymptotically stagnant, are the same as those of the stagnant sector. Thus, from the moment that in certain activities there is a stagnant and a productive component, over time, the costs of this sector tend to evolve as the costs of the stagnant sector. This evolution is explained as follows: while the fall in the cost of input coming from the productive sector offsets the increasing cost of unproductive input, the average cost decreases. However, there will necessarily be a point in which the cost of productive input gets close to zero, while the cost related to the unproductive component continues to increase indefinitely with time. From this point, the costs of the asymptotic sector evolve the same way as the costs of the unproductive sector.

$AC3/AC1 \approx k2 / b.\ c\ e^{rt}$ (6)

The study of industries that use these two types of inputs illustrates this trend: in the case of the computer industry, the costs of hardware, i.e. the productive production, decrease while the costs of software, labor intensive, increase. The labor costs increase in terms of total costs, which is explained by the presence of a stagnant component. Similarly, in television activities, while the relative weight of technical costs is decreasing (broadcasting), the costs of programs increase, following the logic of the stagnant sector (Herscovici, 1994). In short, we can conclude the following: (a) the differential cost between soft and hardware, increases with time, because the programs are labor intensive (b) in the long term, the total cost of this sector will evolve in the same way as the cost of the stagnant sector.

1.2 *The model with feedback and endogenization of labor productivity gains*

Then, Baumol will relax the hypothesis in which the relative share of inputs of sector 3 is constant (k1 and k2 constants). He will also assume that the sector of Research and Development (R&D), which "produces" technical progress, can be assimilated to a stagnant industry, and that its production depends on the price elasticity of demand from other sectors. Finally, the mechanism that he constructs implies that the gains in labor productivity are determined endogenously.

$Yi = fi\ (Y)\ Ci^{-Ei}$ (7)

Yi represents the production of the sector i, and Y the total output;-Ei represents the price elasticity of demand of sector i.

Equation (7) means that, for a short time, the income effect can offset the price effect regarding the increased demand of sectors 2 and 3.

The value of the expenditures on goods of sectors 1 and 3 can be represented by the following equation:

$$\frac{\text{Value of } y3}{\text{Value of } y1} = \frac{AC3.y3}{AC1.\ y1} \approx \frac{AC2}{AC1} \cdot \frac{y3}{y1}$$

$$\approx \frac{k2\ Ce^{rt}}{b} \cdot \frac{y3}{y1} \qquad (8)$$

Equation (8) shows that when t increases, y3/y1 has to decrease; the production of sector 3 increases relatively less than the production sector 1. Thus, there is perfect substitutability of factors of production, according to their relative prices.

rt represents the rate of growth of labor productivity outside the R&D sector; y3, the production of R&D; and p3, the price of R&D.

$$rt+1 = a + by_{3t} \qquad (9)$$

Productivity, on the whole economy depends directly on the production of R&D, with a one-period lag.

$$p3_{t+1} - p3t/p3t = vr_{t+1} \quad (10)$$

The production of R&D, which Baumol calls Information, is a labor-intensive activity. Consequently, the labor costs and the prices depend directly on the productivity gains achieved in the rest of the economy. Finally, prices are determined from the labor costs. The function of demand for information is as follows:

$$y3_{t+1} - y3t/y3t = -E\ (p3t+1 - p3t) / p3t \quad (11)$$

The demand for information depends directly on the price of this information, and the elasticity price of demand for information is negative.

From (9), (10) and (11), we can write:

$$y3t+1 = y3t(1 - E.v.a) - E.v.b.(y^2_{3t}) \qquad (12)$$

Depending on the value of the parameters, equation (12) shows that the evolution of information production, i.e. y3t can become chaotic (Baumol and Wolff, 1992). From equation (9), we can deduce that these oscillations produce oscillations of y3t. Therefore, it can be assumed that economic growth depends on the growth of labor productivity. These changes in the rate of productivity growth correspond to parallel changes in the rate of GDP growth.

The mechanism of feedback produces these endogenous fluctuations: the increase in the production of information is reflected by an increase in labor productivity in the whole economy (equation 9). In turn, this increase in productivity of the economy will increase the prices of information (equation 10), which leads to a drop in demand for information (equation 11). From there, the same mechanisms operate in reverse. For the 1967 model, there is an effective endogenization of the growth rate of labor productivity. Nevertheless, it is important to note that *the possibility of the system to endogenously generate fluctuations and to become chaotic comes from the fact that the price elasticity of demand for information is negative*.

2) Baumol's Analysis versus Solow and Gordon's paradoxes?

2.1 *The localized effects of technical progress*

Table 1 highlights the fact that approximately half of the factor productivity gains take place in the ICT sector. These data confirm the analysis of Gordon (2000): contrary to Baumol's model, the sector that produces the technological innovation is not asymptotically stagnant. Rather, it performs half of the productivity gains of the entire economy. At this level, the problem is to study the nature and impact of aggregated externalities produced by the ICT sector.

Table 1: Contribution of different sectors to the growth of total factor productivity (in% per year for the U.S. economy)

	1974-1990	1990-1995	1996-1999
Global factors			
Growth productivity	0,40	0,57	1,25
- Computers	0,12	0,13	0,22
- Semiconductors	0,08	0,13	0,41
- Other sectors	0,20	0,30	0,62

Olinet and Sichel (2000)

2.2 *The externalities generated by technical progress*

Table 2: The global effects of technical progress

	Labor productivity growth				% GDP	
	1990-95		1995-2000		(2000)	
	EU	US	EU	US	EU	US
Total Economy	1,9	1,1	1,4	2,5		
ICT using Industrys	3,1	-0,3	2,1	1,2	5,9	4,3
Non ICT using Industry	3,8	3,0	1,5	1,4	11,9	9,3
ICT using Services	1,1	1,9	1,4	5,4	21,1	26,3
Non ICT using Services TIC	0,6	-0,4	0,2	0,4	44,7	43,0
ICT producing industry	11,1	15,1	13,8	23,7	1,6	2,6
ICT producing services	4,4	3,1	6,5	1,8	4,3	4,7

From van Ark B., Inklaar R and McGuckin R, 2002 and personal elaboration

i) The data in Table 2, underscore the fact that ICT does not generate positive externalities to manufacturing activities. Instead, this type of correlation is found with regard to service activities.

ii) Regarding the two study periods, for the European Union and the United States, gains in labor productivity in the whole economy have been, respectively: 1.9 and 1.4 for the European Union (EU), and 1 , 1 and 2.5 for the United States (U.S.). This difference between the EU and the U.S. concerning the 1995-2000 period can be explained by the following: (a) The share of services using ICT in GDP is higher in the US than it is in the EU, which is also true for productivity gains; (b) The productivity gains achieved in the sector producing ICT are more significant in the US.

iii) In the ICT sector, it is already possible to observe a dichotomy between the industries of material (hardware) and services. The component connected to the production of hardware performs important labor productivity gains, but it generates little value. On the other hand, the stagnant component performs smaller productivity gains, but represents a greater relative share of GDP. *This may explain the nonlinear relationship that exists between the growth rate of labor productivity and the growth rate of GDP* (Table 3). These data do not correspond to the existence of a Kaldorian cumulative causal relationship between the labor productivity growth rate and the GDP growth rate (Boyer, Petit, 1989).

Table 3 Economic growth and growth of labor productivity: the case of the United States (in% per year).

	DGP growth	Growth of labor productivity
1975-1982-2	3,0	0,7
1982-3 1990-4	3,7	1,6
1991-1-1999-4	3,5	2,0
Form 1995	4,2	2,6

Digital Economy, http://wwww.commerce.gov

The observation of these data allows us to formulate some questions:

i) The role of ICT-using services is essential to explain the gains in labor productivity: they are large network services used as inputs and that generate externalities whose social and geographical appropriation modalities are highly differentiated.

ii) Technical progress is selective, because it only generates positive externalities for certain sectors of the economy, especially for the sector of services. If we consider the weight of these sectors in the entire economy, this weight is equal to 21.1% of GDP in the EU, and 26.3% for the U.S. The modalities of appropriability of ICT are

geographically distinct: the impact of ICT-using services on the productivity of labor is 0.336 for the EU, and 2.939 for the US (Ark et alii, op cit.., 2004, p. 26).

iii) One of the main macroeconomic consequences is that the sectors related to ICT cannot not be regarded as a leading sector (in the Schumpeterian sense), which can promote a new long phase of expansion. Their potential in terms of increase in labor productivity and GDP growth rates depends on the nature of the externalities they generate, on the forms of appropriation of these externalities, and on the IPR system that currently limits these types of appropriation (Herscovici, 2007);

iv) The difference between Fordism and post-Fordism depends mainly on the gains in labor productivity achieved in the field of ICT-using services. This is particularly important concerning the 1995-2000 period. However, their relative weight in GDP (26.3%) limits their spillover effects on the rest of the economy. So, we need to examine to what extent this sector is able to sustain economic growth[2].

In Fordism, the spillover effect of technical progress was related mainly to the industrial and manufacturing activities. In contrast, post-Fordism is reflected by a change in the nature and role of service activities, a decrease in industry weight, and a change in the nature of technical progress and in its modalities of propagation.

As shown in Table 2, the increase in productivity in the industry can be conceived as an autonomous technical progress, a process which does not depend directly on ICT.

The nature of the externalities generated by this type of technical progress and their potential effects in regard to economic growth depend on the following factors:

i) The IPR system and the limitations its modification imposes in terms of social appropriability are reflected by a small impact of the externalities produced by technical progress (Herscovici, 2007);

ii) the institutional variables, as conceived in the regulationist or the neo-schumpeterian approach, have an important role: they define the specific ways employed to endogeneize externalities and the different effects of technical progress.

2.3 *The historical limits of the Baumolian models*

2.3.1 The R&D sector does not produce private commodities – these commodities must be conceived as *public good*s. As such, they are neither rivals nor exclusive: (a) the indivisibility of consumption is reflected by the fact that they can be consumed *in their entirety* by various economic agents simultaneously; (b) They produce positive externalities, and may be appropriated by agents who do not pay for the right to use them [3]. In this respect, the theories of endogenous growth emphasize this specificity.

---

[2] See Thirwall (2002), p. 45.

[3] Arrow, 2000.

Given these characteristics, it is not possible (a) to establish a linear relationship of inverse proportionality between price changes and decrease in quantity demanded (b) or between the amount "produced" and the aggregated effects. Thus, the mechanisms that correspond to the endogenization of r and Baumol's feedback relationship are not enforced.

2.3.2 There have been major changes in the forms of competition and in the economic nature of goods and services: competition is no longer price competition, but *quality competition*. In this regard, some economists conceived it as variety competition (Pascal Petit, 2005). Attempts to incorporate qualitative components in the construction of aggregates goes in the same direction [4]. In a more general way, *the relationship between costs and prices is not decisive concerning competitive dynamics*: in the case of network economy, the direct price paid by the consumer is no longer an important factor as other forms of income linked to *intermediate markets* are developed (two-sided markets) – the free or semi-free services illustrate this strategy (Herscovici, 2008).This contradicts the whole architecture of the different models built by Baumol.

2.3.3 Contrary to the hypothesis adopted by Baumol, expenditures on R&D commodities and service factors are not substitutable. In terms of industrial organization, these costs represent a means to build barriers to entry, and they are irreversible. Ultimately, *the presumed reversibility of these expenditures meets the conditions for formulating the contestable markets, notably, the absence of sunk costs.*

2.3.4 Finally, in regards to the modification of the IPR system and the income distribution modalities, the labor remuneration that produces innovation, i.e. information, is directly linked to rentier logic, and not to a wage one. The "information and knowledge economics" is characterized by the increasing socialization of knowledge production, according to the cumulative character of this type of production. On the other hand, the IPR system consists in internalizing the externalities from appropriate temporary monopoly rents.

The economic valorization of such production is particularly uncertain, in the sense that it is not regulated from a logic of costs, whether it is in terms of equalization between marginal cost and marginal product, or in terms of labor costs. So, this invalidates Baumol's assumptions once again.

[4] Hedonic prices, for example, and all the tentative in term of price and quantities, to incorporate qualitative indicators.

II) Elements for an alternative analysis

1) Some historical and methodological remarks

In industrial capitalism, the creation of value, or wealth, can be explained by the social labor applied to the production of commodities. Economic growth is measurable and depends directly on the gains in labor productivity. Unlike in the post-industrial capitalism, the historical forms of creation and appropriation of value have changed: the production of wealth, more specifically in the form of knowledge and information, is highly socialized. It is not possible to quantify the amount of direct and indirect labor required to produce a particular good or service. Likewise, it is possible to measure gains in labor productivity both at the sectorial and the national levels: the sectorial gains of labor productivity are the product of the stock of existing knowledge available to date, as well as its corresponding externalities.

The increased use of information and knowledge in the different services and products and in the different production processes results in a heterogeneity of labor, in a diversification of supply and its qualitative characteristics, and in a segmentation of the demand. The process of aggregation implies that (a) there is a unit of measurement common to all social objects; and (b) their qualitative characteristics are abstracted in the very process of aggregation. As a result, the instruments used to measure wealth creation, growth and productivity of production, are increasingly questionable:

i) The GDP, in the way it is currently conceived, is no longer able to measure the wealth produced. The qualitative component is underestimated. According to some assessments, the production of the immeasurable sectors represents 70% of total production (Griliches, 1994). The measure of labor productivity is the object of the same type of distortion.

ii) *Given the heterogeneity of the different labor processes, it is no longer possible to establish a linear relationship between productivity gains and output growth*. In other words, it is not longer possible to establish a positive correlation between a certain amount of labor and a particular product. In this respect, it is interesting to note that the very methods of income distribution have changed:

a) due to a lack of definition of the objects on which the IPRs act (Herscovici, 2007), it is no longer possible to assimilate the income from production factors to its contribution to product formation, as defined by the traditional neoclassical framework.

(b) On the other hand, Kaldor's second law is not verified: the growth of output is not necessarily reflected by an increase in global productivity as the increased demand relates only to certain sectors of the economy (Keynes, op . cit, p. 224). On the contrary, as shown by the different statistical data, technical progress and increased labor productivity are limited and do not spread to all the other sectors.

In regards to the heterogeneity of the different factors of production, especially capital and labor, we can observe changes in the modalities of income distribution: the relative share of non-wage income in GDP (financial capital, monopoly rents associated with ownership of IPR) increases in all countries. The economy based on wage labor is partially replaced with an essentially speculative economy.

In Keynesian terms, this can be interpreted as follows: the elasticity of employment is relatively weak and, in all cases, lower than the industry. In view of the speculative dimension and of the random valorization, this economy can be likened to a casino economy. Given these factors, the multiplier effect related to the development of all forms of intangible assets is relatively weak, and lower than that of the industry.

Ultimately, we need to place the problem concerning value creation, as highlighted in the hard-software dichotomy (see Table 2). Value creation is not implemented in industrial production, but in the production of intangible commodities. This enables us to provide a different interpretation of deindustrialization: *the decreasing weight of industry in GDP cannot be explained by the decrease in industrial activity in itself, but from the fact that the average value created in this sector is decreasing*. The increase in production volume does not correspond to a relative increase in the value thus created (Oreiro, op. cit, p. 2). In fact, part of the problem is explained by the changes in modalities of production and creation of value in the different sectors.

2) Economics of variety and qualitative competition

The modalities of competition have changed in a radical way due to the fact that the valorization of assets depends on the amount of information and codified knowledge incorporated. This is translated into significant changes concerning the modalities of consumption, production, and economic valorization.

On the supply side, the valorization of goods depends more and more closely on the information and knowledge embedded in them. The intangible component embedded in goods is a decisive factor concerning economic valorization. This depends less and less on the costs needed for production of materials, (namely, goods) and increasingly on information and codified knowledge. It is possible to talk about qualitative competition as the competition depends on the "complexity" and diversity of information embedded in those goods. *Competition is increasingly divorced from the productivity of factors, which highlights the limited explanatory power of the aggregates built by today's different systems of social accounting.*

This type of economy is not regulated from the labor theory of value. The prices are not determined from the direct and indirect labor costs. Similarly, the methods of value creation, namely wealth, have changed. (a) They are no longer linked to the quantity of abstract labor in the sense defined by Marx, they are no longer quantifiable and measurable; (b) with the development of activities related to intangible assets, and due to their social and cumulative dimension [5], it is theoretically impossible to measure the productivity of a given amount of labor. In view of this cumulative characteristic of knowledge production, it is impossible to (a) quantify the overall labor needed to produce a particular type of knowledge, as well as (b) evaluate the sectorial labor productivity. Given these factors, the second law of Kaldor loses its explanatory power.

[5] For example, it is impossible to evaluate the total quantity of labor necessary to produce a software, from the creation of the binary system, 5000 years BC, until the production of the algorithm necessary to produce the software

3) An alternative formalization

3.1 *The hypotheses*

We will consider the following three sectors: sector 1 is the stagnant sector in the sense defined by Baumol; sector 2 is the industrial sector (excluding the production of hardware), and sector 3 is the one that produces the ICT goods and services.

Hypothesis 1: There is an autonomous technical progress, which is translated into an increase in labor productivity in sectors 2 and 3.

Hypothesis 2: The goods and services of sector 3 are public goods.

The economic implications are the following: (a) the presence of externalities means that there is not an inverse relationship between price changes and changes in the amounts demanded; (b) the cost structure is such that average costs decline with consumption and that marginal cost is decreasing – prices are not determined by costs.

Hypothesis 3: Depending on the dynamics of the markets, the costs of R&D are irreversible. It is not possible to substitute the investments in R&D by other factors of production. At a microeconomic level, this hypothesis corresponds to the complexity of assets, or to an increased endogenous specificity of these assets (Saussier, Yvrande-Billon, 2007). Such investments are irreversible (Williamson, 2002).

Hypothesis 4: the competition takes place partly out of prices

Hypothesis 5: The valorization of goods and services of sector 3 is random.

We cannot build a production function in which the amount produced depends on the quantity of labor used. Labor is not homogeneous, and the randomness of valorization does not permit such a linear relationship.

Hypothesis 6: The growth rate of wage is determined by the average growth rate of labor productivity across the entire economy, r; only part of the productivity gains are passed on to wages. Moreover, the relative share of wages in GDP decreases, to the benefit of financial gains, profits and income related to intellectual property and innovation. This should be interpreted as a minor redistribution of productivity gains for the labor factor.

3.2 *The relations of the model*

3.2.1 *The functions of production*

$$Y1t = a\ L1t \qquad (1)$$

$$Y2t = b\ L2t\ e^{r2t} \qquad (2)$$

$$Y3t = c\ L3t\ e^{r3t} /\ \Omega \qquad (3)$$

ri represents the growth rate of labor productivity in sector i, r represents the average growth rate of labor productivity in the economy, and Ω, the random component on the valorization of output of sector 3. A series of industry studies show that the randomness of valorization is part of the strategies developed by different actors and is translated into an over-cost and/or an underproduction (Herscovici 2009, Nelson 2003).

3.2.2 *The evolution of costs*

Supposing that xi, yi and zi represent the technical coefficients of each sector, i.e. the amount of inputs that come from 1, 2 and 3.

The average costs are as follows:

$$C1 = \frac{We^{rt}\ (L1t + y1L2t + z1\ L3t)}{a.L1t} \qquad (4)$$

$$C2 = \frac{We^{rt}\ (\ L2t + x2\ L1t + z2\ L3t)}{b.\ L2t.e^{\ r2t}} \qquad (5)$$

$$C3 = \frac{W\ e^{rt}\ L3t/\Omega}{c.\ L3t\ e^{\ r3t}\ .\ n} \qquad (6)$$

n represents the number of consumers, the production of knowledge and information is characterized by the fact that the average cost decreases with the number of consumers.

C1 increases with time, as shown in equation (4). The evolution of C2 depend on r2; if r2 is greater than or equal to r, C2 decreases or is constant.

Following the analysis of Gordon, we have r3t> rt, consequently, C3 decreases. This decrease can be offset by an increasing randomness from Ω, and this is necessarily translated into an increase in transaction costs (Herscovici, 2009).

$$C3/C1 = \frac{we^{rt}\,[L3t/\,\Omega\,]}{c.\,L3t\,e^{\,r3t}\,.\,n} \times \frac{a.L1t}{we^{rt}\,(L1t + y1L2t + z1\,L3t)} \quad (7)$$

At the aggregate level, if the increase in Ω is less than er3t, C3/C1 decreases.

The value of Y3/Y1 = Y3/Y1. C3 / C 1. (8)

If the second term on the right decreases, the first one has to increase, so Y3/Y1 increases.

3.2.3 *The relationship between the production of information and productivity*.

The characteristics of public goods of Information and Knowledge do not allow establishing (as does Baumol) a linear relationship between (a) the variation in prices and demand information, or (b) between the production of information and increased productivity in all economy. Externalities and their modes of internalization based on the definition of the IPR system, represent a key variable. Thus, the more open the IPR system, the greater the aggregate effect of these externalities, and the higher the growth rate of labor productivity (Nelson, 2003).

The fact of considering that, in sectors 2 and 3, the technical progress is autonomous shows clearly that (a) contrary to the analysis of Baumol, the technical progress is not endogenous; (b) there is not a linear relationship between the production costs of this technical progress and production of innovations; and (c) due to the fact that the technical coefficients are constant, the price of innovation does not explain the level of its demand.

3.2.4 *The determinants of growth in overall productivity of labor*

We can define different forms of technical progress in relation to gains in labor productivity (Nordhaus, 2002, p. 215).

i) an autonomous technical progress, defined in an exogenous way, i.e. outside the model.

ii) The Baumol effect, i.e. the relationship between the growth of productivity gains in the sector and its relative share in total product. If the relative share of sectors with low

(high) productivity increases with time, global productivity gains of the economy will decrease (increase), as well as output growth. This mechanism corresponds to the model of 1967.

iii) An effect that measures the variation in productivity from the relative weight of inputs, i.e. an induced effect. This effect can be induced from a decrease in the value of inputs and/or the modes of internalization of externalities produced by these inputs.

With regard to industry, technical progress is largely autonomous. There is no correlation between the use of ICT and changes in labor productivity. The comparison between the EU and U.S. shows clearly that the Baumol effect was negative: a lower relative weight of industry accounts for a positive differential in productivity.

Concerning services, the induced effect explains the productivity gains and the Baumol's effect – the component that uses ICT sees its productivity increase as well as its relative weight.

Thus, the impacts of the new economy on productivity are twofold: (a) an autonomous and intra-sectorial technical progress deriving from the Baumol effect; (b) the technical progress that has induced a positive effect on the services.

These data demonstrate that the Baumol's effect (disease costs) has reached its limits. The sectors whose share of the GDP increases are those who have the biggest increases in the labor productivity growth rate (Nordhaus, 2002, p. 228). *The sector of services now partially internalizes the externalities produced by the technical progress. This can be explained both by the changing nature and function of this sector and by the changing nature of technical progress.*

$$r = \Phi (ri, yi/GDP, \delta ij/yi) \qquad (10)$$

ri represents the autonomous technical progress of sector i; yi/GDP represents the relative share of that sector in total output; and δij/yi represents the technical progress induced by the use of inputs that come from industry j, or the externalities generated by this sector. This approach is fundamentally different from Baumol's analysis. (a) part of the technical progress that is reflected in an increase in labor productivity is determined regardless of knowledge production; (b) the increase in global productivity can be explained by labor productivity in the ICT sector; and (c) the global productivity depends on the effects induced in different sectors and on their relative weights.

According to some assessments during the period, the new economy would be responsible for one third of the total increase in productivity (Nordhaus, 2002, p. 229). This can be explained by the relative weakness of the ICT sector and the impact limited to 26 % of GDP. Thus, two thirds of the productivity gains are related to progress alone.

Technical progress can be compared with the Schumpeterian grapes innovations, as they are determined in an exogenous way. Nevertheless, the pivotal role of these sectors is questionable. The weight of the dynamic sectors in the GDP accounts for only a little over 30% and the modes of internalizing externalities are highly selective.

Finally, the productivity gains achieved in the new economy seem limited. The average productivity gains are not more important than those that characterized Fordism. Moreover, the relative share of the component that experiences the highest productivity gains (hardware) is a weak part of GDP, while the stagnant component represents a twice as important relative part. This can be explained by the specific modalities of valorization of knowledge production ("logic of prototype"), and it emphasizes the limits of the new economy as a source of productivity gains in the long term.

Conclusion

In light of the macroeconomic modifications produced by the development to this "new economy", one could say that the industry can no longer be conceived as a leading sector. Thus, it does not produce a cumulative causation able to sustain a long-term growth. This type of analysis is no longer able to explain the current phase of the capitalist economies. They do not incorporate the major changes relating to methods of production, to modalities of appropriation of technical progress, and to their economic nature. The mechanisms used to build these models have the following characteristics: (a) demand growth is overall implemented by a redistribution of productivity gains for labor; (b) a large and undifferentiated appropriation of the externalities produced by technical progress, based on a relatively open IPR system; (c) in the sphere of non-differentiated offers, competition takes place on a price basis. These mechanisms are characteristic of the Fordist phase.

Today, changes in the nature of productive labor, of the externalities generated by technical progress, of modalities of competition, and of valorization allow us to question the explanatory value of economic growth models and tools built for measuring the main economic aggregates. The employment multiplier applied to these sectors is smaller, as well as its global impact in terms of increase in output and employment.

This type of problem highlights the lack of linearity between the different aggregates and the difficulty in building these aggregates. In this perspective, we must question the role of industry in the dynamics of economic growth, and thus redefine the general problem of deindustrialization.

Bibliography

Ark B. van , Inklaar R and McGuckin R, 2002, *"Changing Gear", Productivity, ICT and Services Industries: Europe and the United States*, Research memorandum GD-60, Groningen Growth and Development Center, December.

Ark Bart van, Ewout Frankema and Hedwig Duteweerd, 2004, *Productivity and Employment Growth: An Empirical Review of Long and Medium Run Evidence*, Research Memorandum GD-71, Groningen Growth and Development Center, May.

Arrow K, 2000, " De la rationalité de soi et des autres dans un système économique", *Théorie de l´Information et des organisations*, Edité et présenté par Thierry Granger, Paris, Dunod, 2000: 233-50.

Baumol W., 1967, "Macro-economics of unbalanced growth: the anatomy of urban crisis" , *American Economic Review*, 6/1967.

Baumol W., and Edward N. Wolff, 1992, "Feedback Between R & D and Productivity Growth: A Chaos Model", in *Cycle and Chaos in Economic Equilibrium*, Jess Benhabib, Princeton University Press.

Boyer R et Petit P., « Kaldor´s growth theory: past, present and prospects for the future" in Semmler W. and Nell E., editors, *Nicholas Kaldor and Mainstream Economics*, Mac Millan, p.485-517.

Bresser Pereira L.C., Gala P. *Macroeconomia estruturalista do desenvolvimento e novo desenvolvimentismo*, Trabalho escrito para o número 100 da Revista de la CEPAL, 2 de janeiro de 2010**.**

Feijo Carmen A, Tostes Lamonica M., 2007, *Crescimento e industrialização no Brasil, as lições das lei de Kaldor*, Encontro Nacional da ANPEC, Recife

Gordon R., 2000, "Does the New Economy Measure up to the Great Innovations of the Past", *Journal of Economic Perspective*.

Griliches, Z., 1994. "Productivity, R&D, and the Data Constraint." *American Economic Review 84*, no. 1 (March): 1-23.

Herscovici, Alain, 1994, *Economie de la Culture et de la Communication*. 1. ed. Paris: L'Harmattan.

----------, 2002, *Dinâmica macroeconômica: uma interpretação a partir de Marx e de Keynes*, EDUFES/EDUC, São Paulo.

----------, 2007, Capital intangível e Direitos de Propriedade Intelectual: uma análise institucionalista. Revista de Economia Política, São Paulo, v. 27, p. 54-76, 2007.

----------, 2008, Direitos de Propriedade intelectual, novas formas concorrenciais e externalidades de redes. Uma análise a partir da contribuição de Williamson. Rio de janeiro: UFRJ, 2008 (Série Seminários de Pesquisa/IE/UFRJ).

----------, 2009, Économie de la connaissance, Droits de Propriété Intellectuelle et coûts de transaction : limites des procédures de négociation privée et modalités de régulation alternatives.. In*: Forum de la régulation, 2009, Paris. Actes du Forum, 2009*.

Keynes, John Maynard**,** , *A teoria geral do emprego, do juro e da moeda*, Atlas, São Paulo, 1990

Nelson R., 2003, *The Market Economy, and the Scientific Commons*, Laboratory of Economics and Management, Sant'Anna School of Advanced Studies, Pisa, Working papers Series n.24.

Nordhaus William, D, 2002, Productivity Growth and the New Economy, *Brookings Papers on Economic Activity*, Vol. 2002, No. 2. (2002), pp. 211-244.

Oliner and Sichel, 2000, The Resurgence of Growth in the Late 1190s: Is Information Technology the Story, *Federal Reserve Board.*

Oreiro, José Luis, 2009, *Desindustrialização: conceituação, causas, efeitos e o caso brasileiro*, acessado em 25/01/2010: http://jlcoreiro.wordpress.com/2009/12/22

/desindustrializacao-conceituacao-causas-efeitos-e-o-caso-brasileiro/.

Petit, Pascal, 2003, 2003, Large network services and the organisation of contemporary capitalism, presented to the workshop *Globalization and diversity of Capitalism/New concepts for a Post-Neo-Liberal Era*, London School of Economics, June 23rd and 24 rd 2003.

----------, 2005, *Croissance et richesse des nations*, La Découverte, Paris.

Saussier Stéphane, Anne Yvrande-Billon, 2007, *Économie des coûts de transaction*, La Découverte, Paris, 2007.

Thirwall Anthony P. 2002, The nature of economic growth: on alternative framework for understanding the performance of nations, Edward Elgar Publishing Limited, UK

Williamson Oliver E, "The Theory of the Firm as Governance Structure: From Choice to Contract", *Journal of Economic Prospectives* – Volume 16, Number 3 - Summer 2002 (2002): 171-95.