

# “INADEQUACY OF TECHNOLOGY” AND INNOVATION SYSTEMS AT THE PERIPHERY: notes on Celso Furtado’s contributions for a dialogue between evolutionists and structuralists\*

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## INTRODUCTION

The polarization “modernization-marginalization” and its structural root are important subjects in Celso Furtado’s work.

Furtado’s main contribution to economic theory is on underdevelopment. The polarization “modernization-marginalization” is a feature of underdevelopment (Furtado, 1987).

In his view, underdevelopment is a historical process, a historical barrier to development, but a superable historical barrier. In his elaboration, there is a group of “high level underdeveloped economies”,<sup>1</sup> which involves countries like Brazil. UNDP (2001) shows how countries like India, South Africa, Mexico and Brazil combine traces of modernization with indicators of marginalization. This heterogeneity as a structural feature could be translated in a puzzle - the unequal and combined nature of their development (see D’Costa, 2002, for the Indian case). The puzzle is the combination of wealth and poverty, areas of technological development with areas of deep backwardness, in sum, modernization with marginalization. These social and historical features might be deeply rooted in their systems of innovation.

Therefore, the polarization “modernization-marginalization” would be relevant for the understanding of “high level underdeveloped economies” - economies that, at large, have immature national systems of innovation (Albuquerque, 2003).

The motivation of this paper is a result of previous investigation on the relationship between scientific and technological capabilities and human development in Brazil, taking the municipal level as reference (Machado et al, 2003). Not surprisingly, the results indicate the geographical co-localization (a sort of statistical correlation) between science and technology resources and indicators of poverty (slums, for instance). São Paulo and Rio de Janeiro are cities that concentrate *both* science and technology resources *and* slums. This co-localization is present in other Brazilian metropolitan regions.

In other words, a very preliminary investigation on geographical features of the Brazilian national innovation system (NSI, henceforth) identified a combination between “modernization and marginalization” (modern labs and slums, side by side).

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<sup>1</sup> In the original: “Economias subdesenvolvidas de grau superior”.

Furtado (1987, p. 33) links the polarization “modernization-marginalization” with “inadequacy of technology”.<sup>2</sup>

From the start it is necessary to differentiate Furtado’s concept from other versions of “inappropriate technology” (see section II.2). Amsden’s entry on “appropriate technology” (1987) describes some of these meanings, including the “small is beautiful” movement. Amsden makes no reference to Furtado’s interpretation.

This paper suggests that elaboration of Celso Furtado on this subject has a very specific meaning, and that this meaning is very important for the understanding of technological dynamics (or the limited nature of this dynamics) in peripheric countries.<sup>3</sup>

More specifically, it may be a contribution to the understanding of NSIs in the periphery.

First, it is a fine contribution for assessing the technological condition of underdevelopment. The inadequacy of technology helps the understanding of the uneven and combined nature of development, highlights the deep historical roots of some socially non-inclusive features of these societies. These features are reflected and might be present in the resulting (immature) systems of innovation. And Freeman (1995) stresses the need for historical perspective in the study of national systems of innovation.

Second, it may be a guide for the transformation of national systems of innovation at the periphery. In countries with immature systems, that in Furtado’s view face a “condition of stagnation at an intermediate level of development” (1986, p. 205), there is an important question: whether or not existing “islands of efficiency” will be able to push the rest of the country in a catching up process. This paper conjectures that this cannot be done without overcoming technological inadequacy. But, to overcome these deep-rooted problems is not an easy task. In evolutionary terms, the inadequacy of technology may point for a “lock in” condition not easy to overcome.

This paper focus on technological inadequacy may be seen as an attempt to connect two theoretical strengths (the evolutionary understanding of innovation and the structuralist approach of underdevelopment). The discussion on the inadequacy of technology is in the intersection between innovation systems and underdevelopment.

In sum, Furtado’s discussion on technological inadequacy presents a very interesting challenge to the elaboration of NSIs in the periphery, facing the question of how to escape the ever-repeating cycles of limited economic growth with permanent repositioning the polarization modernization-marginalization. To escape this repetition, catch-up is necessary and it should be supported by the maturation of NSIs. This maturation is for the breaking of the social perverse features that feeds the “modernization-marginalization” process. By its turn, this process of “modernization-marginalization” needs to be broken to allow the maturation of NSI.

And here there is the rub: how to break this negative feedback, this strong “lock in”?

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<sup>2</sup> In the original: “The inadequacy of technology perceived by Latin American economists in the 1950s was better defined in the 1960s, from a sociological standpoint, as a polarity of modernization and marginality” (Furtado, 1987, p. 223). It is noteworthy to stress the use by Furtado of the expression “inadequacy of technology” (“inadequação da tecnologia” in Portuguese versions), instead of “inappropriate technology”. The use of “inadequacy of technology” hints a different approach of the subject by Furtado, vis-à-vis the “inappropriate technology” approach (section II.2 discusses this differentiation).

<sup>3</sup> This paper focuses a very specific part of Furtado’s elaboration. For a deeper and broader discussion on Furtado’s seminal work, see Szmrecsányi (2001), Tavares (2000), Oliveira (2003), Bresser-Pereira & Rego (2001), among others.

## I. ENRICHING A DIALOGUE BETWEEN STRUCTURALIST AND EVOLUTIONARY THEORIES

Celso Furtado is a “pioneer in development” and a leading theorist of the structuralist school (Meier, 1987). The origins of the development theories during the 1940s and the 1950s are multi-national. Researchers from different countries - Lewis, Rosenstein-Rodan, Prébisch, Clark, Gerschenkron, Myrdal, Hirschman, and Celso Furtado, among others, according to Meier & Seers (1984) – were investigating different realities and different countries in Latin America, Asia, Africa and Southern Europe.

The development theory helped to shape developmental policies and strategies, implemented in a huge number of countries. Amsden (2002) describes the contributions of developmental states for the “rise of the ‘rest’ ”. Rosenstein-Rodan (1984, p. 221) has a positive evaluation of all this movement: “the post-war period of development is a history of triumph – not of failure.... A billion people are still hungry, but it would now be two billion without the achievements that have been made”. These pioneers, however, are not naïve and they have criticisms on the whole process: for instance, Prebisch (1984, p. 191) highlights the need to “combine development with social equity and political advances”.

Brazil, South Africa, India and Mexico are countries that implemented development policies in the post-war period. However, they haven’t overcome underdevelopment. They have reached a new stage, as “high level underdeveloped economies” (Furtado, 1986, pp. 144-146). After the decades of developmental policies, the world is more complex and the layers of development more numerous.

Brazil, South Africa, India and Mexico have other common features, characterizing their “high level underdeveloped economies”: heterogeneity is a structural feature of these countries, both in social, industrial and in the science and technology dimensions.<sup>4</sup> In terms of the literature of economics of technology these countries could be classified as “immature systems of innovation” (see data and references in Albuquerque, 2003).

To understand this set of countries with intermediate position (that could be called “high-level underdeveloped countries” by Furtado, the top of the “rest”, by Amsden, “semi-peripheral states” by Arrighi, “semi-industrialized countries” by Teitel or “immature NSIs” by this paper) a dialogue between evolutionists and structuralists seems to be necessary. This dialogue, of course, would improve the understanding of development in the 21<sup>st</sup> Century.

Explicitly or implicitly, there has been a systematic dialogue between the evolutionary and structuralist theories.

Explicitly, important scholars working at ECLA (a leading source of the structuralist approach) as Fernando Fanzylber and Jorge Katz discussed the role of innovation and change using evolutionary concepts since the 1970s and the 1980s.

Meirelles (1989, 1990), while working on NSIs, investigates the specificities of Latin America. Meirelles stresses the role of technology in Prebisch’s seminal work, emphasizing the contribution of the uneven distribution of the fruits of technical progress on the evaluation of the

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<sup>4</sup> Since the first works of the “pioneers in development”, heterogeneity is seen as a structural feature of underdevelopment (see Lewis, 1954, for instance). As time goes by, the complexity of this heterogeneity has increased.

center-periphery system. This role of technology, according to Meirelles, points to a theoretical affinity between the ECLA tradition and the “neo-schumpeterian” theorists (1990, p. 32).

Initiatives as Globelics (led by Lundvall, see [www.globelics.org](http://www.globelics.org)) and the Catch up Project (led by Nelson, see <http://www.globelics-beijing.cn/paper/Richard%20R%20Nelson.pdf>) are indications of the growing commitment of leading evolutionary theorists with development issues.<sup>5</sup> These initiatives express a dialogue between these two approaches.<sup>6</sup>

It is understandable that this explicit and implicit dialogue has been taking place. Taking as reference evolutionary theorists as Freeman, Nelson, Rosenberg and Dosi, and taking Celso Furtado as a representative of the structuralist theory, even a superficial reading of both approaches would find at least eleven points of identity and similarity:

- 1) the centrality of technology for development;
- 2) the key role of the capital goods industry for economic development;
- 3) a non mono-causal understanding of development process;
- 4) a non log-linear vision of economic development;<sup>7</sup>
- 5) history matters;
- 6) institutions matter;
- 7) a theoretical approach that includes dialogue with other social sciences for the understanding of development process;
- 8) the identification of huge concentration of technological resources in the central countries (divergence of technological capabilities) and its implication for international income concentration (income divergence);
- 9) a convergent intuition of the impact of income concentration and of limited internal markets on the economic processes;
- 10) “orientation of technological progress” as an important issue;
- 11) identification of “vicious circles” of poverty and stagnation.

An intensification of the dialogue between the evolutionary and the structuralist approaches would be a theoretical cross-fertilization, jointing forces as they put together the strongest points of each approach. The structuralists may learn a lot with the elaboration on national systems of innovation (that could be seen as a synthesis of previous elaboration from the evolutionary approach),

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<sup>5</sup> Nelson’s involvement with development issues is not new: in a 1956 paper, he discussed in a formal model the “low-growth trap” (Nelson, 1956).

<sup>6</sup> An indirect link could be added, as Abramovitz (1989) has among his references several “pioneers in development” (Clark, Rosenstein-Rodan, Young, Gerschenkron and Tinbergen). Nelson (1998) indicates the relevance of Abramovitz to evolutionists.

<sup>7</sup> Adelman (2001) in an interesting chapter presents the “three fallacies” of conventional growth economics: 1) “underdevelopment has but a single cause”, 2) “a single criterion suffices for evaluating development performance”, and 3) “development is a log-linear process”. Both evolutionist and structuralists do not incur in any of these fallacies.

while the evolutionists may learn a lot with the elaboration on underdevelopment and its multifarious causes.<sup>8</sup>

This dialogue would contribute for development theory because development today has dilemmas and issues that are not necessarily the same from the post-war period. This feature seems to escape scholars as Krugman, for whom the trouble with the post-war development theories seems to lay only in their lack of formal modeling (Krugman, 1993).

After the 1950s deep changes have taken place in the world. Inter alia, the underdeveloped world is more complex and variegated, the level of internationalization of societies and economies is deeper, two technological revolutions have taken place, and last but not least, the role of science and technology for the overcoming of underdevelopment is much more important now. These deep changes are enough to explain why the dialogue between evolutionists (with their concept of national systems of innovation) and structuralists (with their investigations of underdevelopment as an historical process) may contribute to understand the challenge of development in the 21<sup>st</sup> Century.

## II. INADEQUACY OF TECHNOLOGY AS AN ASSESSMENT OF UNDERDEVELOPMENT

Celso Furtado's major contribution to economic theory is on underdevelopment: underdevelopment is an "autonomous historical process" (1986, p. 146). As a historical process, underdevelopment has its own roots, related to the emergence of capitalist development, to the way that technological progress shapes the international division of labor, creating a dynamic center and a periphery in which development is mainly a responsive process. Therefore, underdevelopment is not a necessary phase of a historical process of development, a phase that would be automatically superseded as time goes by.

In his book *Criatividade e dependência na civilização industrial* (1978) Furtado presents the "emergency and diffusion of industrial civilization".

The emergence of industrial civilization is connected with the industrial and bourgeois revolutions. Two tracks of this civilization are: 1) firms, seeking accumulation; 2) social organizations, struggling for "social diffusion of the fruits of the growing labor productivity that feeds accumulation" (p. 23). This process involves a structural relation between: 1) the level of accumulation; 2) the sophistication of productive techniques; 3) the diversification of consumer patterns of individuals and collectivities (p. 32).

The diffusion of industrial civilization is a different process. Countries and regions that lagged behind the Industrial Revolution and its initial diffusion have three ways of "indirect access" to industrial civilization: Japan and the former USSR exemplify two ways. The third way is linked to "structural dependency", characterizing the case of Latin American countries.

Looking to cases like Brazil,<sup>9</sup> Furtado points that "integration in international markets ... is a way of access to industrial civilization, although in an indirect form" (p. 37). In this process, the

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<sup>8</sup> For instance, the word "underdevelopment" is not an entry in the index of *The Oxford Handbook of Innovation* (Fagerberg et al, 2004), although it has two important chapters on catching up (Fagerberg & Godinho, 2004; and Verspagen, 2004).

<sup>9</sup> One of Furtado's major books is a classic of economic history: "Formação Econômica do Brasil".

workforce's transfer from self-subsistence activities towards "coffee, cocoa, rubber and other plantations originated purchasing power in international markets. This buying power allowed access to the fruits of technical progress to parts of the population" (p. 37).<sup>10</sup> There is a sharp contrast between this way of indirect access and the others: "the consumer patterns have diversified with almost no evolution of productive techniques".

This specific "indirect access to industrial civilization is consequence of the structural rupture 'center-periphery'" that "...has ever since characterized the evolution of capitalism" (p. 37).

The industrialization of these economies with indirect access to industrial civilization is a result of the evolution of their "international relations". This evolution reflects both internal and external factors. The industrialization is a reaction to tensions in international relations, more precisely, to problem in payment balances.<sup>11</sup>

The specificity of the "dependent industrialization" can be seen clearly "in the evolution of internal social structures" (p. 40). The determinant of technology is the "diversification degree of the demand created by the social groups with indirect access to industrial civilization" (p. 41). The implications are noteworthy: 1) "the industrialization process assumes the form of an adaptation effort of the productive system to this sophisticated demand, with no links to pre-existing productive forces" (p. 41); 2) the result is a "capital intensive productive subsystem with no correspondence to the society's accumulation level, with *low capacity of new job creation*" (p. 41). If the starting point is a reality of "structural labor surplus" (or unlimited supply of labor, as Lewis puts forward), the results are socially perverse. And the dependence links renew themselves as time goes by.

The interconnections between new demand created by the center and the internal arrangements of countries shocked by the waves emanated from the Industrial Revolution created possibilities for development at the periphery. But the resulting social arrangements also created severe limits in the ability and will of local leading social groups to absorb technology from the center.

Underdevelopment is a stalemate, a "historical trap" (1992). But it is superable (surmountable): South Korea and Taiwan are two recent examples of how this "historical trap" can be overcome (1992, p. 51).<sup>12</sup>

## **II.1. Dependency, international division of labor and underdevelopment**

Prebisch elaboration on the concept of "center and periphery" stresses the role of technological progress from the beginning, paying attention to "the question of the international dissemination of technology and the distribution of its fruits" (1984, p. 176).

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<sup>10</sup> In the original: "A transferência de mão-de-obra de atividades de auto-subsistência" ... "para plantações de café, de cacau, de borracha e outros, dava origem a um poder de compra nos mercados internacionais, mediante o qual certas populações passavam a ter acesso aos frutos do progresso técnico".

<sup>11</sup> Suzigan (1986) presents a reinterpretation of Furtado's elaboration of the origins and beginnings of Brazilian industrialization.

<sup>12</sup> Evolutionists have been studying in depth South Korea and Taiwan, as examples of successful catching up process (for an up-to-dated survey, see Fagerberg & Godinho, 2004): this is another point for a dialogue.

Technology is a key factor for the understanding of development in Furtado's view. As Furtado puts forward, his starting point is "the relationship between underdevelopment and external dependency, from the standpoint of the effects of technological progress" (2003b, p. 7).<sup>13</sup>

For a dialogue with evolutionists it is important a comment on Soete's (1981) criticisms of the "technological dependency": Soete deals with less elaborated visions of the subject, therefore Furtado's elaboration is out of reach of his criticisms (by the way, Furtado is not among the authors discussed by Soete: the references are Sercovitch, Theotonio dos Santos, Merhav, among others).

There are two main criticisms from Soete.

First: "technologic self-sufficiency" is a problem and the theory misses the fact that countries like Sweden and Japan are "technological dependents" (p. 199). The definition of "technological dependency" is a deficit in the technological balance of payments (pp. 200-201).

Second: the "technological dependency argument" "seriously" underestimates "the benefits and dynamic spill-over effects of imported technology or the so-called 'transfer' of technology" (pp. 201). This criticism leads to a call for more investigations on the "crucial role for developing countries of the international diffusion of technology on development 'shortcuts'" (p. 204).

These criticisms have nothing to do with Furtado. He is very clear on the subject of self-sufficiency: "isolation is not a solution, the goal is to minimize the costs of dependency and to explore all ways to substitute *interdependency* for dependency" (1978, p. 114) (my italics, EA).<sup>14</sup> The reference for Soete's criticism in this point is Cardettini, for whom "total autarky would be the only state of the economy where technological dependence would not arise" (apud Soete, p. 199).<sup>15</sup> Furtado is also very clear on the subject of the role of foreign technology in his agenda for development, highlighting the need of a "huge effort for the assimilation of known techniques" (1968, p. 84-85).

Furtado's elaboration on dependency is much more sophisticated and nuanced than Soete's criticism of naive versions of dependency would suggest (underdevelopment is only a consequence of the rich countries that do not leave room for the poor countries...). In a 1966 book, Furtado distinguishes between external constraints to development (chapter 2) and the internal factors blocking development (chapter 3: limitations of internal market, nature of import substitution industrialization, impact of unequal income distribution, weakness of local capital goods sector). The bulk of the discussion suggested by this paper lies on the "internal constraints" to development (in this point probably lies the greater structuralists' contribution to the proposed dialogue). The need of changes in the international framework seems to be more consensual: UNDP (2001) is a good reference (IPRs, trade rules etc). Of course there is debate on the scope and speed of these changes. This need for change is highlighted in initiatives led by evolutionists as Globelics and the Catch-up Project. By the way, the reorganization of international relations is a persistent subject of Furtado work (see 1968, Part II; and 1986, Chapter 24, specially the topic "Restructuring the international economy").

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<sup>13</sup> In the original: "As relações entre o subdesenvolvimento e dependência externa, observados do ângulo dos efeitos do progresso tecnológico, são o ponto de partida de uma linha de reflexão..."

<sup>14</sup> In the original: "Se admitimos que o isolamento não é solução, o objetivo estratégico passa a ser minimizar o custo da dependência e explorar todos os caminhos que conduzem à substituição desta pela interdependência".

<sup>15</sup> O.Cardettini, (1976), *Technological dependency and self-reliance in underdeveloped countries*. Lima, STPI, mimeo.

In a synthetic definition of development, Furtado establishes the links between the dynamics of capital accumulation and innovation: “accumulation, through innovation, is only the vector for the introduction of changes in the productive system and in the social structures that is development” (1978, p. 48).<sup>16</sup>

Underdevelopment is “consequence of a disequilibrium in the assimilation of new technologies generated by industrial capitalism” (1992, p. 41).<sup>17</sup> A dependent economy is characterized by “the subordinate role of technological progress” (2003b, p. 107).<sup>18</sup>

## **II.2. An interregnum: What does differentiate Furtado’s approach?**

This section suggests that Furtado’s elaboration on inadequacy of technology is much more complex and nuanced than the meanings normally attached to “inappropriate technology”.

Amsden (1987) surveys the various meanings of appropriate technology in *The New Palgrave*. During the 1950s and 1960s the debate was on the subject of “choice of technique”, to maximize the output growth (Eckhaus, 1962 and Sen, 1964 are examples of this line), in the 1970s the debate was on the technology appropriate to maximize employment. Amsden (1987) mentions Schumacher’s *Small is beautiful* and a so-called Appropriate Technology Movement. For her, this movement identified appropriate technology and self-reliance.

In the intersection between evolutionists and structuralists, Meirelles (1989, pp. 147-156) discusses the “problem of appropriate technology”, specially the neoclassical version of the subject (Eckhaus, 1962). For Meirelles, a labor division between developed and underdeveloped countries in R&D activities is a necessary but not sufficient condition for an appropriate technology (p. 149). He articulates the technology used with the patterns of competition in operation (à-la Steindl), indicating the existence of “technical barriers” to the use of labor-intensive techniques. Correctly, Meirelles points that the goal of internal efforts on R&D cannot be to avoid “capital-intensification”. Therefore, capital-intensive techniques may be part of the appropriate technology solution.

Teitel (1978) summarizes the “conventional wisdom” on “inappropriate technology”: 1) Less-industrialized countries (LICs) are passive recipients of technology transferred from the industrialized countries (ICs); 2) that this technology is generally transferred *en bloc* with little or no adaptation; 3) that the prices of the factors of production are severely distorted in LICs, leading to excessive utilization of capital and underutilization of labor”. Teitel’s discussion is very interesting, and the results of his investigation useful for the criticism of naive versions of inappropriate technology. However, his investigation is centered around specific techniques and on efforts at firm level (and it is useful due to this focus: Teitel is discussing some “islands of efficiency” that exist in immature NSIs). The results are interesting both in the cases of success in adaptation of foreign technologies and in the cases of failure in this adaptation.

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<sup>16</sup> In the original: “... a acumulação é apenas o vetor que permite, através da inovação, introduzir modificações no sistema produtivo e nas estruturas sociais que chamamos desenvolvimento”.

<sup>17</sup> In the original: “... o subdesenvolvimento é fruto de um desequilíbrio na assimilação de novas tecnologias produzidas pelo capitalismo industrial”.

<sup>18</sup> In the original: “O que caracteriza uma economia dependente é que nela o progresso tecnológico desempenha um papel subalterno”.